Undergraduate Research Opportunities Program

Proceedings 2014-15

香港科技大學
THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

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* Abstracts from each School are listed first by alphabetical order of Department name, and then by alphabetical order of Advisor's surname.

Summary of UROP Courses

UROP 1000	Undergraduate Research Opportunities Program (0 credit with stipend option, offered in summer session only)
UROP 1100	Undergraduate Research Opportunities Program Series 1 (1 credit, offered throughout the year)
UROP 2100	Undergraduate Research Opportunities Program Series 2 (1 credit, offered throughout the year; prerequisite is pass in UROP1100, with approval by project advisor)
UROP 3100	Undergraduate Research Opportunities Program Series 3 (1 credit, offered throughout the year; prerequisite is pass in UROP2100, with approval by project advisor)
UROP 4100	Undergraduate Research Opportunities Program Series 4 (1 credit, offered throughout the year; prerequisite is pass in UROP3100, with approval by project advisor)

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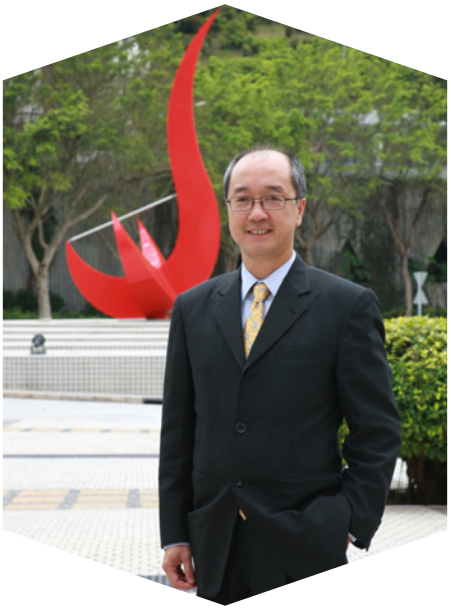
Message from the President



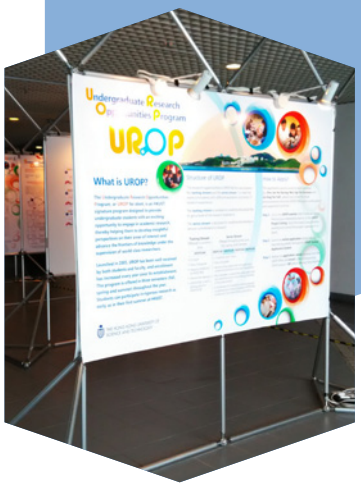
Commencing its 10th anniversary, the Undergraduate Research Opportunities Program (UROP), as a signature program at the Hong Kong University of Science and Technology (HKUST), has gained recognition from its faculty members as well as undergraduate students since its launch in 2005. In the 2014–2015 academic year, approximately 160 faculty members have offered over 300 research projects, and nearly 400 students have conducted research in their areas of interest.

The UROP has long been supporting the university's undergraduate educational framework by offering unique research opportunities and learning experience at HKUST. We value the importance of knowledge production from our students during their first stage of tertiary education. Through the UROP, students can apply their solid academic knowledge through hands-on experience by working alongside our world-class researchers. Moreover, participants are presenting opportunities for utilizing the most advanced and pioneering facilities that have been typically available only to postgraduate students in the past. Under the guidance of our faculty members who serve a supervisory role, our undergraduate students are committed to a wide range of projects, and their endeavors and hard work are summarized and showcased through these proceedings.

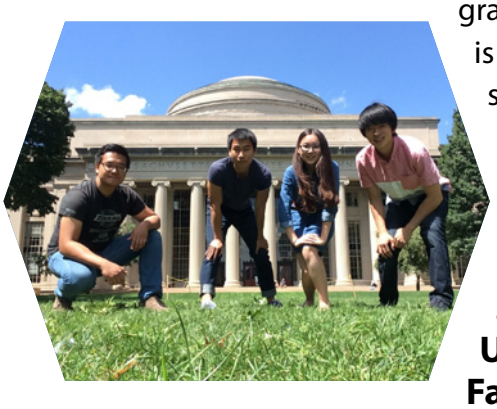
I hereby express my sincere gratitude to the faculty members for shouldering additional responsibilities beyond their routine lectures. With such stimulating and invaluable research opportunities, I call for the support and participation of all undergraduate students and faculty members to engage in the UROP in order to promote and cultivate the research culture among undergraduates at HKUST. I am certain that this will greatly enhance and uphold HKUST's reputation as a source of first-rate academic research.

Tony F Chan
President
HKUST

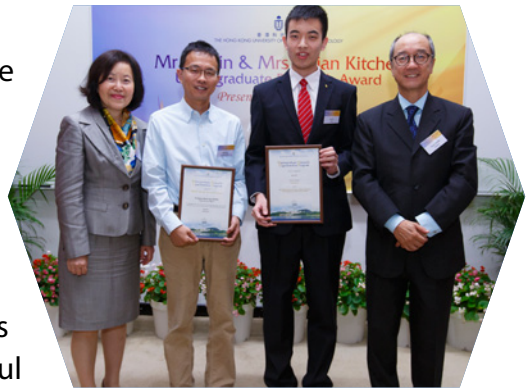
UROP Overview 2014–15



In the 2014–15 academic year, the Undergraduate Research Opportunities Program (UROP) continued to gain significant attention on the Clear Water Bay campus. Compared with the last academic year, the participation rate among faculty members rose by 10%, and that among undergraduate students rose by 6%. Approximately 30% of the university's faculty members have contributed to the program by offering over 300 projects this year, and nearly 400 undergraduate students have enrolled to the UROP to become involved with research in their early years. Of the many students who have joined the UROP since our establishment, approximately 30% have pursued postgraduate studies, either locally in Hong Kong or in leading overseas higher education institutions after graduation. These encouraging figures show that the UROP is an excellent platform for providing our undergraduate students the opportunity to consider research as a potential career, as well as for sustaining the popular research culture within our university community.



2015 Mr. Armin and Mrs. Lilian Kitchell Undergraduate Research Award and UROP Faculty Research Award



The Mr. Armin and Mrs. Lilian Kitchell Undergraduate Research Award was designed to highlight the outstanding performance of UROP students each year. In 2015, supervisors recommended 24 of their students, among whom 10 candidates were shortlisted and invited to provide a final presentation on their research findings to the UROP Advisory Board (composed of seven members from different schools). After a comprehensive and careful selection process, 6 awardees were announced at the UROP Award Presentation Ceremony held on April 14, 2015, on campus. This year, the first UROP Faculty Research Award was presented to the supervising team of each student awardee for their dedication to the UROP and efforts in supervising these students. To demonstrate their excellent research achievements, all 10 finalists' posters were exhibited and shared with fellow students at the UROP Showcase Corner in the Academic Concourse at HKUST during UROP Week 2015 (April 13 to 17, 2015).

SCHOOL OF SCIENCE

Modeling Protein–ligand Interactions by Using Docking and Other Computational Tools

Advisor: **HUANG Xuhui/CHEM**
Student: **POON Chung Yan/CHEM** **UROP Course: UROP1000, Summer 2015**

Molecular recognition in signaling pathways that are critical in many cellular processes occur when specific enzymes recognize the substrates. Drugs are specifically designed to bind to these corresponding receptors to alter these signaling pathways, the abnormal activity of which can contribute to the development of diseases. In the UROP 1000 course (Summer 2015), computer simulations and large-scale docking were conducted on a group of periplasmic binding proteins, with the goal of showing the relationships between the mechanism of protein structures in the recognition process, and its intrinsic dynamics were performed.

Development of Electrochemical Methods for the Quantitative and Selective Detection of Redox-active Small Molecules in the Life Sciences

Advisor: **LI Xiaoyuan/CHEM**
Student: **LAI Wing Sze/CHEM** **UROP Course: UROP2100, Fall 2014**

The dimension-activity relationship of Platinum working electrodes toward methanol electrooxidation has been of great interest in investigations on direct methanol fuel cell efficiency. For investigating this dimension-activity relationship, it is essential to determine the accurate electrocatalytic active surface area, which is then critical in representing the normalization factor for the catalytic activity determination of Pt electrodes at different dimensional scales and dimension-activity evaluations. Techniques including steady-state current and the underpotential deposition of hydrogen atoms were examined to evaluate the electroactive surface area. Discrepancies (by varying degrees) of area values determined using these techniques were noted among Pt electrodes, which were found to be related to the electrode dimensions and their correlated reaction pathways.

Application of Molecular Orbital Theory to Transition-metal Complexes

Advisor: **LIN Zhenyang/CHEM**
Student: **WAN Ho Chuen/CHEM** **UROP Course: UROP1100, Spring 2015**

Benzyne was first postulated by Georg Wittig in 1940, and was experimentally confirmed by Roberts in 1953. Because of the discovery of benzyne, the development of synthetic methodologies has been stimulated to render this highly reactive intermediate useful for organic synthesis. At present, various natural products have been prepared using benzyne as intermediates, such as dehydroaltenuene B, taxodione, and herbindole A (Scheme 1). However, benzyne is difficult to isolate because of its low stability. Metal substitution on the ring carbons of benzyne can stabilize benzyne to form metallabenzyne, but only osmabenzyne has been isolated and characterized by Prof. Jia and his colleagues. These metallabenzyne complexes can undergo many reactions and act as a reactive intermediate in catalysis processes. Investigations into the reasons metallabenzynes are more stable compared with benzyne is of interest, and thus, I have reviewed some of the literature on this topic, and the following is a summary of what I have learned.

Design and Synthesis of Functional AIE Luminogens and their Biological Applications

Advisor: **TANG Benzhong/CHEM**
Student: **LEE Wai Hang/CHEM** **UROP Course: UROP1100, Spring 2015**

Aggregation-induced emission (AIE) luminogens have great application values in bioscience. In this work, a new AIE luminogen has been synthesized for specific cell membrane imaging. Its aggregates emit bright greenish-yellow emission with large Stokes shift and strong single/ two-photon absorption. It can generate efficient reactive oxygen species upon photo-excitation, endowing it has potential to be used as a photosensitizer for photodynamic therapy.

Advisor: **TANG Benzhong/CHEM**
Student: **CHUNG Jin Teng/BCB** **UROP Course: UROP1100, Summer 2015**

The demand for functional AIE-active fluorescent luminogens is high because of its importance of biological applications. In this study, a new tetraphenylethylene (TPE) derivative with a large π-conjugation was designed and synthesized through multi-step reactions involving Sonogashira coupling, McMurry coupling, and Glaser coupling. The final product was fully characterized through NMR and mass spectrometries, and its absorption and emission properties were studied. The TPE compound exhibited typical AIE characteristics with long absorption and emission wavelength of 473 nm and 608 nm, respectively. In addition, with alternate fuming between HCl and NH_3 gases, it exhibited a reversible color change because of protonation and deprotonation. Therefore, it has great potential as a fluorescent probe for intracellular pH sensing in living cells.

Development of Fluorescent Bioprobes with an Aggregation-induced Emission Characteristic

Advisor: **TANG Benzhong/CHEM**
Student: **PARK Hojeong/BCB** **UROP Course: UROP1000, Summer 2015**

Fluorescent dyes have become increasingly crucial in cell biology because they enable the visualization of morphological changes in specific organelles. To study the morphology of specific organelles, particular photostable fluorescent dyes are required. Therefore, for this study, mitochondria- and lysosome-targeting dyes were synthesized by linking triphenylphosphine (TPP) and 4-(2-aminoethyl)-morpholine groups with a near-infrared emissive fluorophore, which exhibits aggregation-induced emission characteristics. These highly specific dyes may facilitate the studies of the intracellular reaction kinetics and the mechanisms of targeting organelles. In addition, they may further assist in developing diagnostic and treatment strategies against intracellular organelles dysfunction related diseases.

Division of Life Science

Characterization of Suppressor Mutations that Antagonize the Body-Size Control

Advisor: **CHOW King Lau/LIFS**
Student: **WONG Chi Fung/BCB** **UROP Course: UROP1100, Spring 2015**

The *lon-1* downstream target is negatively regulated via the bone morphogenetic protein pathway. Its expression in hypodermal cells inhibits endoreplication, leading to the tight regulation of the growth in the body length of *Caenorabditis elegans* (*C. elegans*). Screening and characterizing the suppressor mutations of *lon-1* might shed light on potential factors that interact with LON-1 for endoreplication regulation, or on components in other unknown pathways that also affect body-size control. The mutant allele *wx132* was found to suppress the Lon phenotype caused by *lon-1* mutation. Furthermore, *wx132* might be responsible for a new big-head phenotype that was identified at the L1 stage which disappeared in the adult stage.

Advisor: **CHOW King Lau/LIFS**
Student: **WONG Man Chun/BCB** **UROP Course: UROP1000, Summer 2015**

In *Caenorhabditis elegans* (*C. elegans*), the bone morphogenetic protein pathway plays a critical role in controlling the body size of *C. elegans*. This pathway negatively regulates the *lon-1* downstream target. It exerts its effect in the hypodermis, which is the focus of body-size determination. *lon-1* inhibits hypothermal endoreduplication, and thus, it regulates the body size of *C. elegans*. Screening and characterizing the suppressor mutations of *lon-1* might shed light on potential factors that interact with LON-1 for the regulation of endoreduplication, or on the components in other unknown pathways that also affect body-size control. The mutant allele *wx127* was identified, which can suppress the long phenotype of the *lon-1* mutant. The characterization and mapping of this allele are the primary focus of this project.

Construction of a Signal Transduction Pathway Reporter Indicator for Monitoring Signaling Strength

Advisor: **CHOW King Lau/LIFS**
Student: **SO Chui Wa/BCB** **UROP Course: UROP1100, Fall 2014; UROP2100, Spring 2015**

Transforming growth factor-β (TGF-β) signaling is a signal transduction pathway conserved in eukaryotic animals for development and homeostasis. In nematode *Caenorhabditis elegans*, the DBL-1 ligand of TGF-β signaling is involved in body-size regulation. Because the effect of DBL-1 on body size is dose dependent, measuring the DBL-1 signaling strength is crucial for studies on the mechanisms and components of the DBL-1 pathway. However, conventional methods for quantifying the signaling strength require the extraction of molecules such as RNA and proteins as well as sophisticated equipment. In this project, we constructed transcriptional reporters to identify DBL-1 signaling strengths in *C. elegans*. The aim was to devise a rapid and easy method for measuring the signal strength of a transduction pathway.

Advisor: **CHOW King Lau/LIFS**
Student: **CHOW Chiu Cheuk/BIOT** **UROP Course:** **UROP1000, Summer 2015**

Pathways related to transforming Growth Factor-β (TGF-β) are vital to eukaryotic organisms, and are conserved in *Caenorhabditis elegans*. One of these TGF-β related pathways, the DBL-1 pathway, has a significant effect on the body size and male ray pattern of *C. elegans*. Because the DBL-1 pathway is dose dependent of its signaling ligand, the signaling strength should be quantified precisely for studying the DBL-1 pathway; hence, a transcriptional reporter is being devised and injected into *C. elegans*. In a previous study, 2 reporters, *wrt-4p(2kb)*::*nls.gfp.lacz* and *wrt-4p(3kb)*::*nls.gfp.lacz*, were constructed, but no GFP signal could be observed from the transgenic line because the cis-regulatory information in the promoter might be insufficient to induce transcription. The characterization of the existing reporter, its modification to optimize the reporter signal with the inclusion of the Open Reading Frame (ORF) plus the 3' Untranslated Region (3'UTR) of *wrt-4* was performed. I show that this *4p(3kb)*::*nls.gfp.lacz* is a robust reporter marker to reflect the activity of BMP signal in the hypodermis

Monitoring Endoreduplication Event in Epithelial Tissue

Advisor: **CHOW King Lau/LIFS**
Student: **CHIU Man Chun/BISC** **UROP Course:** **UROP2100, Fall 2014; UROP3100, Spring 2015**

Endoreduplication is the replication of a nuclear genome in the absence of cell division, which results in an elevated nuclear genome content and polyploidy. To monitor the endoreduplication event and discern how it is regulated, I aim to construct a molecular reagent that is indicative of the ploidy in cells. I aim to use the fluorescent fusion protein as the reporter to indicate the DNA content of targeting cells. Plasmids containing a tissue-specific promoter, the coding sequence of a DNA-binding protein, and a fluorescent protein tag will be constructed and injected into the model organism, *Caenorhabditis elegans*. The successful deployment of the indicator reagent in live tissue will provide a useful tool for live animal studies and tissue ploidy analysis.

Control of Cell Numbers in the Brain

Advisor: **HERRUP Karl/LIFS** **Co-advisor:** **HUNG Siu Chun/LIFS**
Student: **CHUNG Yin Kwan/SSCI** **UROP Course:** **UROP1100, Summer 2015**

A data set was statistically tested before confirming the nature of distribution. Several counting sessions have been conducted on mouse brain neurons: despite its inability to present a multimodal distribution, the results confirmed that Herculano-Houzel's number of counting sessions conducted reflects a considerably high statistical power for distinguishing between two population means. The scatter plot showing the distribution of neuron numbers across the mouse population from Herculano-Houzel was observed to be multimodal. This paper reports on power analysis based on our counting sessions. The chi-squared normality test was performed to test whether the distribution was normal. Its effectiveness in rejecting the normality of the distribution is also discussed.

Advisor:	**HERRUP Karl/LIFS**	**Co-advisor:**	**HUNG Siu Chun/LIFS**
Student:	**TI Chun Hang Eden/SENG**	**UROP Course:**	**UROP1100, Summer 2015**

The possibility exists that the number of cells in the cerebellum of mice of the same species follows a multimodal distribution, and this warrants investigation. We improved the current counting techniques to ensure more precise data collection. In addition, after obtaining the correct amount of data, we developed a model that can simulate the expected multimodal distribution, and determine the factors that are critical in forming the required distribution. The model presented evidence that even the distribution was normal, although this does not signify the nonexistence of multimodal distribution. Moreover, the trend of the distribution from the actual data fits the model, which warrants further investigation using modeling techniques.

Advisor:	**HERRUP Karl/LIFS**	**Co-advisor:**	**HUNG Siu Chun/LIFS**
Student:	**WANG Qingyang/SSCI**	**UROP Course:**	**UROP1100, Summer 2015**

The distribution of the number of brain cells can offer considerable information to the prenatal development literature. The control of the number of brain cells can be regarded as an integrated result of the clone size and number of progenitor cells. Based on the distribution, whether intrinsic or extrinsic factors are affecting the two determinants can be investigated. The proposed hypothesis stipulates that the clone size of each cell is controlled intrinsically, whereas the number of progenitor cells may differ across individual cells within the same strain. A multimodal distribution is expected for the hypothesis. The isotropic fractionator was used as the method to obtain the cell count, and homogeneous cell suspension was applied in the method, which provides greater convenience and ensures accuracy. Using this method, the hypothesis can be investigated to a certain power, which was calculated by performing power analysis and modeling in this preliminary experiment. From the data obtained to date, we hold an optimistic attitude in validating the hypothesis with these data. In addition, excellent precision in the control of brain cell numbers may be revealed through the analytical results.

Visualization of Macromolecule Dynamics within the Contractile Band during Cytokinesis of Early Zebrafish Embryos

Advisor:	**HO Sarah Elizabeth/LIFS**	**Co-advisor:**	**MILLER Andrew Leitch/LIFS**
Student:	**AW Jacqueline Theeng Mei/BCB**	**UROP Course:**	**UROP1100, Summer 2015**

In zebrafish embryos, calcium signaling is required for the final stage of cell division during cytokinesis. The endoplasmic reticulum (ER) is the primary store for generating these calcium transients. However, regarding the depletion of calcium in the ER, the components of store-operated calcium entry (SOCE) are required for replenishment. In this project, the localization of STIM1, a component of SOCE, was examined. Newly fertilized, dechorionated embryos were fixed at 35 min, 40 min, 45 min, 50 min, and 55 min post-fertilization (mpf), and they were then immunolabeled for the STIM1 protein and visualized using confocal microscopy. STIM1 was found to have dynamic localization during cell cleavage, starting from the early stages of cytokinesis.

Biochemical Characterization of Histone Variants and Post-translationally Modified Nucleosomes

Advisor: **ISHIBASHI Toyotaka/LIFS**
Student: **PANG Yu Hin/BCB** **UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**

The nucleosome is a critical structure that is directly responsible for the tight packing of DNA in the nucleus. Its physical characteristics and biological functions are known to be affected by the identity of its constituent histone proteins. The aim of this study was to determine the stability of nucleosome-containing histone variants H2B.FW153 and H2B.FW175. The preliminary salt stability assay results revealed that the H2B.FW153 nucleosome is more stable compared to canonical nucleosomes, and the H2B.FW175 nucleosome was extremely destabilized in an environment with higher ionic strength. This progress report outlines the used protocol and provides a brief description of the current status.

Development of a Pollution Assessment Model: Die-off Rate of Sewage-associated Bacteria in the Marine Environment of Hong Kong

Advisor: **LAU Stanley Chun Kwan/LIFS**
Student: **CARIM Sean/BIOL** **UROP Course:** **UROP1100, Fall 2014**

Net phosphate-uptake (P-uptake) by unknown polyphosphate-accumulating organisms (PAOs) was measured in a laboratory-scale reactor that performed novel sulfur-cycle-enhanced biological phosphate removal (EBPR) wastewater process. Sludge samples from the reactor were stored at -20°C for subsequent identification and characterization of the P-uptake biological entity. The research detailed here involved the comparison of different sludge agitation techniques that aimed to facilitate the visualization of the PAOs using fluorescence microscopy. The sonication of resuspended 10 mg sludge samples at an output of 2 with a 10% duty cycle for 30 s yielded the most dispersed PAOs per microscopic view. This agitation will be used in subsequent fluorescence in situ hybridization (FISH) studies to identify the unknown PAOs with as substantially precision as possible.

Keywords: sonication, phosphate-accumulating organisms, fluorescence microscopy.

Evolutionary Relationship between *E. coli* Strains Isolated from Marine Waters in Hong Kong

Advisor: **LAU Stanley Chun Kwan/LIFS**
Student: **NGAN Tsun Tat/BCB** **UROP Course: UROP1100, Fall 2014**

The UROP 1100J project (Fall 2014) "Evolutionary relationship between *E. coli* strains isolated from marine waters in Hong Kong" was an investigation of the genetic diversity of *E. coli* strains found in Hong Kong. It involved the determination of the genetic differences between animal-host-associated *E. coli* strains and environmental *E. coli* strains. My role in the project was to identify the *E. coli* strains by examining their seven house-keeping genes (adk, fumC, gyrB, icd, mdh, purA, and recA) using polymerase chain reaction and agarose gel electrophoresis. The seven trimmed house-keeping genes of each sample were combined into a single sequence using Bionumerics and were incorporated into a phylogenetic tree for further study of the genetic relationships.

Advisor: **LAU Stanley Chun Kwan/LIFS**
Student: **PANG Yu Hin/BCB** **UROP Course: UROP1100, Fall 2014**

Escherichia coli is a gram-negative bacteria commonly found in the gut of warm-blooded animals. The traditional belief is that *E. coli* is quickly eradicated after the ejection from its primary habitat (the gastrointestinal track of animals) into the secondary habitat (the environment external to the animal host), and that it is unable to proliferate under the harsh environmental conditions. Thus, it is considered a good indicator of fecal contamination, and the Environmental Protection Department adopted *E. coli* count as the beach water quality indicator in Hong Kong. Yet, a seemingly separated group of microorganisms capable of surviving in external environmental conditions, one that highly resembles *E. coli*, has been discovered in recent years. This finding challenges the viability of using the *E. coli* count as an indicator of fecal contamination. This research project investigated the evolutionary relationship between *E. coli* strains isolated from marine waters in Hong Kong using multiloci-sequence typing and phylogenetic analysis. This report is a summary of the project, the methodology used, the results obtained, and my personal reflections after joining this project.

DNA Replication in Human Cells

Advisor: **LIANG Chun/LIFS**
Student: **KONG Mingpeng/BCB** **UROP Course: UROP1100, Spring 2015**

The Arl13b, ADP-ribosylationfactor-like 13B, is an atypical GTPase in a member of the Arf (ADP-ribosylation factor)/Arl (Arflike)-family. The Arl13b facilitates primary cilium formation and cancer-related signaling pathways; thus, we propose that it is involved in tumorigenesis and cancer development through unknown mechanisms. The objective of our research is to uncover the role of Arl13b in cancer cell migration, and the effect of the presence and defects in Arl13b on the occurrence and rate of cancer cell migration, which were incubated in vitro. This report mainly details the preparation procedures for Arl13b-EGFP plasmid construction, which provides materials enabling further observations of cancer cell formation and migration rate measurements.

DNA Replication-initiation Proteins in Budding Yeast

Advisor: **LIANG Chun/LIFS**
Student: **JIANG Yuanbing/BCB** **UROP Course: UROP1100, Fall 2014**

DNA replication-initiation proteins play a key role in regulating DNA replication. Several types of proteins interact with each other to form functional complexes. Because the interactions between different proteins and domains are unclear, the objective of this experiment was to subclone the hCDC6 gene and provide raw materials for further yeast two-hybrid operations with Human DNA replication-initiation protein ORC and MCM. During the experiment, several methods are required, including polymerase chain reaction, restriction digestion, and agarose gel electrophoresis. By identifying the DNA expression and concentration conditions after plasmid transformation and subcloning, multiple hCDC6 DNA sequences can be obtained. At the end of this report, more details of the future study plan regarding the yeast two-hybrid are discussed.

DNA Replication-initiation Proteins in Human Cells

Advisor: **LIANG Chun/LIFS**
Student: **HUANG Xiner/SSCI** **UROP Course: UROP1000, Summer 2015**

Cancer has become the second most common cause of death for humans. Most occurrences and developments of cancer can be traced to mutated or deregulated expressions of a series of genes. Scientists have recently discovered that the deregulation of the claudin (CLDN) multigene family in cells might have a relationship with cancer. Therefore, we aimed to determine whether we could detect or even treat cancer by controlling the expression of these genes. To validate its practicability, we first need to identify the relationships between the deregulation of CLDN genes and cancer. Therefore, we extracted RNA from normal cells and cancer cells, and employed reverse transcription to obtain the relevant cDNA. Afterward, we performed real-time polymerase chain reaction to amplify the target genes before comparing the expressed quantity in both groups. The results revealed that most CLDN genes under examination were expressed more significantly in cancer cells, and this approach may be used for the detection and/or treatment of cancer.

Keywords: cancer, CLDN genes.

Advisor: **LIANG Chun/LIFS**
Student: **SHIN Soo Kyung/SSCI** **UROP Course: UROP1000, Summer 2015**

DNA replication is a critical process that occurs during the S-phase of the cell cycle in human cells. In this study, to determine cell cycle progression and DNA replication in human cells, we adopted HeLa cells as a model and cultured them in a controlled environment. By using mainly mimosine and nocodazole blocks, we synchronized, released, and harvested the cells to obtain the cell population at different phases.

For this report, the collected cells were subjected to FACS analysis, and the result was examined extensively, which is discussed to enhance our understanding of how DNA replication plays a crucial role in the cell cycle of human cells.

Mechanisms of Lung Cancer Metastasis

Advisor: **LIANG Chun/LIFS**
Student: **ANIRUDH Vaishak/BISC** **UROP Course: UROP1000, Summer 2015**

Lung cancer metastasis is characterized by the massive proliferation of cells. The FOP gene plays a major role in metastasis. We first transfected A549 cells with an FOP–GFP construct to increase the expression of the gene. Afterward, we performed western blotting, and found that the cell overexpression of FOP exhibited higher levels of p53, a tumor suppressor gene. We then employed the MTT assay to measure cell proliferation as well as the wound-healing assay to measure cell migration. The results revealed that the cells overexpressed with FOP have higher rates of proliferation and migration, indicating that the gene could be involved in lung cancer metastasis.

Advisor: **LIANG Chun/LIFS**
Student: **FONG Chun Ki/BCB** **UROP Course: UROP1000, Summer 2015**

The purpose of this experiment was to test the efficiency of two types of anticancer drugs: Camptosar and Baileyolin. Human lung adenocarcinoma A579 cells with different concentrations of these drugs were used; the absorption values at 450 nm were then measured. The ratio of the resultant cells' absorption value to the control were then calculated, and the experimental result revealed that Camptosar and Baileyolin are most effective at a concentration of 1 ug/mL and 100 ug/mL, respectively.

Advisor: **LIANG Chun/LIFS**
Student: **LIU Yang/SSCI** **UROP Course: UROP1000, Summer 2015**

The purpose of Origin Recognition Complex (ORC) in eukaryotic cells is in facilitating the assembly of pre-replication complexes (pre-RCs) on chromatin by choosing specific sites. The quantity of chromatin-bound ORC is consistent during DNA replication, and recent studies have reported the existence of an "ORC cycle," which restricts the function of pre-RCs during DNA replication. However, the details of the ORC cycle in different types of mammalians remain unknown. Previous studies have presented two hypotheses on the mechanism regarding when and how ORC combines to newly synthesized origins during the entire cell cycle. We are employing a chromatin-binding assay with western blotting to determine when the ORC binds to newly synthesized chromatin.

Water Quality Survey on Hong Kong's Marine Fish Farming Zone

Advisor:	**LIU Hongbin/LIFS**	**Co-advisor:**	**LAU Wing Keung/LIFS**
Student:	**NGAN Tsun Tat/BCB**	**UROP Course:**	**UROP1100, Spring 2015**

A monthly survey of the water quality of marine fish farming locations was conducted under an on-going survey contract with the Agriculture, Fisheries and Conservation Department. The objective of this study was to check whether the environmental conditions were suitable for fish culturing by regularly monitoring the water quality at fish culture zones. Water samples from different water levels were taken biweekly or monthly from fish farming locations around Hong Kong's coastal waters. A list of hydrographic, water chemistry, and biological parameters, including the temperature, salinity, dissolved oxygen, inorganic nutrients, chlorophyll concentrations, total suspended solids, and bacteria abundance, were measured. In this project, the levels of suspended solids, which were a physical parameter obtained from the suction filtration of the water samples collected from different geographical locations, were investigated.

Advisor:	**LIU Hongbin/LIFS**	**Co-Advisor:**	**LAU Wing Keung/LIFS**
Student:	**CHAN Cheuk Yan/BISC**	**UROP Course:**	**UROP1000, Summer 2015**
	NG Cho Fung/BISC	**UROP Course:**	**UROP1000, Summer 2015**
	YEUNG Chun Chung/SSCI	**UROP Course:**	**UROP1000, Summer 2015**

Twenty-six designated marine fish culture zones are distributed in Northeastern, Eastern, and Southern Hong Kong. Monitoring the water quality of these fish farming zones is a critical duty of the AFCD, because water quality is directly related to the health of fish and citizens. A water quality survey has been conducted in these culture zones since June 2012. We cooperate with the AFCD for collecting samples from these core zones biweekly and from the non-core zones monthly. In addition, further analyses are conducted such as on suspended solids, chlorophyll a, and nutrients (N, P) to monitor the water quality. For example, chlorophyll a can indicate the level of phytoplankton biomass. These three parameters are measured and discussed.

Intrinsic Mechanisms Regulating Adult Axonal Regeneration

Advisor: **LIU Kai/LIFS**
Student: **LIU Binkai/SSCI** **UROP Course: UROP1100, Summer 2015**

Patients with central nervous system (CNS) injuries have always had difficulties recovering. At present, scientists mostly focus on external forces for inducing axon regeneration. However, when we conducted observations on the intrinsic mechanism of axon growth, we found that the deletion of PTEN (the phosphatase and tensin homolog) negatively affected the mammalian target of the rapamycin (mTOR) pathway, which robustly promotes axon regeneration in adult retinal ganglion cells after optic nerve injuries. Following this concept, we aimed to devise a convenient tool for the precise manipulation of the pten gene. A clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated (Cas) protein 9 system (CRISPR/Cas9 system) is the updated tool we are using in our experiments. To apply this system on the pten gene in the dorsal root ganglion (DRG) cell culture, we have to design a px601 construct carried by both Cas9 and pten single-guide RNA (sgRNA) and transfect it into adeno-associated virus (AAV) to produce a large quantity of the virus carrying the AAV–pten CRISPR/Cas9 system, which enables us to add it to the DRG culture. After a controlled time under incubation, we may test the efficiency of this system on the pten gene throughout different times in vitro, and devise a timetable for the most suitable manipulation of the system on the pten gene.

Building Real-time Single Organelles Tracking the Microscopy Setup by using Optics

Advisor: **PARK Hyo Keun/LIFS**
Student: **WAN Yeuk Ling Ricky/PHYS** **UROP Course: UROP1100, Spring 2015; UROP2100, Summer 2015**

This report focuses on an experiment involving florescent molecules, optical systems, and corresponding data analysis. For florescent molecules, Cy3 and Cy5 are key for measuring the energy transfer. Optical systems include the IX73 inverted microscope and other components and equipment connected to the laser. Different precautions and functions are described as follows. Data analysis involves the use of ImageJ and MATLAB after CCD-receiving light signals, which are crucial for determining the energy transfer. We hope that more advanced experiments (e.g., those measuring the step size of molecules) can be performed after gaining a more in-depth understanding of the setup.

Targeting Mitotic Regulators in Cancer Cells for Potential Treatment

Advisor: **POON Randy Yat Choi/LIFS**
Student: **SO Wai Lam Raphaella/BCB** **UROP Course:** **UROP1100, Fall 2014**

Haspin, a serine/threonine kinase, phosphorylates histone 3 at threonine 3 to facilitate centromere recruitment of the Aurora B complex. Aurora B kinase (AURKB) plays a major role in mitosis, including in phosphorylation, the biorientation of chromosomes, the recruitment of proteins to the kinetochore, and the maintenance of the spindle-assembly checkpoint. The drug 5-Iodotubercidin (5-Itu) is a specific and potent inhibitor of Haspin. Previous studies have reported that 5-Itu causes anomalies in the kinetochores and chromosomes, and compromises the spindle-assembly checkpoint. This project explored the effects of 5-Itu on the entire cell cycle. The experimental findings revealed that 5-Itu prolonged mitosis as well as the S/G2 phase and promoted apoptosis during mitosis in a dose-dependent manner.

Advisor: **POON Randy Yat Choi/LIFS**
Student: **TANG Tsz Ching Chloe/BCB** **UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**

Thyroid hormone receptor interactor 13 (TRIP13) has been studied at length through its role as pachytene checkpoint 2 (Pch2) in *Saccharomyces cerevisiae* and *Caenorhabditis elegans*. One recent report indicated that TRIP13 is involved in DNA damage in human cells through the promotion of non-homologous end joining. However, its role in DNA damage response is not fully understood. In this study, we focused on the localization of TRIP13, because it can yield insights into the function of TRIP13 for further study. We found that TRIP13 localized mostly in the cytoplasm during the interphase, and localized specifically on chromatids when the cell underwent mitosis. We also found that TRIP13 knockout did not result in differences in p53, p21, and MDM2 expression levels, and did not cause significant differences in the DNA content of the cells. These data suggest that the relationship between TRIP13 and DNA damage may be more complex than previously thought. Further studies are required to elucidate the detailed relationship between TRIP13 and DNA damage responses.

Microtubule Regulation during Cell Proliferation, Migration, and Morphogenesis

Advisor: **QI Robert Zhong/LIFS**
Student: **LAU Pwu/BIOT** **UROP Course:** **UROP1100, Spring 2015**

The Bac-to-Bac® system has been proven to be a robust tool for recombinant proteins in insect cells. This report presents a discussion on the procedure and applied methods in the construction of the Bac-to-Bac® expression system. The pFastBac™ HT B is used as donor plasmids, into which the gene(s) of interest are cloned with the aid of restriction enzymes. The selection of recombined plasmids is conducted by identifying *E. coli* transformants that are resistant to ampicillin. The purified plasmid is then transformed to DHA10Bac™ *E. coli* to produce recombinant Bacmid, which is determined with blue/white selection. After isolation and analysis, the Bacmid is ready for transfecting insect cells and producing recombinant Baculovirus.

Advisor: **QI Robert Zhong/LIFS**
Student: **LUI Ming Hong/SSCI** **UROP Course: UROP1100, Summer 2015**

TOM20 is a protein targeting the outer mitochondrial membrane used for importing cytosol proteins to the mitochondria, and CDK5RAP2 is a protein that recognizes the γ-tubulin ring complex, which enhances microtubule nucleation substantially. In this study, we used an array of molecular cloning methods from polymerase chain reaction to bacteria transformation, in addition to mammalian cell expression, to create a DNA sequence with the aim of rendering the fusion protein TOM20-EGFP-CDK5RAP2 to be translated inside the U2OS mammalian cells. The experiment was successful until the creation of the EGFP-CDK5RAP2 sequence. However, the final immunofluorescence microscopy results might suggest that this fusion protein was unable to the recruit γ-tubulin ring complex at the mitochondria.

Bioactive Compounds from Marine Bacteria Associated with Tunicates from the Red Sea

Advisor: **QIAN Peiyuan/LIFS**
Student: **LAM Wai Yun/SSCI** **UROP Course: UROP1000, Summer 2015**

Resistance to antibiotics is extremely common in different bacterial strains, and the diseases caused by antibiotic-resistant bacteria are difficult to treat. Certain bacteria develop different antibiotics to inhibit the competitor. Therefore, certain types of new drugs may be identified for solving associated problems. Tyrocidine, an aged antibiotic with high toxicity, is the focus of this study. Because of its mechanism in killing bacteria, resistance to tyrocidine is believed to be difficult for bacteria to develop. Therefore, we are attempting to identify a new type of tyrocidine with high bioactivity and low toxicity for killing antibiotic-resistant bacteria in the extraction of different bacterial cultures.

Possible Cross-talk of Nitric Oxide Pathway and P38 MAPK Pathways in Larval Settlement and Metamorphosis of Major Fouling Barnacle Species

Advisor: **QIAN Peiyuan/LIFS**
Student: **CHAN Tat Yin/SSCI** **UROP Course: UROP1000, Summer 2015**
LEUNG Pok Man/SSCI **UROP Course: UROP1000, Summer 2015**

The mineral and matrix components of barnacle shells have been widely studied, although research on the biological, morphological, and functional features of the membranous tubings in the parietal canals of barnacle shells is scant. Therefore, this study focused on characterizing the membranous tubings to shell formation. We found that the membranous tubings are possibly of a non-living nature because of the absence of nuclei observed with HE and DAPI staining. A network-like structure with patches of spherical crystals was discovered on its surface. Settlement-inducing protein complex (SIPC) was also found in the tubings with SIPC immunostaining. We employed X-ray diffraction for analyzing the possible mineral composition of the shell.

Blood Cell Development Investigation Using a Zebrafish Model

Advisor: **WEN Zilong/LIFS**
Student: **SHI Hongyu/SSCI** **UROP Course: UROP1100, Summer 2015**

Definitive hematopoiesis is a critical process in embryonic development. During the definitive hematopoiesis of numerous vertebrates, HSCs migrate from one anatomic compartment to another. The gene *itga4*, which encodes integrin α4, is related to the migration of hematopoietic progenitor/stem cells. Studies on *itga4* and HSC migration have mostly been conducted on mice or primates, and we know little regarding how *itga4* may influence zebrafish hematopoiesis. In this UROP, we used zebrafish with mutant *itga4* to investigate how *itga4* may influence definitive zebrafish hematopoiesis. We found that the mutation in *itga4* substantially reduced the HSC number at CHT in 4dpf zebrafish, and we did not notice a difference in lymphoid development between the mutants and wild-type embryos. The results confirmed that *itga4* is necessary for normal HSC distribution at this development stage, and suggested that *itga4* may be required for normal HSC migration from VDA to CHT.

G Proteins and Their Regulators in Cancer Biology

Advisor: **WONG Yung Hou/LIFS**
Student: **CHEN Peiwei/BCB** **UROP Course: UROP1100, Spring 2015**

The heterotrimeric G protein controls numerous cellular activities in virtually all eukaryotic cells. The widely accepted activation model of the G protein involves the dissociation of Gα and G$\beta\gamma$ subunits, which current studies have revisited to investigate the potential activation model without subunit dissociation. For this report, we adopted the $G\alpha_s$- $G\beta$ fusion protein with a 1- or 16-amino acid linker to examine the physiological functionality of this non-dissociable G protein. The $G\alpha_s$ sequence was modified to enable its activation by $G\alpha_i$-related GPCR, because of the availability of inhibiting endogenous $G\alpha_i$, but not endogenous $G\alpha_s$. This article only reports on the successful expression of $G\alpha_{s/i5}$- $G\beta$ fusion proteins and $G\alpha_{s/i5}$ proteins in cells, and the physiological functions of this non-dissociable G protein model will be examined in the future.

Advisor: **WONG Yung Hou/LIFS**
Student: **TSE Man Yin/BICH** **UROP Course: UROP1100, Spring 2015**

The regulators of G protein signaling (RGS) can activate GTPase for heterotrimeric G-protein alpha-subunits. By activating GTPase, the hydrolysis of the alpha subunit of heterotrimeric G proteins is accelerated. Thus, G proteins are inactivated, and their G protein-coupled receptor signaling pathways are switched off rapidly. Previous studies have shown that RGS19 downregulates Gαz-linked signaling. RGS20, which belongs to the same subfamily (RZ) as RGS19, was examined to determine its downregulation effects of receptor-mediated erk phosphorylation in the MAPK/ERK pathway. A defect in the MAPK/ERK pathway may lead to uncontrolled cell growth, eventually leading to cancer. Thus, the effect of RGS20 on the inhibition of the pathway can yield a potential drug for cancer treatment.

Tissue Morphogenesis and Growth Control in Developmental Organisms

Advisor: **YAN Yan/LIFS**
Student: **LAU Shun Fat/BCB** **UROP Course: UROP1100, Spring 2015**

Cell competition is a process in which cells compete with other cells for survival. The winner cells survive and proliferate, whereas the loser cells undergo programmed cell death, also known as apoptosis. This is an essential process in regulating tissue, organ size, and development. The failure of proper control may lead to excessive tissue growth and uneven cell distribution. *Drosophila* is one of the most popular modeling organisms used for cell competition investigations. By observing imaginal disc signals under a fluorescent microscope, the effects of specific conditions on cell competition can be visualized. In this project, we found a possible linkage between Spaghetti squash (Sqh) and cell competition by using *Drosophila*.

Advisor: **YAN Yan/LIFS**
Student: **ZHOU Chuying/BCB** **UROP Course: UROP1100, Spring 2015**

In metazoan organ development, a quality control process called, “cell competition” plays an essential role; it refers to a short-range elimination of suboptimal cells among cells with relatively higher fitness. Studies conducted on *Drosophila* imaginal discs have found several possible signal transduction pathways and molecular factors related to the initiation, processing, and end result of cell competition. Moreover, this report presents a brief discussion on the basic features and molecular mechanism involved in the discovered pathways, including the BMP/Dpp pathway, NFκB pathway, Flower (Fwe), SPARC, and Azot, based on experiment results from recent papers as well as the speculated relationship between these pathways.

Department of Mathematics

Lunar Study based on Data obtained by the Chang'e Spacecraft

Advisor: **CHAN Kwing Lam/MATH**
Student: **MAK Hugo Wai Leung/MATH-MP** **UROP Course: UROP1100, Fall 2014**

For this study, we will test different methodologies for analyzing the data obtained from Chang'e 1 and Chang'e 2. From the obtained laser altimeter data, several crucial properties and characteristics of the lunar surface can be deduced, thus helping researchers understand the development and reworking of the planetary surface in a vacuum environment or its respective evolution.

Apps for Scientific Computing

Advisor: **CHASNOV Jeffrey Robert/MATH**
Student: **ZENG Xiaohui/MATH** **UROP Course: UROP1100, Spring 2015**

Computable Document Format (CDF), designed by Wolfram Research, is a published public format of interactive documents supporting GUI elements such as buttons and sliders. Driven by runtime computations powered by the Wolfram Language content in CDF, it can respond to interactions between users of Mathematica for generating CDFs. In this manner, we can create interactive applications for computing and presenting dynamic figures. The live eBook, which provides enhanced illustrations of mathematical concepts and immerses readers in the content, can be viewed with the free CDF Player downloaded from Wolfram.

Based on "Introduction to Differential Equations," the textbook written by Professor Jeffrey Chasnov, this project chiefly involves using Mathematica to create CDFs for modeling systems of linear differential equations as well as nonlinear dynamical systems, including a phase space plot of coupled first-order equations, the GUI of a mass-spring system, a diagram plot of four basic types of 1D bifurcations, and a forced damped pendulum. Users can adjust the parameters of the figures and immediately navigate the interactive figures. Concepts in the traditional textbook such as normal mode, bifurcation, fixed point, and its stability can thus be supported with visualizations in such a CDF-enhanced eBook.

Symmetry Breaking in the Rocking Block Problem

Advisor: **CHASNOV Jeffrey Robert/MATH**
Student: **NGAI Ying Tim/MAEC** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

The rocking block model has been a long-extant model of a civil engineering problem. The features of this model have significant meaning because it helps us understand how architectures react to horizontal and vertical ground motion. In the original model, we assume that a slender block is reacting to ground excitation. This model can be examined as a nonlinear dynamical system by investigating how an arbitrary block (without a limitation to slender blocks) reacts to external excitation. In this paper, we consider only horizontal excitation of ground motion. To investigate the toppling of the block, we assume that the block is a cube, so that unnecessary calculations can be avoided when we consider toppling. We will begin our investigation by examining the governing equations, and then the phase diagram, bifurcation, and stability in this nonlinear dynamical system.

Asymptotic Methods for High-Frequency Wave Phenomena

Advisor: **LEUNG Shing Yu/MATH**
Student: **LAW Ho/MATH-PM** **UROP Course:** **UROP1100, Summer 2015**

In laser engineering, whenever engineers have to model a desired laser beam, they might have to compute the following integral, where the integrand is a product of a user-defined function and a highly oscillatory kernel with a Fox–Li operator:

$$\mathrm{I(x)} = \lim_{w\to\infty} \int_0^x e^{i\omega(x-y)^2} U(y)\, dy\,, x \in [0,1]$$

However, it has not been possible to compute the integral analytically, but only to approximate it with computers. This paper aimed to provide simple mathematical formulas for engineers to build the program and approximate the integral. The integral was first simplified by following the process by William Thomson in 1887, with some slight modifications in the deduction, because the bounds of the integral were different. This process can reduce the integral to a product of a constant and a function of x. Building on the result, the program could then be coded to compute the integral repeatedly with linearly spaced $x \in [0,1]$, and hence, plot the graph of I(x) against x. Despite the simple expression that the final approximation could be, the error is in the neglected net area of the bounded curve that is away from x. A more accurate approximation regarding the ignored area is still desirable.

Advisor: **LEUNG Shing Yu/MATH**
Student: **ZHAO Zixuan/SSCI** **UROP Course: UROP1100, Summer 2015**

This report presents a discussion on the methods of integrating

$$\mathrm{I(x)} = \int_{-1}^{1} U(y) e^{i\omega(x-y)^2}\, dy$$

where w → ∞, and *U(y)* is a discrete function. In this report, we assume that the function *U(y)* is sufficiently smooth that all of its derivatives used in the analysis exist. Certain classical and universal methods including the Newton–Cotes formulas and Gaussian quadrature are first discussed, and the reasons they are incapable of being highly oscillatory are provided. Certain specialized methods of these integrals including asymptotic methods and Filon's methods are discussed to show their improvements compared with traditional methods. Only the original proofs were written in detail.

Financial Engineering Problems in Trading and Investment

Advisor: **PENG Xianhua/MATH**
Student: **HE Tianyang/MAEC** **UROP Course: UROP1100, Spring 2015**
PANG Zheng Rui/MAEC **UROP Course: UROP1100, Spring 2015**

Stock prices are affected by various factors including market news. Based on technological developments that have induced the expansion of online businesses, stock news is available online and updated at a frequency close to real time. Therefore, it may be useful to retrieve and analyze online stock news for managing the risk of fluctuations in stock prices. News published within a time period may be judged according to the news content, the time published, and the amount of news published throughout that period. Good news for a specific stock may spike its stock price in a short time, whereas bad news may lower the price in a similar timespan.

Advisor: **PENG Xianhua/MATH**
Student: **ZHANG Keyu/MAEC** **UROP Course: UROP1100, Spring 2015**

For this study, we aimed to develop effective investment strategies on the stock market based on information from public earnings announcements and analysts' forecast revisions. Contrary to the efficiency market hypothesis, market information requires time for incorporation into stock prices, from several weeks to several months. These time lags provide opportunities for investors to arbitrate by assuming a long (short) position quickly after a news announcement and waiting for the stock price to shift up (down). This type of arbitrage appears too attractive to be real, and in this progress report, we aim to understand why professional traders continue to engage in this type of arbitrage opportunity by conducting literature reviews. Furthermore, this progress report briefly proposes a method that might be considered for use in generating investment strategies. In the future, we will use data to test whether the strategy is supported, and might also verify its effectiveness based on historical market data.

Advisor:	**PENG Xianhua/MATH**		
Student:	**DONG Chenyang/MAEC**	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**
	WANG Qiuqi/MAEC	**UROP Course:**	**UROP1000, Summer 2015**

In this report, we first plan to review previous papers on extant methodologies of sentiment analysis, especially for stock-specific news. Afterward, a few prevalent scenarios and parameters regarding sentiment analysis (e.g., polarity and subjectivity) will be discussed. Several concepts involving news analytics will be developed accordingly. Finally, we will apply basic statistical models to analyze the effects of news arrivals on the stock market from both high-frequency and daily perspectives. The correlation between news sentiments and the stock price change rate, volatility jump, as well as the concept of news beta will be preliminarily evaluated.

Keywords: sentiment analysis, news analytics, news beta.

Advisor:	**PENG Xianhua/MATH**		
Student:	**HE Jieyyan/MAEC**	**UROP Course:**	**UROP1000, Summer 2015**
	LIANG Junyao/RMBI	**UROP Course:**	**UROP1000, Summer 2015**
	ZHANG Kao/SSCI	**UROP Course:**	**UROP1000, Summer 2015**

In this report, we detail our understanding of the paper. We first discuss the background and preparation of the paper, including data usage, the hypothesis positing that the earnings–surprises consistency plays a critical role in analyst career outcomes, which justifies the incentives for analysts to avoid the earnings–surprises contradiction. Afterward, we discuss the development, functionality, and robustness of the original hypothesis, which posited that analysts tend to avoid the earnings–surprises contradiction, by using several approaches, and finally, we present our doubts and discuss possible improvements after delineating the entire paper (e.g., the definition of true beliefs of analysts).

Advisor:	**PENG Xianhua/MATH**		
Student:	**ZHOU Tianhao/RMBI**	**UROP Course:**	**UROP1000, Summer 2015**

According to the efficient markets hypothesis, financial markets, especially the stock market, should be efficient in responding to related information. This has sparked endless discussions on the efficiency of the market in the real world. However, numerous studies have shown that the stock performance reacting in response to that information, which we also call, “news,” to an extent. The issue at present concerns how exactly the news affects stock performance. How does one quantify the news text? What metrics should be used in correlation analysis? What consequential influence will the news have on the stock? This paper provides a concise review of past related studies we referred to, so that we could determine how previous researchers have analyzed the correlation between the occurrence of news and stock performance.

Combinatorial Tiling of the Sphere by a Pentagon

Advisor: **YAN Min/MATH**
Student: **HE Wuxian/MATH-PMA** **UROP Course: UROP1000, Summer 2015**

This is a progress report regarding research on the edge-to-edge tilings of the sphere using more than 12 congruent pentagons, such that a tile with four vertices exists with degree 3, and one with degree 4 or 5. Moreover, the edge length combinations are a^2b^2c, a^3bc, or a^3b^2, with different a, b, and c. This report covers mainly the results of the cases with the central pentagon having one vertex of degree 4 and others of degree 3, whereas the edges are a^2b^2c and a^3bc. The remaining cases are covered in a future report.

Department of Physics

Ultrahigh Vacuum System for Surface Science

Advisor: **ALTMAN Michael Scott/PHYS** **Co-advisor:** **LIN Nian/PHYS**
Student: **HE Pingge/PHYS** **UROP Course:** **UROP1000, Summer 2015**
LI Tianhao/PHYS **UROP Course:** **UROP1000, Summer 2015**

Two vacuum-related instruments are investigated to perform Auger electron spectroscopy for surface analysis: the cylindrical mirror analyzer (CMA) and the retarding field analyzer (RFA). The RFA may also be used for performing low-energy electron diffraction for surface structure determination. In this project, we reviewed the physical operation principles of the CMA and RFA, re-assembled obsolete research-grade equipment, repaired faults that we encountered, and learned and modified existing control software. The CMA system was successfully brought into operation and preliminary data have been acquired that demonstrate how measurement results depend upon relevant control parameters.

Entanglement of Identical Particles

Advisor: **CHEN Tian Wen/PHYS**
Student: **TSUI Yan Lok Enoch/PHYS** **UROP Course:** **UROP1100, Summer 2015**

This report was submitted in partial fulfilment of the UROP 1100 course (Summer 2015). For this report, we examined the entanglement of quantum systems composed of two identical two-state particles. We expressed the general pure-quantum state of such systems by using second quantization, and then employed a general change of basis to the creation operators. By necessitating a unitary transformation for the change of basis (which it must be), and by imposing certain constraints on the coefficients of each term of the quantum state in the new basis, we investigated the possibility of “disentangling" an originally entangled quantum state with a change of basis. In other words, by investigating the existence of a basis set that allows the expression of a quantum state entangled in one set of basis into a separable one, we attempted to answer the question of whether entanglement is an intrinsic property of the quantum system.

Quantum Optics and Atomic Physics

Advisor: **DU Shengwang/PHYS**
Student: **SHU Chi/PHYS** **UROP Course:** **UROP4100, Fall 2014**

We present a technique of temporal quantum-state tomography and the generation of polarization-frequency-coupled hyperentanglement for narrowband biphotons produced from spontaneous four-wave mixing in laser-cooled atoms. Using polarization-dependent and time-resolved two-photon quantum interference, we successfully reconstructed the biphoton complex temporal wave function. Moreover, we present a robust scheme for generating narrowband biphotons with polarization-frequency-coupled hyperentanglement through a frequency shifter and linear optics. This demonstration provides a foundation for engineering photonic entanglements in polarization and frequency Hilbert spaces.

Advisor: **DU Shengwang/PHYS**
Student: **CHOW Tsz Kiu Aaron/SSCI** **UROP Course:** **UROP1000, Summer 2015**

In modern quantum optics experiments, one need to identify single-photon level signals for further purposes. A Fabry-Perot cavity resonator can satisfy such a need. However, the finesse and transmission of the cavity has limitations due to cavity geometry and mode mismatching. I have designed a plano-convex FP cavity suitable for use as a narrow band filter for entangled photons. The cavity performance is characterized by obtaining a 40dB suppression of unwanted noises at 3GHz away from cavity resonance while maintaining a bandwidth of 70MHz. The cavity geometry is designed to match the input Gaussian beam optical signal so that lost due to angular misalignment can be minimized.

Advisor: **DU Shengwang/PHYS**
Student: **LAU Sze Cheung/PHYS** **UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**

Light-sheet microscope illuminates and images a sample layer by layer, achieving high resolution yet high imaging speed and low photo-bleaching. A lattice light-sheet microscope was recently introduced; it uses a “non-diffracting” patterned light sheet. This report proposes an improved method for creating lattice light sheets, and presents the progress in implementation. This method can enhance efficiency and reduce costs. The preliminary results revealed that the novel method is promising.

Building Quantum Gas Microscopy with Ultracold Ytterbium Atoms

Advisor: **JO Gyu Boong/PHYS**
Student: **CAI Geyue/PHYS** **UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**

With the development of experiments in the field of ultra-cold atoms, more accurate measurements have been found to be required, and more advanced measuring technique must be applied. One technique is super-resolution microscopy, which is useful for performing ultra-cold atom experiments such as optical lattice and in situ measurements of the spatial distribution of cold atom clouds.

Traditional lens designing has been a privilege reserved for professional optical companies because they had substantially more appropriate designing experience and great computational power for performing ray tracing, which simulates the real tracking of lights, and most times it yields a good prediction. However, in recent years, the emergence of commercial software has enabled non-professional physicists to simulate optical systems on a personal computer with a basic knowledge of optics.

In this report, I conclude how Zemax (demo version) is used for simulating the microscopy system in our ultra-cold Ytterbium gas laboratory, and characterize the properties of our microscopy system.

Advisor: **JO Gyu Boong/PHYS**
Student: **CHAN Wing Kin/SSCI** **UROP Course: UROP1100, Summer 2015**

With the recent development in cooling alkali metals with various techniques, physicists can now explore the behavior of atoms under temperatures at the nanokelvin scale. Under such temperatures, experimentalists can gain insight into quantum-phase transition and study Bose–Einstein condensation, Fermi gas, Bardeen–Cooper-Schrieffer (BCS) superfluidity, and many other intriguing properties of cold atoms. Apart from these studies, by creating a different optical trap by using laser, the ultra-cold atom experimental setup can be used to simulate physical phenomena with a tunable system. This report presents a discussion on the basic principles involved in creating ultra-cold atoms, and then on the creation of optical traps and the potential application of ultra-cold atoms in an optical trap.

Characterizing Single-molecule Electronic Properties by using Low-temperature Scanning Tunneling Microscopy

Advisor: **LIN Nian/PHYS**
Student: **CAI Qianhang/SSCI** **UROP Course: UROP1000, Summer 2015**

The catalysis of Pd toward the covalent polymerization of 5,15-di(4-bromophenyl)-10,20-di(4-pyridyl)porphyrin molecules at room temperature was investigated in an ultrahigh vacuum environment by employing scanning tunneling microscopy. After completing the evaporation of organic molecules and Pd onto a Au(111) surface, various areas were scanned and imaged to obtain sufficient evidence for the reaction. By measuring the distance between the adjacent molecules, we identified the type of molecular interactions between molecules, which enabled us to estimate whether covalent bonds have formed. After accomplishing these procedures, the catalytic effect of Pd was proved concretely.

Advisor: **LIN Nian/PHYS**
Student: **HUNG Siu Fai/PHYS** **UROP Course: UROP1100, Summer 2015**

The purpose of this project was to investigate the behavior of 2D molecules by using DFT and STM. The working principles of STM and the mechanism of DFT were studied. A gold atom was deposited on the lead surface. The data collected to date revealed that not many interesting islands formed on the surface of lead atoms, even after more gold was deposited. Density functional theory and a Gaussian® system were used to predict the molecular orbital of the symmetric polycyclic molecules. When the number of rings increased, the edge state appeared. The discovered edge state was relatively similar to that found on graphene in recent studies.

Monte Carlo Simulation of 2D Supramolecular Assembly

Advisor: **LIN Nian/PHYS**
Student: **KAO I-hsuan/PHYS** **UROP Course:** **UROP2100, Summer 2015**

A complete Kinetic Monte Carlo simulation program was written to investigate the 2D metal organic supramolecular self-assembly on a lattice substrate. The simulation was initially designed to simulate the network development of a porphyrin molecule called 5,10,15,20-tetra(4-pyridyl)-porphyrin (TPyP) as well as lead atoms on the Au(111) substrate under different deposition rates, reaction temperatures, and deposition orders. The energy parameters (e.g., Pb metal bond) coordinates the bond between Pb and TPyP as well as the diffusion energy of adatoms in an exact range, which fit the experimental data obtained from the scanning tunneling microscope in Professor Lin Nian's laboratory. The simulation is also flexible because it can fit various 2D metal-organic self-assembly systems.

Quantum State Calculation of Two-dimensional Supramolecular Nanostructures

Advisor: **LIN Nian/PHYS**
Student: **HUANG Zengle/PHYS** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

When different periodic potentials are imposed on a lattice, the band structures of the electrons might differ. By manipulating the potential, the desirable properties of the lattice might be obtained. Therefore, a MATLAB program was designed to simulate a system in which a kagome potential was imposed on a hexagonal lattice. After changing the parameters of the potential configuration, we conducted an analysis on the band structure to examine how the band gaps and band widths evolve.

Advisor: **LIN Nian/PHYS**
Student: **XIE Ayu/PHYS** **UROP Course:** **UROP1000, Summer 2015**

A previously designed MATLAB program was used to simulate the electron properties of a 2D system imposed by a periodic potential by numerically solving the time-independent Schrodinger equation. The objective of this project is to modify this program and construct a model of a finite system, and then test the density of states, the local density of states in this system, and the edge states for a large finite system. These test results contain critical information that can enhance our understanding of electron activity and the properties of finite systems.

Advisor: **LIN Nian/PHYS**
Student: **YANG Tianyi/PHYS** **UROP Course: UROP1100, Summer 2015**

The project concerned the quantum-state calculation of 2D supramolecular nanostructures. The aim of this project is to identify the eigenstates of certain finite benzenes structures because the benzene structure is a part of grapheme, and the finite structure may have certain different properties to infinite lattices. The main method I employ is the tight-binding model in solid-state physics. In this model, the approximation involves the addition of hopping between adjacent lattice points to the atomic orbitals of lattice points as perturbation. In finite structures, the lattice points are finite. Consequently, I can write Hamiltonian as a matrix based on atomic orbitals, which enables me to diagonalize it easily to obtain eigenstates.

Nature of the Nematic Order in Fe-based Superconductors

Advisor: **LORTZ Rolf Walter/PHYS**
Student: **TAM Pok Man/SSCI** **UROP Course: UROP1100, Summer 2015**

The high-temperature superconductor (HTS) was discovered approximately 30 years ago. Its discovery has led to various critical applications involving superconductors, and has simultaneously resulted in more quandaries regarding this novel material. High-temperature superconductivity marks the insufficiency of BCS theory. To develop a more comprehensive theory, physicists must enhance their understanding of the phases of the HTS, and how it transits from one phase to another. In the last 10 years, the Nernst effect has become a critical tool for probing the phases of various HTC materials, especially in the mixed state as well as its high-temperature fluctuating regime. This report first presents a review of the basic properties of the HTS, as well as the nematic phase and density-wave orders. Afterward, the basic concepts of the Nernst effect are presented. The experimental setup I used is then explained. Certain fresh—but as yet unfitted—experimental data are also presented and analyzed. Finally, I conclude by providing a possible explanation for the observed results.

Chaotic Dynamics in a Complex Network

Advisor: **SZETO Kwok Yip/PHYS**
Student: **YIK Hiu Fai/PHYS** **UROP Course: UROP1100, Fall 2014**

The chaotic behavior of a system is a critical topic that is investigated for obtaining accurate predictions in classical mechanics. In the project, I started to learn the chaotic system from the simplest system, the 1D lattice, and the simplest chaos model, the logistic map. After one semester of learning, I want to study the effects of nonlinear disturbance, the duffing oscillator, being introduced to a different topological system.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **SOU Chon Man/SSCI** **UROP Course: UROP1000, Summer 2015**

The coupling effects of chaotic attractors were investigated in a model with two oscillators and were later extended to a model with a complex network of oscillators. This report details the selection of the complex network as a scale-free network. After the selection, the chaotic attractors were generated using the logistic map, the chaotic behavior of which has been widely studied, and two of their coupling effects, the properties of the attractors and the synchronized effect, were respectively investigated in the two models. Quantitative methods including the Lyapunov exponent, Jacobi matrix, Laplacian matrix, and the master stability function, have also been applied to the models, and certain deviations from the theoretical prediction have been observed.

Damage Spreading in Networks

Advisor: **SZETO Kwok Yip/PHYS**
Student: **GUO Wenshuo/SSCI** **UROP Course: UROP1000, Summer 2015**

This study investigates the Ising model, Monte Carlo simulations, and damage spreading based on different structures. For the 1D Ising model, the solution of a critical temperature T_c, below which the system becomes magnetized, is presented using mean field approximation. For the 2D Ising model, T_c for various lattices is estimated using Monte Carlo simulations. Lattices with different topological structures discussed in the report include the square, hexagonal, and triangular lattices. In addition, damage spreading on these lattices was examined. For each type of lattice, the simulations estimated the transition temperature above which the damage becomes saturated. The report also presents a discussion on the results.

Evolutionary Computation for Optimization

Advisor: **SZETO Kwok Yip/PHYS**
Student: **LI Qingjie/PHYS** **UROP Course: UROP1100, Spring 2015**

Genetic algorithms are search algorithms based on the process of natural selection. They combine the survival of the fittest among string structures with a structured yet randomized information exchange to form a search algorithm with some of the innovative skills involved in human searching. In every generation, a new set of strings is generated using bits and pieces of the fittest of the old; an occasional new part is attempted for good measure. When randomized, genetic algorithms are no simple random walk. They efficiently exploit historical information to speculate on new search points with expected improvements in performance.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **CHEUNG Chak Lun/SENG** **UROP Course: UROP1000, Summer 2015**

This study investigates the Ising model, Monte Carlo simulations, and damage spreading based on different structures. For the 1D Ising model, the solution of a critical temperature T_c, below which the system becomes magnetized, is presented using mean field approximation. For the 2D Ising model, T_c for various lattices is estimated using Monte Carlo simulations. Lattices with different topological structures discussed in the report include the square, hexagonal, and triangular lattices. In addition, damage spreading on these lattices was examined. For each type of lattice, the simulations estimated the transition temperature above which the damage becomes saturated. The report also presents a discussion on the results.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **LEE Cheuk Long Frank/SSCI** **UROP Course: UROP1000, Summer 2015**

The genetic algorithm is a method for finding the optimal solution to a problem. It is a process in which random solutions evolve toward a better solution. By contrast, Parrondo's game is a combination of two losing games with pattern results specific to a winning game. This report investigates different patterns by using the genetic algorithm. In other words, different random sets of specific patterns are allowed to play Parrondo's game, which eventually evolve into an optimal pattern. This is the focus of the investigation. Moreover, this report presents a comparison between the respective evolved patterns that emerge after changing certain rules of Parrondo's game.

Maxwell Demon and Information Thermodynamics

Advisor: **SZETO Kwok Yip/PHYS**
Student: **IYER Aditya Varna/SSCI** **UROP Course: UROP1000, Summer 2015**

By the end of the nineteenth century, thermodynamics was established as a well-defined branch of physics with clear laws and boundaries. However, the famous thought experiment by the eminent physicist James Clerk Maxwell destroyed the foundations on which thermodynamics was built. Maxwell's Demon, as it was later referred to by Lord Kelvin, led to critical developments in the field of thermodynamics and its correlation with information theory, as envisioned by Claude Shannon. The critical tools of a mathematical nature such as Markov chains were obtained as part of this study, in addition to basic computer-programming skills in Java and MATLAB. Another significant area surveyed for this project included Parrondo games and their analogy with Brownian ratchets. We also considered a more practical approach to playing Parrondo games, which involved the use of memory on the history of these games.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **SO Chi Long/SSCI** **UROP Course: UROP1000, Summer 2015**

This marks my first attempt at learning a subject primarily for research purposes. Python was the language I used in the simulation. For the entire month, I worked on the random walk simulations on a 4 ×4 array of rooms and a network with three hexagons. Although they are not directly related to Maxwell's demon, they had a degree of physical significance and provided me with good training in designing simulations.

Prisoner's Dilemma Game on Complex Networks

Advisor: **SZETO Kwok Yip/PHYS**
Student: **KIM Minsam/COSC** **UROP Course: UROP4100, Fall 2014**

By the end of the nineteenth century, thermodynamics was established as a well-defined branch of physics with clear laws and boundaries. However, the famous thought experiment by the eminent physicist James Clerk Maxwell destroyed the foundations on which thermodynamics was built. Maxwell's Demon, as it was later referred to by Lord Kelvin, led to critical developments in the field of thermodynamics and its correlation with information theory, as envisioned by Claude Shannon. The critical tools of a mathematical nature such as Markov chains were obtained as part of this study, in addition to basic computer-programming skills in Java and MATLAB. Another significant area surveyed for this project included Parrondo games and their analogy with Brownian ratchets. We also considered a more practical approach to playing Parrondo games, which involved the use of memory on the history of these games.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **LEUNG Sze Ching/PHYS** **UROP Course: UROP1100, Fall 2014**

Parrondo games refer to a counterintuitive phenomenon where playing two losing games alternatively can generate a winning result. This paper investigated the optimal game sequence, which was found to be ABABB or its combinations. I studied multiplayer Parrondo games on a ring structure with information flow between neighbors. There are two feedback controls after the player obtains information: follow the winner or avoid the loser, and a mixture of these two switching schemes. The results indicated that following the winner or avoiding the loser typically results in a loss, but a mixture of them leads to a win. In a particular M combined with a specific number of steps, avoiding the loser can result in a win.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **LO Wai Leuk/PHYS** **UROP Course:** **UROP1100, Fall 2014**

Although the field of the prisoner's dilemma has been researched considerably, for this research, we explored various aspects of Parrondo's games on a ring, where a certain number of players could access their neighbors' information and play the game by using certain strategies. These aspects included the influence of different strategies on the capital, the effects of different gaps (the distance to which the player observed) on the capital, and the impact of group sizes on the capital. Through a simulation, we found that strategies affected the behavior of the group, as did the gaps and group sizes.

Keywords: Parrondo's games, strategy, unambiguous winner/loser, capital, gap, M.

Quantum Random Walker on Networks

Advisor: **SZETO Kwok Yip/PHYS**
Student: **SORN Sopheak/PHYS-PM** **UROP Course:** **UROP2100, Fall 2014**

We examined a Hadamard quantum random walk on a band structure with degree 4. A computation was performed using the Fourier transform, solving iterative equations, analyzing matrix eigen spectra, and conducting inverse Fourier transform to obtain the wave function of the random walk at each node, thereby enabling information on the probability distribution of the random walk on the band structure. The second part of the report addresses the analytical method in finding the distribution of a self-avoidant random walk on a network. However, because of the complications of the problem, only the solution to completely connected networks is obtained.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **CHERN Li Ern/PHYS-PM** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

Grover's algorithm is a quantum algorithm formulated in 1996. It enables a quadratic speedup relative to its classical counterpart in the search for a target in an unstructured database. Its principle is based on amplitude amplification; that is, the probability of finding the target gradually increases toward unity over time. For this paper, we constructed a genetic algorithm drawing inspiration from Grover's geometric concept. We aimed to maximize a fitness function of several variables by successive rotations of a normal vector to explore the solution space. The paper also presents a discussion on the established standard model of the simple genetic algorithm. Finally, the performance of both algorithms for certain functions of the three variables was tested and compared.

Keywords: Grover's algorithm, amplitude amplification, genetic algorithm, geometric concept, fitness function, rotations, normal vector, standard model.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **SAN Yik Chuen/SSCI** **UROP Course: UROP1000, Summer 2015**

In this project, a 1D discrete classical random walk on an infinite line and on an n-gon were considered, along with a 1D discrete quantum walk (specifically, the Hadamard walk). Certain known theoretical results were derived primarily by using the combinatorial method. In addition, we focused on the probability and first-passage time distributions. Specifically, the simulations for these processes were conducted, and the results were verified against theoretical predictions. Furthermore, certain potential extensions of the problems considered were recommended for future investigation.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **WANG Juntao/ SSCI** **UROP Course: UROP1000, Summer 2015**

The objective of this study was to determine the first-passage time (FPT) of a classical random walker. The first phase of the research led to a theoretical solution regarding the distribution of the arriving possibility after n steps by using Fourier transform. We will also calculate the FPT on a 1D line by using the reflection principle, and FPT on a 2D lattice by using the generating function or Markov chain method. By using the Markov chain method, we can obtain a theoretical solution for the mean FPT on a 1D ring.

Advisor: **SZETO Kwok Yip/PHYS**
Student: **YU Yue/PHYS** **UROP Course: UROP1100, Spring 2015; UROP2100, Summer 2015**

Starting from the plane-wave eigenstate of the infinite-line system, we examined the effects of electric potential on the bound energy and wave function. Specifically, we focused on the periodic delta electric potential, and we obtained the band structure of the quantum random walk, which can be related further to the density of states. For the second part of this report, we analyzed the simple quantum walk in the finite system, and discuss two types of bound states. We then obtained the probability distribution in the presence of a constant electric field. Several possible experimental realizations are delineated in the last part of this report.

Random Walk on a Complex Network and Application to Numerical Simulation for Statistical Physics

Advisor: **SZETO Kwok Yip/PHYS**
Student: **YU Yue/PHYS** **UROP Course: UROP1100, Fall 2014**

Starting from the summation series formula for the mean first-passage time, we noted two factors controlling the average of the mean first-passage time (AMFPT), the degree distribution, and the number of small loops, which can be further related to the clustering coefficient. To find the ideal approach to rewiring one link to reduce the AMFPT, we introduce two methods based on these two factors. In the last part of this paper, we compare these two methods on networks with different clustering coefficients to show their application under different conditions.

Keywords: mean first passage time, clustering coefficient.

Negative Refractive Index Meta-materials

Advisor: **TAM Wing Yim/PHYS**
Student: **FANG Yawen/PHYS** **UROP Course: UROP4100, Fall 2014**

The phase change of light after reflection off a material can be measured with Fourier transform infrared spectroscopy. The measurement of the phase change is of considerable importance in studying high precision optical systems to obtain a wide range of physical parameters. The intensity of the interference signal typically varies sinusoidally with the wavenumber. However, when the numerical aperture increases, the relation between the intensity of the interference signal and the wavenumber is no longer sinusoidal with single frequency, and an additional frequency component is introduced, after which the phase change cannot be obtained using the typical method. I attempt to solve this problem by applying the FFT filter with different filter windows. The method is assessed in a theoretical case as well as an experimental case.

An Experimental Study of Turbulent Thermal Convection

Advisor: **TONG Penger/PHYS**
Student: **YIK Hiu Fai/PHYS** **UROP Course: UROP1100, Spring 2015**

A semi-2D convection Rayleigh–Bénard Convection cell was built to study the convection pattern of fluid. Shadowgraph movies were captured with Rayleigh numbers $\mathrm{Ra} = 2.26 \times 10^9, 3.76 \times 10^9, 4.83 \times 10^9, \text{and } 6.22 \times 10^9$, but no quantitative analysis was conducted. In this project, we attempted to obtain the velocity field from the shadowgraphs.

CMB Cold Spot from Inflationary Feature Scattering

Advisor: **WANG Yi/PHYS**
Student: **QI Jie/PHYS** **UROP Course: UROP1000, Summer 2015**
RAJAN Adithya/PHYS **UROP Course: UROP1000, Summer 2015**

A recent study suggested that an inflationary feature-scattering mechanism can explain the cold spot in the CMB WMAP. This report examines the mechanism by considering the features of various potentials by using classical methods. Analytical solutions to the fields were found with a degree of potential for the scattering angle and kinetic energy loss as a function of the impact parameter. Additional numerical examples are provided.

Exciton Dynamics in Organic/Inorganic Solar Cells

Advisor: **WONG Kam Sing/PHYS**
Student: **LAU Ka Ki/SSCI** **UROP Course: UROP1000, Summer 2015**

This UROP lasted approximately 2 months. Various experiments were conducted to study the PL properties of certain organic or perovskite materials, which can potentially be applied in solar cell production. The time-resolved luminescence technique was used to observe exciton events after absorbing a specific wavelength. Four materials were investigated. The quantum yield of perovskite film with a 300-nm thickness on glass (G300) and 268-nm thickness on Pedot (P268) was 0.0435 and 0.0050, respectively. Both of them had PL in the range of 700–850 nm, and dominated the nonradioactive process as the temperature increased. At room temperature, semiconducting 2D $(CH_3(CH_2)_3NH_3)_2(CH_3NH_3)_{n-1}Pb_nI_{3n-1}(n = 3)$ perovskite thin film had PL with a 752-nm peak, lifetime t1 = 1.624 ns, t2 = 0.339 ns, and $CH_3NH_3PbBr_3$ single crystals had peaks at approximately 740 nm and 760 nm.

Ultrafast Spin Relaxation Dynamics in 2D Layered Semiconductors

Advisor: **WONG Kam Sing/PHYS**
Student: **TANG Yongjian/MATH-MP** **UROP Course: UROP1100, Spring 2015; UROP2100, Summer 2015**

Monolayered transition metal dichalcogenides (TMDCs) abide by optical selection rules in coupling emission polarization to the exciton valley degree of freedom in the absence of centrosymmetry. Using polarization-resolved spectroscopy, researchers have recently found circular polarization (CP) in TMDCs by exciting electrons in the valence band to the conduction band, forming quasi-particles called excitons. We imaged a molybdenum disulfide sample and obtained its reflection spectrum from a monolayer. The results revealed an absorption peak within the 640–650 nm range, which is in excellent agreement with the results of previous experiments. Based on these results, the photoluminescence (PL) experiment, temperature dependence, as well as polarization- and time-resolved experiments can be designed for understanding absorption, relaxation, and emission dynamics, and for increasing intensity and CP in PL.

Neural Dynamics

Advisor: **WONG Michael Kwok Yee/PHYS**
Student: **LAU Sze Cheung/PHYS** **UROP Course:** **UROP1100, Fall 2014**

We model the flickering illusion perceived by humans using a 1D continuous attractor neural network. Based on evidence of the alpha rhythm modulating visual perception in human brains, we incorporated spatially and temporally modulated signals as a model of alpha modulation. Traveling excitation in the network, which represents the flickers in illusions, were produced successfully, and the dependence of the flickers on the spatial frequency of the illusory stimulus was shown. Further research directions are discussed.

Advisor: **WONG Michael Kwok Yee/PHYS**
Student: **LO Ka Chun/PHYS-PM** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

Subject to various types of mechanisms manipulating the interactions between neural cells, our perception of things could differ from their actual status. An illusion is a false visual perception concerning the motion of things. The objective of this project is to explain certain types of illusions by using a neural network model. In this model, the activity of neural cells is controlled by two parameters corresponding to two mechanisms: global inhibition and short-term depression (STD). In the past few months, the flickering illusion was modeled using a static wheel as the visual input. The experimental results revealed that we often falsely observed flickering when we observed the static wheel. Incorporating an additional control called the alpha wave into the neural model, we found that the responses of the neural system to a static wheel can be qualitatively classified into four categories: “homogeneous spike,” “static bump,” “moving bump,” and “emitter,” under varying strengths of global inhibition and STD. Certain clues indicated that the strength of global inhibition and STD corresponding to the emitter phase as well as the alpha wave might be the cause of the flickering illusion. In the emitter phase, the peak of neural activities shifted among the neural cells, both clockwise and anticlockwise in sharp time, and the frequency of the shift matched that of the alpha wave.

Space Orbit Design

Advisor: **WONG Michael Kwok Yee/PHYS** **Co-advisor:** **CHAN Kwing Lam/PHYS**
Student: **SIN Ho Pan/PHYS** **UROP Course:** **UROP1100, Spring 2015**

This study examines the behavior of the solutions to low-thrust two-point boundary value problems under different boundary conditions. For simplicity, we demonstrated the low-thrust trajectories under constant gravitation in two dimensions. By implementing different control functions, we found the limit of the initial and final velocities by using the boundary value problem solver in MATLAB. We then compared the numerical results to their analytical counterparts, and found a correlation between the limits and the control parameters (e.g., the control magnitude and thrust duration). We also determined the range of the initial and final velocities, and related them to the control parameters.

Advisor:	**WONG Michael Kwok Yee/PHYS**	**Co-advisor:**	**CHAN Kwing Lam/PHYS**
Student:	**CHIU Wen Han/PHYS**	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**

The design of space orbits is critical for any space mission. To determine a trajectory and its feasibility in terms of costs, astronomers typically rely on programs known as propagators that plot a trajectory based on the initial conditions. We previously designed a two-body propagator written in C++ to replace the previous MATLAB-based propagator. We improved this two-body propagator further in terms of accuracy and functionality over the past few months. This two-body propagator is ready to be generalized to a fully-fledged N-body propagator, to be integrated into GALLOP.

Advisor:	**WONG Michael Kwok Yee/PHYS**	**Co-advisor:**	**CHAN Kwing Lam/PHYS**
Student:	**SHING Ming Tony/PHYS**	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**

This study examines the behavior of the solutions to low-thrust two-point boundary value problems under different boundary conditions. The last study reported on low-thrust trajectories under constant gravitation, and also provided analytical proof for the regular patterns of the allowed range of the initial and final velocities. As a continuation, in this report, we demonstrate 2D trajectories under central force. After a series of numerical experiments, we found certain velocity range patterns of interest, and certain properties related to the control are discussed in this report.

Stability and Robustness in Power Grids

Advisor:	**WONG Michael Kwok Yee/PHYS**		
Student:	**HO Wing Sang Vincent/PHYS**	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**

A disastrous cascading breakdown can occur in a power grid if power lines are faulty, and thus, it is critical to increase the robustness of power grids. The first step is in knowing which power lines are more vulnerable; therefore, in this study, we aim at identifying approaches for predicting the next power line that would break down if a random line were removed from the power grid. There appeared to be no relation between the ability to resist fluctuations in demand and supply and the ability to manage redistribution resulting from the removal of power lines. The one-pass approach for estimating the current appears reliable in predicting the next most vulnerable power line in both scale-free and square lattice networks.

SCHOOL OF ENGINEERING

Department of Chemical and Biomolecular Engineering

Mechanism of Ultrasound-mediated Transscleral Drug Delivery

Advisor: CHAU Ying/CBME
Co-advisor: SUEN W L Langston/CBME
Student: ZHOU Zixu/CBPE
UROP Course: UROP2100, Fall 2014; UROP3100, Spring 2015

With the rising popularity of electronic devices, overuse of the eyes is now becoming an increasingly common phenomenon, which could result in a higher incidence of eye diseases. A safer and more convenient approach to delivering drugs into the eyes is therefore in demand. For our research, we used an ultrasound as a method for facilitating transscleral drug delivery. The mechanism of enhancement and the relationship between the enhancement effects and the mechanical index values were studied. During the experiment conducted this spring semester, a trial took place of a new data-processing technique, which involved directly modeling each line drawn in the picture, instead of modeling the averaged profile. Moreover, new sets of controls were introduced to the database, and three methods for standard deviation processing have been proposed and are discussed based on how well they can elaborate the deviation. This report first details the data-processing techniques we applied, followed by a discussion on newly introduced control sets and the three standard deviation estimation methods. According to the diffusivity yielded by the MATLAB model, we observed a vague tendency of the enhancement effect first increasing and then decreasing, peaking at the point MI = 0.136.

Bimetallic Photocatalysts for Antibiotics Degradation

Advisor: LAM Leung Yuk Frank/CBME
Co-advisor: HU Xijun/CBME
Student: PATRIA Raffel Dharma/CBME
UROP Course: UROP1100, Summer 2015

In recent years, antibiotics have become recognized as one of the most effective types of medication for treating many diseases. However, considerable amount of antibiotics has been directly disposed of, and therefore, they have contaminated the environment. This contamination causes a negative effect on the aquatic and terrestrial ecosystem, because the microorganisms in the ecosystem develop antibiotic resistance. This report delineates the development of an effective Au–BiOBr catalyst for the photodegradation reaction of antibiotics. Experiments were performed to determine the remaining concentrations of the norfloxacin and organic contents after the photodegradation reaction by using HPLC and performing TOC analyses. The BiOBr catalyst was produced; however, because of time limitations, the experiment remains unfinished, and the effectiveness of the Au–BiOBr catalyst has not yet been determined.

Fabrication and Characterization of Metal-based Core-shell Materials

Advisor: **LAM Leung Yuk Frank/CBME**
Student: **ARESDHAYANA Mika/SSCI** **UROP Course: UROP1000, Summer 2015**

Metal nanocatalysts have garnered considerable attention in the field of chemical engineering in the last few decades, which utilize the effectiveness of various chemical reactions under industrial scales. Monodisperse silica nanospheres are widely used as support for the formation of various metal nanocatalysts because of their porous property. Core-shell silica was synthesized through the hydrolysis of the TEOS in a basic solution, and the metal-silica core-shell was prepared using the impregnation method, which can exhibit a remarkable catalytic ability and compromised stability. In this experiment, various metals were impregnated onto the core-shell silica (SiO_2) such as cobalt (Co), nickel (Ni,), iron (Fe), and niobium (Nb), which were obtained using the reduction method from its respective salts, calcined at 300 °C in pure hydrogen and air flow.

Production of Furfural from Xylose by Niobium-based Catalysts

Advisor: **LAM Leung Yuk Frank/CBME**
Student: **CHAN Hiu Yin/CBME** **UROP Course: UROP1000, Summer 2015**

The demand for furfural has increased substantially because furfural is applied in numerous applications, specifically the intermediates of furan-based chemical synthesis. Furfural can be obtained through the dehydration of xylose, which is a main component of hemicelluloses. Conventional acids are used for catalyzing the xylose-to-furfural reaction, but a novel suggestion was proposed regarding the use of flyash. Flyash, as a catalyst support, contains various types of metal-oxides aiding catalysis. The experiments were designed to optimize the yield, conversion, and selectivity of the xylose-to-furfural reaction by using flyash as the catalyst. We found that optimal ranges for the reaction were a reaction time of 3 – 4 h at a temperature of 170 – 200 °C, but no conclusion was drawn on varying the xylose-to-catalyst ratio.

Keywords: xylose, furfural, flyash, heterogeneous solid catalyst, dehydration.

Xylose-to-Furfural Transformation by Nickel-based Catalysts

Advisor:	**LAM Leung Yuk Frank/CBME**	**Co-advisor:**	**HU Xijun/CBME**
Student:	**LAU Kwun Hei/CBME**	**UROP Course:**	**UROP1000, Summer 2015**

Furfural, produced from pentosan-rich biomass, is widely used as an industrial solvent, and is a multi-usable chemical intermediate for producing value-added products. Its raw material can be xylose, a pentosan-rich biomass obtained through acidic hydrolysis of hemicelluloses. The manufacturing process we currently use to produce furfural, however, presents several disadvantages. These processes result in corrosion issues, toxic effluents, and high separation costs. In this study, different types of metal-organic frameworks and heterogeneous catalysts were prepared to examine their performance during the conversion of furfural from xylose. We found that our approach can overcome the difficulties in the removal of the homogeneous acid catalyst from the products, and the cost is also more reasonable.

Keywords: xylose, furfural, heterogeneous, catalysis; SBA-15.

Advisor:	**LAM Leung Yuk Frank/CBME**	**Co-advisor:**	**HU Xijun/CBME**
Student:	**THAKUR Garima/CBME**	**UROP Course:**	**UROP1000, Summer 2015**

This report details an environmentally friendly, solvent-free method for the synthesis of metal-organic-framework (MOF) catalysts by using mechanochemical ball-milling techniques to catalyze the conversion of xylose to furfural. Trimesic acid was used to synthesize three separate catalysts by using the metallic salts $PdCl_2$, $MnCl_2$, and $AlCl_3$. These catalysts were then examined for their furfural yield, stability, and crystalline structure quality. The trimesic-$MnCl_2$ catalyst produced the highest yield, whereas the trimesic-$PdCl_2$ catalyst was the most stable. The trimesic-$AlCl_3$ catalyst was found to be generally unsuitable. Thus, the experiment led to a useful and feasible catalyst for the xylose-to-furfural reaction, and we successfully reported the effectiveness of using mechanochemical ball-milling techniques over traditional solvothermal methods for MOF catalyst preparation.

Keywords: metal-organic framework, catalyst, mechanochemical ball mill, xylose-to-furfural reaction.

Chemical Engineering and Society

Advisor:	**MAK Andrew Tsz Chung/CBME**	**Co-advisor:**	**LIU Yuanshuai/CBME**
Student:	**LEE Pui Ying/CEEV**	**UROP Course:**	**UROP1000, Summer 2015**

This research project focused on the operations of non-governmental organizations (NGOs), especially green groups involved in engineering in society. The findings included certain trends and diverse strategies for fundraising that evolved under NGO interactions with the government, in addition to the business sector. Moreover, partnerships with educational institutions for accomplishing projects are becoming increasingly common, advancing the interests of both parties, and hence, engineering applications can also be promoted. To cope with present-day society with competition among a wide variety of sectors, a form of NGO partnerships with other organizations is developing from their unidirectional dependence on others in the past to establishing more interdependent relations between the parties.

Particle Entrainment Mechanisms at the Base of a Slurry Reactor

Advisor: **MAK Andrew Tsz Chung/CBME** **Co-advisor:** **LIU Yuanshuai/CBME**
Student: **HO Kwan Chak/CIVL** **UROP Course:** **UROP1000, Summer 2015**

This study investigates whether solid suspension in jet mixers could be more efficient compared with agitators. We conducted a literature review and compared the experimental results. Our findings revealed that a nozzle should be installed from the top of the vessel, with the tip pointing downward toward the center to achieve effective suspension. We also found that the nozzle should be placed at half the fluid height based on past literature, but the optimum clearance is likely to be T/2 to T/4. The vessel base, and hence, the last suspension location, is believed to be a chief contributor to the major difference in suspension jet velocity between different geometrical configurations. Therefore, additional energy input is required to remove the dead area.

Monolayer Electrocatalysts for Ethanol Oxidation

Advisor: **SHAO Minhua/CBME**
Student: **HU Qibang/CBME** **UROP Course:** **UROP1100, Summer 2015**

Ethanol, one of the best renewable and easily obtainable fuels, is the ideal energy resource for alcohol fuel cells. However, because of the slow and incomplete oxidation process of ethanol as well as the costliness and limited supply of Pt, the commercial application of fuel cells is considerably limited. Therefore, we synthesized -monolayer-modified Au nanoparticles, which were used as new electrocatalysts for ethanol oxidation, with a one-atom-thick Pt layer covering a Au core to form the catalyst. Afterward, we increased the number of Pt atom layers and examined the catalytic activity of each catalyst of the different layers. We found that the electrocatalyst with one Pt monolayer achieved the best catalytic ability, and that the activity of Pt decreased with the number of Pt monolayers.

Keywords: nanoparticles, monolayer, catalyst, electro-oxidation.

Production of Disinfection Technologies

Advisor:	**YEUNG King Lun/CBME**	**Co-advisor:**	**KWAN Siu Ming/CBME**
Student:	**BONGSO Nadia Benedicta/CBME**	**UROP Course:**	**UROP1000, Summer 2015**

The objective of this project was to develop a commercial mosquito-repellent product that employs the technology of inorganic gel, which has previously been investigated for disinfection. A literature review was conducted to compare the performance of different mosquito-repelling essential oils. The results revealed many potential options that have been used in the formulations, such as thyme oil, rosemary oil, citronella oil, and lemon eucalyptus oil. The sol-gel process, combined with these oils, was investigated using different formulations and under various conditions to identify the optimal preparation of inorganic gels. The gels were then colored differently and shaped into bead form by using a mold, and the intent to have the beads be used in different types of wearable accessories such as bracelets or hair bands.

Advisor:	**YEUNG King Lun/CBME**	**Co-advisor:**	**KWAN Siu Ming/CBME**
Student:	**SULAIMAN Jordy Evan/CBME**	**UROP Course:**	**UROP1000, Summer 2015**

The objective of this project was to develop a commercial mosquito-repellent product in bead form by encapsulating essential oils through the use of sodium alginate. The essential oils used in this study were thyme oil, rosemary oil, citronella oil, and lemon eucalyptus oil. The beads had a hard texture and exhibited favorable aesthetic factors when the preparation parameters were 1.0% sodium alginate and 2.0% calcium chloride, with 20 min of cross-linking. We confirmed that sodium alginate could also encapsulate inorganic gels containing essential oils when the ratio of the oils and DPG is 1:1 and the amount of colloidal silica AS-40 is below 0.5 w/v%. The encapsulation of inorganic gels containing essential oils was found to yield a harder structure for the beads, and could potentially provide an enhanced control release of the oils. The beads can be used in different types of wearable accessories such as bracelets or hair bands by employing a mesh-nylon tube as a flexible structure for holding the beads.

Department of Civil and Environmental Engineering

Developing a Smartphone-Based Condition-Monitoring System for Civil Infrastructure

Advisor: **CHANG Chih-chen/CIVL**
Student: **MAO Suxin/CIVL** **UROP Course: UROP1100, Fall 2014**
WANG Jingwen/CIVL **UROP Course: UROP1100, Fall 2014**

Smartphone technology has recently become increasingly sophisticated. Its portability and computing ability have prompted engineering applications in various fields. In civil engineering, crack detection through the use of digital imaging has undergone development since the end of the last century. Many functions have been proposed and modified in these two decades for improving the accuracy and efficiency of crack detection. For this UROP, we proposed a smartphone-based crack detection method. First, image-processing techniques were applied to perform crack detection as well as crack calculation in MATLAB. Afterward, the MATLAB Coder was used to generate a readable and portable C code based on the developed MATLAB algorithms. The generated C code was then modified and used to create an actual smartphone app.

Dynamics of Rocking Structures: Rocking Isolation of Bridges

Advisor: **DIMITRAKOPOULOS Ilias/CIVL**
Student: **TSE Kwan Shu/PHYS-PP** **UROP Course: UROP1100, Fall 2014**

For this project, we studied the rocking block problem by using the averaging method, which has been determined to be the most suitable method for calculating transitory solutions. Two types of rocking were investigated: free rocking and forced rocking. In free rocking, the amplitude and period of oscillation are determined, and the approximate solution is calculated explicitly. The approximate solution fits the exact solution well under a comparison of a specific problem. By contrast, in forced rocking, various types of sinusoidal excitations are investigated. Using the same trial solution, the expressions for the averaged time rate of the changes in amplitude and phase are deduced, and the steady-state solutions of each type of excitation are obtained.

Advisor: **DIMITRAKOPOULOS Ilias/CIVL**
Student: **TIAN Tian/CIVL** **UROP Course: UROP1100, Spring 2015**

For this project, we investigated a nonlinear oscillator system modeled by the slender bar problem by using the averaging method, which is an appropriate technique for TNL differential equations with transitory solutions. Two types of rocking are discussed in this report: free rocking and forced rocking. For free rocking, the amplitude and period of the oscillation is determined using two averaging methods: the specific method and the standard method. The approximate solutions were identical to those of the exact solution for this simple oscillation. By contrast, for forced rocking, we discuss simple sinusoidal excitation by using the general solutions obtained from the free rocking case, which provides the amplitude and phase expression in the steady state.

Economical High-Impact Pedestrian Bridges

Advisor:	**DIMITRAKOPOULOS Ilias/CIVL**		
Student:	**LAU Tak Kei/CIGBM**	**UROP Course:**	**UROP1100, Summer 2015**
	LI Yat Fai/CIVL	**UROP Course:**	**UROP1000, Summer 2015**
	TSANG Wing Sum/ CIVL	**UROP Course:**	**UROP1000, Summer 2015**
	ZHU Xiaoming/ CIVL	**UROP Course:**	**UROP1000, Summer 2015**

The main purpose of this project was to understand how to build a bamboo pedestrian bridge, and to investigate the strength of the bamboo connections under vertical loading. The proposed bamboo footbridges can be built in remote areas without requiring available funding, industrialized materials, specialized contractors, or skilled workers. The report delineates the process of our investigation and the hands-on practices we engaged in. It presents the critical tests for bamboo members such as the buckling test and the tensile test. For the project, we also tested truss bamboo joints after researching similar methods as well as a trial test on a wooden model. The project provides experimental data for the bamboo elements and pedestrian bridges for further research and practical implications.

Vehicle–Bridge Dynamic Interactions: High-Speed Railways

Advisor:	**DIMITRAKOPOULOS Ilias/CIVL**		
Student:	**FAN Chuen Yee/CIVL**	**UROP Course:**	**UROP1100, Spring 2015**

This study examines two analytical models to track the amplitude of the peak deformation of a bridge when a vehicle passes through. By comparing the exact solution of the peak displacement and the analytical solution of its amplitude computed using two methods and obtained by MATLAB, we investigated the accuracy of the amplitude. The analytical solutions derived from the two methods involved enveloping the peak displacement only, but not the peak deformation of the bridge itself. This paper shows all the calculation procedures and a comparison.

Climate Change Impact Analysis for Hong Kong and Nearby Regions

Advisor: **LAU Alexis K H/CIVL**
Student: **LEONG Kuan Zian/CIVL** **UROP Course: UROP1100, Fall 2014**

Climate change, specifically the rise in temperature, has triggered both local and global concerns because it causes various problems such as a rise in sea levels, which may affect the operations of low-rise areas and generate an unpredictable trend on crop yield, which may threaten the economy and livelihood of people who are dependent on plantation. Therefore, it is critical to reverse, or at least retard, the current trend of climate change (i.e., the rise in temperature to reduce the negative impacts of these threats), and to achieve this, an understanding on the causes behind climate change, especially in urban areas, must be established. The objectives of this study were as follows:

1. Study the relationship between the industrial structures of major cities or countries and the annual rise in temperature in respective regions, or specifically, on the ways in which the composition of an industrial structure is correlated with the rise in temperature in that region.
2. Study the relationship between the rise in temperature in Hong Kong and the use of electricity in various industries.

This paper first presents a discussion on the methodology employed to examine and verify the relationship between the composition of industries in major cities and countries, and their respective annual rise in temperature. Afterward, we deduce possible reasons to explain the trend of the relationship. The relationship between the rise in temperature and electricity consumption, with a specific reference to Hong Kong, is then presented.

Cement-based Piezoelectric Sensor and its Application

Advisor: **LI Zongjin/CIVL**
Student: **WONG Yan Yan Annie/CIVL** **UROP Course: UROP1100, Fall 2014**

Sensors and actuators are useful components in the health monitoring of structures. One of the most efficient mechanisms involves applying piezoelectricity. The preferred approach for performing the health monitoring of structures is the use of cement-based piezoelectric sensors because it has similar lifespan as the structure as well as a similar acoustic impedance. This paper presents the sample fabrication procedures and the experimental results. In the report, we describe the experiment of the piezoelectric performance of piezoelectric disks under different volume proportions of lead zirconate titanate (PZT) in the discs by measuring the piezoelectric strain factor (d_{33}). The piezoelectric disc with 78.4 vol% PZT exhibited a superior piezoelectric property among the tested volumes of PZT.

Innovative Photo-iron-based Processes for Water Disinfection

Advisor: **SHANG Chii/CIVL**
Student: **LI Wai Lok Bernard/CIVL** **UROP Course: UROP1100, Summer 2015**

This study presents the simulation of advanced oxidation processes that emerged as a prevalent removal method for regulating microbial contamination contributed by the presence of such pathogenic enteric bacteria as *E. coli* in contaminated drinking water. The method in this study is based on the use of zero-valent iron ($Fe^{o}(s)$), solar radiation (in the UVB-A region), and *E. coli*. The removal mechanism of the photocatalytic disinfection is attributed to both the inactivation of total coliform and particle-mediated adsorption to iron/iron (oxyhydr-)oxides. A simplified 9222D standard method was used to quantify the fecal coliforms in diluted *E. coli* samples upon incubation. Removal efficiencies were up to 84.3% (based on *E. coli* testing) within 30 min, which evidences the effectiveness of this removal method.

Optimization Approach for Soil Constitutive Model Calibrations

Advisor: **WANG Jui Pin/CIVL**
Student: **CHEUNG Yuet/CIEV** **UROP Course: UROP1000, Summer 2015**

Because of advancements in computer programming, optimization has been widely used in different fields of engineering. They include transportation, logistics engineering, financial engineering, and civil engineering. As in certain previous papers on the optimization method, this paper presents an alternative application of the optimization approach to civil engineering. In this paper, three of the five parameters of the hyperbolic soil constitutive model are used to demonstrate that the novel approach is more accurate and effective compared with the conventional approach. In addition to the methodology, examples are presented to showcase the superior performance of the optimization method.

Uncertainty of Soil Liquid Limit

Advisor: **WANG Jui Pin/CIVL**
Student: **ZHENG Yang/CIVL** **UROP Course: UROP1100, Fall 2014**

As a critical property in geotechnical engineering, the liquid limit is typically determined using two approaches: the Casagrande cup test and the Cone penetrometer test (the Fall cone test was used interchangeably in this project). Regarding the frequent differences emerging between these two tests, experiments were conducted to study the differences between the two in a statistical manner. By conducting linear regression, we derived an empirical formula from the test data, which were compared against those obtained from other studies. A possible explanation and recommendations are also provided at the end of the report.

Application of Environmental-friendly Transparent Soil in Geotechnical Engineering

Advisor: **WANG Yu-Hsing/CIVL**
Student: **WONG Yan Yan Annie/CIVL** **UROP Course: UROP1100, Spring 2015**

Using transparent soil in geotechnical engineering can facilitate the visualization of soil behavior in various processes. The choice of material is essential for the fabrication of transparent soil because its properties must be similar to those of real soil. This paper presents the procedures and the experimental results of using a sugar solution for developing environmental friendly transparent soil. This paper introduces two approaches for reducing the viscosity of the sugar solution to simulate phenomena involving flow processes under conditions where particles can flow easily. The first approach involves combining the sugar solution with a salt solution; however, the experimental results revealed that it may be an unfeasible probable approach because of the need for excessive amounts of sodium chloride, which can lead to corrosion. The second approach entailed mixing the sugar solution with a viscosity reducer used in the Indian sugar industry. This approach was also found to be infeasible because its refractive index decreased with the viscosity of the solution, and thus, failed to achieve an optimal value, where the viscosity of the solution is within the acceptable range, and the refractive index remained at 1.459.

Big Data Architecture and Machine-Learning Initiative for Real-time Landslide Monitoring and Early Warning System

Advisor: **WANG Yu-Hsing/CIVL**
Student: **HO Chun Tak/CIVL** **UROP Course: UROP1100, Spring 2015; UROP2100, Summer 2015**
YUEN Chi Fai/CIVL **UROP Course: UROP1100, Spring 2015**

We introduce big data, which are defined primarily as a complex and large data set that renders conventional data processing inadequate, to geotechnical engineering. This presents the traditional geotechnical science community with a great opportunity to review and conduct improvements by using this innovative application, in addition to major challenges that must be overcome. The concept of big data is introduced because a large amount of raw data generated by microelectromechanical systems accelerometers are used in this system; nearly 4 Mb/s is obviously a massive and unprecedented speed compared with experimental data in the conventional geotechnical sciences. This progress report presents the following information:

1. How the computation of raw data can finally be developed for creating self-improving real-time landslide predictions and warning systems.
2. How the concept of big data and machine learning can be applied to geotechnical science through Python software.
3. Future developments and improvements to this project.

With the successful development of this real-time system, a more powerful, fast response, economical monitoring approach for landslide monitoring and an early warning system can be devised.

Advisor: **WANG Yu-Hsing/CIVL**
Student: **HE Zhou/CIVL** **UROP Course: UROP1100, Summer 2015**
LI Mengyuan/CIVL **UROP Course: UROP1100, Summer 2015**

Landslides are hazardous disasters that occur in numerous areas. The fatal outcomes can be massively attenuated if accurate prediction and monitoring mechanisms can be implemented. However, it is always difficult to predict landslides sufficiently early and to determine the specific time and location. To help resolve this issue, a big-data architecture with a reliable database and processing system was established. For this project, we combined field sensing systems and online data acquisition from various observatories, and then stored and analyzed the data by using the database and processing systems. When the collected data were sufficient and large-scale data collection was provided, the machine-learning initiative was visible. In this manner, the accuracy of the landslide early warning system can be improved.

Advisor: **WANG Yu-Hsing/CIVL**
Student: **MAK King Yin Calvin/CIVL** **UROP Course: UROP1000, Summer 2015**

A landslide is a geological phenomenon that includes different types of ground movement. Rock falls and debris flow are examples. These movements have an enormous impact on humans because the collapse of slopes results in fatalities. Therefore, a landslide monitoring and early warning system is essential for landslide prediction. This project proposes the construction of a big-data architecture that can rapidly process unlimited amounts of data. This can be achieved by employing a distributed database and a batch-processing system. The proposed system can process and store data that are collected from the Internet and MEMS sensors. These data consist of specific parameters (e.g., rainfall, temperature, and microseismic activity), which determine the real-time stability of slopes.

Keywords: landslide monitoring, early warning, distributed database, batch-processing system, MEMS sensors, microseismic activity, stability.

DEM Simulations and Experiment on the Kinematic Behavior of Soil Contacts in Response to Biaxial Shearing

Advisor: **WANG Yu-Hsing/CIVL**
Student: **GAO Jiayi/CIVL** **UROP Course: UROP1100, Fall 2014**

After one summer assisting with the project, I gradually solidified my knowledge on how the biaxial test functions, such as the basic knowledge on what technique is required for printing experimental materials, which equipment can actually be used during the biaxial test, how particle tracing functions, and what is a photo-editing technique. In learning such knowledge, I commenced reviewing the literature on basic concepts such as on 3D printers, PIV, biaxial devices, trackers, MATLAB, and Photoshop. During the study period, my knowledge was relatively enhanced, and thus, this year I am continuing my participation in the project with the same experimental portion, as well as commencing more detailed calculations. Moreover, this report details what I have learned from my viewpoint.

Contract Management Practices in Delivering Various Types of Infrastructure Projects through Public Private Partnerships

Advisor: **ZHANG Xueqing/CIVL**
Student: **LEONG Kuan Zian/CIVL** **UROP Course: UROP1100, Spring 2015**

A public private partnership (PPP) involves cooperation and coordination between the governmental sector and the private sector for delivering public infrastructure services to the population. Infrastructure services such as the water supply and waste management services are typically provided by the government, but as the system becomes more complex, the private sector is involved, in varying degrees of participation based on the PPP model, to provide such services instead.

PPP can emerge in various forms based on the needs and nature of a particular industry. The most common types of PPP include build-operate-transfer (BOT); design, build, finance, and operate (DBFO); service agreements; joint ventures; and concessions, each with varying degrees of participation and investment from the private sector.

This paper primarily examines the factors that affect the choice of PPP, which include the following:

1. The nature of a particular service industry, and
2. The sophistication of the market that hosts PPP.

An Analytical and Numerical Investigation of Debris Flow and its Impact on Hong Kong

Advisor: **ZHAO Jidong/CIVL**
Student: **CHUNG Ka Lung/CIVL** **UROP Course: UROP1000, Summer 2015**

This study employs the discrete element method (DEM) to investigate the mechanism of debris flow in rapid granular flow. Certain case studies have validated the DEM tool, LIGGGHTS, by matching the site observation velocity with the simulation and in a comparison against the results with 2D-DMM. The main challenge of this research concerns the interpretation of the result regarding dry granular flow as a hydrodynamic result. In the macroscopic view, the constitutive flow propertied in the DEM should be similar to the actual case.

Regarding our progress, this report discloses the calibrations of Sham Tseng San Tsuen debris flow, which occurred in 1990, which will be included in the final project. The calibrations involved various parameters.

Department of Computer Science and Engineering

High-performance Wi-Fi Technologies for Throughput and Coverage Improvements

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **WU Yun-chen/COMP** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

Good indoor localization technology requires high accuracy, which is difficult to achieve. To improve the performance of Wi-Fi indoor localization, excellent knowledge on the pattern of the probe request sent by cellphones is a critical issue because it contains numerous useful information for conducting further analyses. Various phone brands may have relatively different behaviors when transmitting a probe request because of their hardware or operating systems. Statistical were are collected regarding different phone brands as well as certain other, different settings to study the probe request thoroughly.

The data collection process was conducted on a coded router. Studies on the Linux system and libpcap were also performed to enhance the experimental results.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **AGATHA Felicia/SENG** **UROP Course:** **UROP1000, Summer 2015**

In a multi-AP WLAN system, users might experience problems with Internet services because each AP operates at a certain channel or frequency, and if this channel interferes with that of another AP, this problem arises. An appropriate power and channel must be assigned to each AP, so that they do not interfere with each other. Therefore, this project focuses on the creation of a program that extracts the information required for optimizing the power and channel assignment from a database, and then returning the processed information to the database. Performance testing on the routers after power and channel optimization was also attempted, but could not be completed.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **CHOI Hong Joon/COMP** **UROP Course:** **UROP1000, Summer 2015**

The performance of wireless network connections from any device relies heavily on the mechanism used by devices for selecting the best access point (AP). The current mechanism of choosing the AP in most devices involves comparing the signal strength from all nearby APs. This mechanism, however, is well known to be a suboptimal solution because it ignores the load of each AP. Because all clients tend to connect to the AP with the strongest signal, the selected AP might not provide the best service. In our project, we address this problem by using an app that collects the load information of APs from the server, and identifies the AP with optimal performance. By using a simple algorithm, we select an AP that can potentially provide the best bandwidth. Our group, Hong Joon and Steve, constructed an Android app that implements such a solution in the background. This report presents a discussion on our developmental process and outcome.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **GOWDARA VENKATA REDDY Vedanth/SENG**
UROP Course: UROP1000, Summer 2015
TSANG Hauton J./SENG **UROP Course: UROP1000, Summer 2015**

For this project, we first conducted a field test to collect data and calibrate the Wi-Fi mesh network system at various points in the university, and then ran a server that aimed to localize individuals based on data collected during calibration. This effectively permits tracking any individual located within the range of the calibrated mesh network, yielding valuable statistical information that can be used for commercial purposes. We found that the calibration process is relatively tedious because it takes a considerable amount of time and effort to establish the wireless mesh network as well as to execute the calibration process.

Indoor Localization and Mobile Computing

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **AHMED Saif/CPGBM** **UROP Course: UROP1100, Spring 2015**

The primary scope of this project involved an app, Wherami. The app aims to provide localization for users who are indoors and cannot use GPS.

Wherami provides the details of the user's current location, information regarding his/her surroundings, and possible routes from different points within a selected map.

The plan is to have both Android and IOS versions of the map, so that greater user bases can utilize the features of this app. Therefore, we are engaged in substantial research and development on the two operating systems. The app is currently being developed with maps for different floors of HKUST.

We plan to eventually conduct commercial and real-site testing.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **SURI Shivam/COMP** **UROP Course: UROP1000, Summer 2015**

Outdoor navigation has become a part of daily life. The use of Google Maps and similar applications has become commonplace among the public, and are used frequently. Although effective outdoor navigation platforms have been developed, the development for indoor navigation remains scant. With such massive structures being built worldwide, finding one's way within a building or a setting can be a daunting task. This project addresses this problem through the development of a product called, "Wherami," a mobile app that provides indoor-navigation features for four locations, including HKUST, Cyberport, Olympian City, and HKIA.

Large-scale Multimedia Streaming Technologies for Mobile Internet

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **YANG Jiajie/CPEG** **UROP Course: UROP2100, Fall 2014**
ZHANG Yuan/CPEG **UROP Course: UROP1100, Fall 2014**

Video on demand (VOD) is currently becoming an increasingly popular term for common users. Searching for movies, television programs, or live shows, everyone from teenagers to senior citizens use the VOD system to meet their needs. With numerous systems of this type becoming commercially available, it is essential to develop a low-delay, content-rich, video interface that provides a smooth performance for potential users. This project focuses on a VOD system based on the distributed server system among various areas, one that provides services for multiple platforms such as personal computers, mobile devices, and others. Our group in this project maintains mainly the user/administrator interface for the CDN and VOD system.

Keywords: CDN, mobile Internet, video on demand.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **DENG Bowen/CPEG** **UROP Course: UROP1100, Spring 2015**

My UROP can be divided into two parts based on time. First, because of my limitation in network knowledge, I attempted to enhance my understanding of computer network programing (i.e., PHP), server setup and configuration, and using Linux. Second, I developed a checking log information program in the second half of the semester. As is widely known, companies have to know which parts of information are requested most frequently, and which parts are not highly popular in their servers. All such logging information is relatively important, which can be utilized to assist companies in making decisions on which resources should be stored in servers in the future; therefore, the main purpose of my project is access the server database, and allow users to download the information according to the start and end times they choose.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **KU Bon Kyung/COMP** **UROP Course: UROP1100, Fall 2014;**
UROP2100, Spring 2015

The number of Internet users is increasing exponentially as Internet services become more widespread. As a consequence of this growing trend of Internet users, scalability has become a major concern for both service providers and application service providers. The same is true for the multimedia industry, where scalability and efficiency become increasingly crucial aspects with the rising number of users as well as their expectations. Hence, this report details the methods used and difficulties in implementing scalable and efficient downloaders and uploaders. The pure Java NIO library was used, which could potentially be employed for practical purposes in the live streaming industry.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **ZOU Yuxuan/CPEG** **UROP Course: UROP1100, Spring 2015**

In multimedia streaming, users receive hls video streams from servers. It is crucial to monitor the working status of these servers to provide stable services for users. The traditional monitor program, which ran on a central computer, however, conducted monitoring by obtaining video streams directly from the servers to supervise their functionality. This is equivalent to watching dozens of live videos simultaneously, which is a heavy burden and is costly in terms of bandwidth. The purpose of this UROP was to design a new monitoring program, which implements distributed monitoring, to be run on the servers as well as a central monitor. Thus, the central monitor receives only the data sent by the servers, which contains abstract information of the hls streams of the channels on the server, and it then analyzes these data, after which it constantly provides reports on the monitored servers.

Advisor: **CHAN Gary Shueng Han/CSE**
Student: **CHE Sen Hei/COGBM** **UROP Course: UROP1100, Summer 2015**

As streaming technology improves daily, people can easily access TV shows, movies, sporting events, music, and others. This report addresses the trend and the market of streaming technology, with information relevant to fog-and-cloud, content delivery networks, and data centers. Throughout the research, the sources were retrieved mainly from newspapers, e-newspapers, Google results, Euromonitor, and Bloomberg. The report provides a table, analysis, a report, and a comparison among different technologies or breakthroughs in the market. Because the market for streaming technology is still growing and changing by the second, this paper focuses on the analysis of the market and technologies, instead of presenting a summary.

Spreadsheet Error Detection

Advisor: **CHEUNG Shing Chi/CSE**
Student: **ZHAO Lucen/SENG** **UROP Course: UROP1100, Summer 2015**

Spreadsheets are a powerful and extensively used tool for data analysis, which requires a high level of accuracy. However, it is easy to make mistakes when manually designing spreadsheets, and potential errors may have severe consequences. For this project, we developed a tool for spreadsheet error detection and correction. After analyzing the results of both AmCheck and the new tool, we found out that this tool is effective for error detection, and summarized certain mistakes it made. We also found a new type of error, which warrants further research.

Advisor: **CHEUNG Shing Chi/CSE**
Student: **ZHOU Xuefan/COMP** **UROP Course: UROP1000, Summer 2015**

Spreadsheets are a popular software tool used worldwide. End users who are unfamiliar with appropriate software development practices are more likely to make errors (e.g., undisciplined copying and pasting and missing formulas). Especially in business, spreadsheet errors can result in great financial losses. It is better to find errors and smells in spreadsheets by using software tools. In this project, I assist with the checking of the results of two types of tools that are used for finding errors and smells in spreadsheets, and gained practical experience in using Java Apache POI.

Distributed Algorithms for Cloud Computing Platforms

Advisor: **GU Lin/CSE**
Student: **HO Chun/COMP** **UROP Course: UROP1100, Spring 2015**

Parallelization is a critical technology in cloud computing and big-data analysis, enabling the fast computation of massive amounts of data. Data Thinker is a highly scalable system for data processing, and it can run on multiple processors in a single computer or on hundreds of high-end servers in a cluster. Puc is a special programming language designed to support massive parallelism on Data Thinker, and it has a syntax similar to that of the C language. We examined parallelization using Puc on Data Thinker by developing a recursive program that solves the N-Queens problem as well as an iterative program of a multilayer neural network with supervised training using backpropagation. After coding and testing these two programs, certain potential problems and areas for potential improvement were discovered.

Advisor: **GU Lin/CSE**
Student: **SHANG Hang/CPEG** **UROP Course: UROP1100, Spring 2015**

Cloud computing is quickly becoming a popular technique for managing large data sets with the substantial increase in the rate of information at present. This report details my learning different types of recommender systems, and my attempt to conduct analysis using collaborative filtering. This report presents my process for analyzing and designing the project.

Distributed Computing in a Virtual Environment

Advisor: **GU Lin/CSE**
Student: **LIE Andrianto/COMP** **UROP Course: UROP1100, Fall 2014**

Emerging trends in cloud computing have forced increasingly more Internet-based applications to conduct computations in a virtualized environment. To manage a larger set of data, such virtualized environments are usually built using numerous loosely coupled computers. One approach to building a virtualized environment by using these loosely coupled computers is Layer Zero. Layer Zero utilizes the ISA layer to abstract hardware implementation, so that the loosely coupled computers can be visualized as one large virtual computer by programmers. With Layer Zero, various sophisticated algorithms can be implemented easily for running in parallel across the loosely coupled computers. This report focuses on the implementation of the producer–consumer problem and sentiment analysis in Layer Zero.

System Software for Cloud Computing

Advisor: **GU Lin/CSE**
Student: **CHOW Ho Yin/CPGBM** **UROP Course: UROP1100, Spring 2015**

This report mainly details the work in the modified scheduler on the D-Thinker platform, which aims to produce more detailed information for programmers regarding memory commit errors, including further debugging information such as variable names. The second half of the report is a discussion on a real-life example, namely k-value determination for clustering, which uses the modified scheduler. To induce more scenarios for memory commit errors, the k-means program adds an iterative and parallel approach to run the algorithm with a different k, so that it can analyze the subsequent commit error information provided by the scheduler.

A Data-Mining-based System for Trip Planning

Advisor: **HUI Pan/CSE**
Student: **CHEN Liyu/COMP** **UROP Course: UROP1100, Fall 2014**
XIE Sirui/ELEC **UROP Course: UROP1100, Fall 2014**

With the rapid development of modern society, traffic congestions have become a prevalent issue in metropolitan cities. Transportation system designing and management have comprised a substantial portion of the financial budget of governments worldwide. The implementation of equipping taxicabs with GPS devices is an initiative that has allowed researchers to examine the inner correlation of traffic anomalies emerging in different regions. The aim of this research is to identify critical regions in a city that have a significant influence on its traffic conditions, which we defined as honeypots in traffic anomalies. Principal component analysis was conducted to detect anomalies from taxi data. A spatial, temporal, and logical correlation model was used in association rule mining for traffic congestions in different regions. Afterward, the regions in the city were ranked by employing the independent cascade model; the honeypots were selected based on this ranking. Experiments were conducted with data retrieved from taxicabs in Beijing.

Algorithms and Games in Android Devices

Advisor: **HUI Pan/CSE**
Student: **HU Yao-chieh/SENG** **UROP Course: UROP1100, Summer 2015**
LIN Shuya/SENG **UROP Course: UROP1100, Summer 2015**
LIU Boyu/SENG **UROP Course: UROP1100, Summer 2015**

The current proliferation of information is uncontainable and irreversible, and communication protocols and channels are continuously under development. Implementing Wi-Fi peer-to-peer (p2p) technology on community chats or for sharing data is a novel concept, and supports a faster and more reliable transfer channel compared with Bluetooth. Wi-Fi p2p provides a longer feasible distance for searching, connection, and file transfer compared with the limited distance of Bluetooth usage. Remaining up to date with recent trends, it is inevitable that the potential of Wi-Fi p2p development on Android warrants a good investment in time and energy. Despite numerous unresolved challenges on this unpredictable path of development, the unlimited rewards from resolving such issues should present substantial opportunities.

Advisor: **HUI Pan/CSE**
Student: **WENG Jiaqi/SENG** **UROP Course: UROP1100, Summer 2015**

The detection of Wi-Fi signals and neighboring cell towers provide information for users to refer to during selection. Many cellphones have these functions, and applications are available online to meet these needs. Every cellphone can show a list of Wi-Fi signals, including the one it is currently connected to. However, numerous adjustments must be made to process the information it can access. Moreover, to make this process more direct, it is possible to locate such sources of signals on Google Maps by using the powerful Android Studio. However, when creating the application, problems arise. These problems concern the Android system, the phone hardware, and other reasons that have yet to be determined.

Advisor: **HUI Pan/CSE**
Student: **YAN Rui/SSCI** **UROP Course: UROP1100, Summer 2015**

As is widely known, compressing a video can be slow, especially when losslessness is required. With the acceleration of data transmission, compressing one video with multiple devices has become practical. The main concept is to sacrifice the time to transmit, and to secure more time through synchronous compression. Five main functions must be implemented: video recording, compression, split, merging, and transmission. Through these five fictions, after recording a video, the program can split it into some small units before distributing them to other devices nearby. When the receivers finish compressing, they return the compressed units to the original device, where the entire video is compressed after the units are merged.

Crowdsensing SLaM and AR System for Mobile/Wearable Devices

Advisor: **HUI Pan/CSE**
Student: **ZENG Cancheng/ELEC** **UROP Course: UROP1100, Spring 2015**

For this project, we examined and developed an intelligent cellphone gimbal system with applications for video stabilization and people tracking. The entire system consists of three parts: a 3-axis gimbal system, a development board with low-energy Bluetooth communication, and a smartphone. This paper presents a discussion on the mathematical models related to computer vision, machine learning, and control theory, which were applied during the development of the system, including camera calibration, visual object detection and tracking, as well as software technologies that were employed for creating the mobile app. Potential applications in augmented reality with visual simultaneous localization and mapping are also discussed in this paper.

Machine Learning on Wearable Devices

Advisor: **HUI Pan/CSE**
Student: **ARSHAD Mohammad Arslan/SENG** **UROP Course: UROP1100, Summer 2015**
LIU Xin/SENG **UROP Course: UROP1100, Summer 2015**
ZHANG Yifeng/COMP **UROP Course: UROP1100, Summer 2015**

The popularity of mobile and wearable devices has increased rapidly in recent years, acting as a catalyst for shifting PC applications to mobile platforms. According to an announcement made by Google on May 10, 2011, the official Android market reached a milestone with 200,000 apps. Compared with non-mobile hosts, mobile devices have numerous advantages such as flexibility. In the field of facial expression recognition, flexibility has been discovered to be vital because it is simpler and more convenient for smartphones or Google Glass to capture images and provide prompt feedback. However, the limitations of computational resources on mobile devices hinder sophisticated tasks such as machine learning. Considering the restrictions, uploading computational parts on a cloud server has become viewed as a suitable solution. This report presents a rough implementation of a simple facial expression recognition project.

Keywords: machine learning, smartphone, expression recognition, mobility.

Privacy by Design Meets Mobile Computing

Advisor: **HUI Pan/CSE**
Student: **KWOK Chung Hin/COMP** **UROP Course: UROP1100, Spring 2015**

In the information era, people have been accessing all types of information conveniently through their devices, which are connected to the Internet. When information is being transferred to users, their private data are being leaked and manipulated by third parties. In this project, we examined two approaches to identify the underlying principles in safeguarding users' privacy. One approach, ipShield, is a sophisticated mobile framework delegating a high level of privacy control on Android devices to users. Another approach, Caché, involves prefetching all location-enhanced content beforehand to enable local mobile computations.

Knowledge-based Search Technologies for Enterprise Websites

Advisor: **LEE Dik Lun/CSE**
Student: **HON Ka Lam/COMP** **UROP Course: UROP1100, Summer 2015**

Most large websites store a large quantity of many types of information (e.g., user profiles and Web usage). This information source is valuable for conducting improvements to a search engine's performance. However, it is inaccessible to external search engines. Enterprise search engines can harness this private source, and provide suitable search capabilities for the website's users.

This paper details our experimentation with the use of Web usage logs to enhance a search algorithm. Specifically, association rules are used. They are incorporated into the Hyperlink-Induced Topic Search (HITS) algorithm, and experiments are conducted to evaluate the effectiveness of the new algorithm.

Keywords: enterprise search engines, data mining, HITS, association rules.

Learning about Social Learning in MOOCs

Advisor: **LI Xin/CSE**
Student: **HUANG Kung-hsiang/SENG** **UROP Course: UROP1100, Summer 2015**

The performance of wireless network connections from any device relies heavily on the mechanism used by devices for selecting the best access point (AP). The current mechanism of choosing the AP in most devices involves comparing the signal strength from all nearby APs. This mechanism, however, is well known to be a suboptimal solution because it ignores the load of each AP. Because all clients tend to connect to the AP with the strongest signal, the selected AP might not provide the best service. In our project, we address this problem by using an app that collects the load information of APs from the server, and identifies the AP with optimal performance. By using a simple algorithm, we select an AP that can potentially provide the best bandwidth. Our group, Hong Joon and Steve, constructed an Android app that implements such a solution in the background. This report presents a discussion on our developmental process and outcome.

Advisor: **LI Xin/CSE**
Student: **LEE Man Tat/COMP** **UROP Course: UROP1000, Summer 2015**

Massive open online courses (MOOCs) are a recent invention in distant education that is undergoing rapid development. MOOCs have the potential to scale higher education through the Internet. Coursera, edX, and Udacity are examples of popular MOOC platforms.

In addition to traditional course materials such as readings and assignments, many MOOCs provide discussion forums for supporting community interactions between students and instructors. For this research, we collected a comprehensive data set by crawling discussion forum data from Coursera. Afterward, a statistically analysis was conducted to examine the activities of MOOC forums.

Advisor: **LI Xin/CSE**
Student: **RYAN Budi/SENG** **UROP Course:** **UROP1000, Summer 2015**

For this project, we examined an indoor localization app, Wherami, developed by Multimedia Technology Research Center at HKUST. In this project, we are expected to briefly learn the technology of Wherami, and assist in the development of the newest version of the mobile app by searching for potential bugs, debugging, and providing suggestions for potential improvements by conducting market research on similar applications. During the research, we expect to gain a considerable amount of knowledge on the technology and usage of Wherami, and apply this knowledge in real commercial settings and for future technology deployment.

Recognizing Handwriting Digits

Advisor: **LIN Fangzhen/CSE**
Student: **LIM Sung Su/COMP** **UROP Course:** **UROP1100, Spring 2015**

Character recognition is a widely used application in daily life. Numerous neural network models and methods have been proposed for recognizing handwritten characters. This report presents our implementation of and discussion on the basic learning model of a perceptron for recognizing handwritten numerical digits from the MNIST data set.

Advisor: **LIN Fangzhen/CSE**
Student: **LIN Geng/COMP** **UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**

The major topic of this project involved using a group of perceptrons to capture any training data set. A program was written to manage the operations on perceptrons. The group's concept was explained and tested in a simple 2D space. The results revealed that the conjunction of several perceptrons was excellent. Although the test could not be run for the handwritten digit database because of a design flaw in the program, the reason and solution are clear, and the issue will be resolved in the near future. The next stage of the project involves analyzing and optimizing the results from the present algorithm.

Detecting Event Connections in Twitter

Advisor: **NG Wilfred Siu Hung/CSE**
Student: **PANG Ka Wing/COMP** **UROP Course: UROP1000, Summer 2015**

Twitter is a social networking site that limits user posts to fewer than 140 characters. This nature of the Twitter message makes it difficult for data mining and natural language processing on Twitter. This report mainly concerns a query-less search framework for Twitter. This framework monitors the Twitter data stream, and then extracts frequently appearing words to form a graph of words. The nodes are words, and the edges are the correlations between words. Our findings showed that the use words as node may be insufficient. Therefore, a Twitter-named entity recognition system was introduced to improve the accuracy.

Visual Analysis of Big Data

Advisor: **QU Huamin/CSE**
Student: **CAO Wang/ELEC-HR** **UROP Course: UROP1100, Fall 2014**

For potential postgraduate students who are preparing to apply for a certain program, the official information from the university indicating the graduation intervals, the number of students that a particular professor typically supervises per year, or the trend of research areas that have attracted increasingly more participants usually is of great assistance in their selection of a suitable postgraduate program. For the Department of Computer Science at HKUST, however, the archives are arranged discretely on different Web pages in traditional text form, which is inconvenient for visitors wanting to acquire information on past circumstances. Therefore, we want to develop a data visualization approach that intuitively presents the general patterns of postgraduate computer science programs at HKUST.

Advisor: **QU Huamin/CSE**
Student: **JEONG Seowon/MATH-ST** **UROP Course: UROP1100, Fall 2014**

This report traces the developmental trends of HKUST and KAIST, two leading Asian USTs, since their inception. The multidimensional approach was employed to scrutinize the similarities and differences in their development. Although the fundamental mission of HKUST and KAIST appears to converge, because of the interference of their cultures and geographic locations, certain aspects such as student interest exhibit distinct heterogeneity. Absolute superiority is unquantifiable because both universities have relative strengths and weaknesses; whereas HKUST is more successful in extending international partnerships for trading intellectual property, KAIST is more actively engaged in research. These institutions' assignment of different weights to the same domain has changed their developmental orientation continuously.

Advisor: **QU Huamin/CSE**
Student: **LO Tsz Cheung/COMP** **UROP Course: UROP1100, Fall 2014**

The purpose of this project was to visualize information on qualifying exams, proposal defenses, and thesis defenses from students who have finished or were still active in their postgraduate programs in the Department of Computer Science at HKUST, from 2000 to 2014. The entire project was divided into two parts, which included using a Web crawler to extract extant data from official archives and performing visualization for a clear reference.

Keywords: postgraduate program, information visualization.

Advisor: **QU Huamin/CSE**
Student: **ZHANG Yifeng/COMP** **UROP Course: UROP1100, Fall 2014**

The number of commercialized software programs is increasing at an unprecedented rate in the twenty-first century. However, with the proliferation of the software industry, source code plagiarism prevention and detection are becoming increasingly crucial for ensuring the healthy development of the field. Among all of the properties of programs, the coding style is an essential criterion for determining whether plagiarism has occurred. The project presents several data visualization methods for analyzing the coding style, which could reveal the level of similarities between two programs with superior results compared with extant numerical tools. Moreover, examples of diverse methods are provided for clarification.

Keywords: software programs, plagiarism detection, coding style, visualization.

Advisor: **QU Huamin/CSE** **Co-advisor:** **CHEN Lei/CSE**
Student: **CHEN Taiyou/COMP** **UROP Course: UROP1100, Summer 2015**

That selecting and pursuing a major or career that suits a student's interests and passions is critical is unanimously supported. Nevertheless, choosing an ideal major remains a critical challenge for students and their parents. A considerable amount of research has been conducted for assisting people identify the majors that suit them, and how their major fits them. Specifically, ACT, Inc. has collected multiple factors including student indications and declarations of their major, ACT test scores, program of study, and so on, to build "best-fit" major and "fitting indices" for every student. However, the performance of ACT assessments—how the perceived major suits the students' actual interests—is still to be examined. This study emphasizes mainly the analysis and visualization of the related factors, and aims to determine whether the perceived interest suits the actual major.

Keywords: visual analysis, fitting index, change of interest.

Advisor:	**QU Huamin/CSE**	**Co-advisor:**	**CHEN Lei/CSE**
Student:	**CUI Minhui/SSCI**	**UROP Course:**	**UROP1000, Summer 2015**

At present, students of higher education tend to have a preference for U.S. universities, which have accumulated major data sets on admissions information. Therefore, research on the regularity of admission outcomes is required to obtain sufficient evidence for this large group with this specific interest. People may exercise their critical thinking abilities, and substantial research has been conducted to identify the trends. However, no good visualization has been obtained, and it is difficult to determine the regularity of universities directly. This paper presents a conclusion based on selected top U.S. universities by using two visualization methods, and provides the results.

Keywords: top universities, admissions outcomes, big-data visualization.

Advisor:	**QU Huamin/CSE**	**Co-advisor:**	**CHEN Lei/CSE**
Student:	**DU Xinnan/SENG**	**UROP Course:**	**UROP1000, Summer 2015**

With the development of new technologies, it is becoming increasingly difficult for individual researchers to conduct groundbreaking research on their own, and thus, scientific collaboration has become increasingly critical. Interest has recently been growing in exploring and visualizing collaborations among various entities. As one of the best research universities worldwide, many research projects are conducted each year at HKUST. However, scientific collaboration has not been fully analyzed. The objective of this project is to provide a general overview and present detailed information on the evolution of collaboration by using publication data provided by the HKUST library. By using various visualization techniques, we identified several patterns across schools, departments, and professors. Specifically, we used node-link diagrams with a force-directed layout [3] to determine the general trend of collaborations directly, and more detailed information is provided through line charts and area charts [5].

Advisor:	**QU Huamin/CSE**	**Co-advisor:**	**CHEN Lei/CSE**
Student:	**PURI Abishek/MAEC**	**UROP Course:**	**UROP1000, Summer 2015**

This paper presents a discussion on the visual analytic system ParkVis, which our team developed for the IEEE VAST Challenge 2015. The data set the system was built for amusement park data, specifically the fictitious DinoFun World Park, which was used for the challenge. This system allows users to filter movement data of parks visitors based on which areas they visited and the rides they went on, and it also scales all of the movement data of a user by employing our MDS and presenting it in MDS view. In this report, I focus primarily on the visual aspects of our system as well as the interactions between various components in the system.

Advisor: **QU Huamin/CSE** **Co-advisor:** **CHEN Lei/CSE**
Student: **WANG Tianyu/MATH-AM** **UROP Course:** **UROP1100, Summer 2015**

This study investigates the role that force-directed graph can potentially play in dimension reduction, which is a category of algorithms that embed points in a high-dimensional space into a low-dimensional space through projection or transformation. To achieve satisfactory results in dimension reduction for visualization through force-directed graphs, we first constructed a graph from high-dimensional data. Afterward, we attempted to discern a suitable layout by fixing certain points in the graph before the points began to evolve with gravity. This report details our attempt to solve the dimension reduction problem from a new perspective.

Visual Analysis of Financial News Articles

Advisor: **QU Huamin/CSE**
Student: **CHAN Yeuk Yin/CPGBM** **UROP Course:** **UROP1000, Summer 2015**

When reading financial news, although certain critics explain the fluctuations in pricing in daily articles, the news often asserts bias on such critics' opinions. By contrast, the amount of financial news published at present is staggering, with widely varying opinions on the same issues. Unless one has expertise on the entire environment, the reader finds it difficult to remain objective and identify useful information from the mass media. If a computer can analyze all news and generate a narrative that addresses all of these concerns related to the news, any reader can obtain a more convincing story. At present, narrative visualization is a popular technique for news media in delivering reader-driven stories, and is a potential field for application. For this paper, we first identified financial news with two features: polarity associated with each news story, and factors impacting the price or being affected by the price. Afterward, we applied these features to explain the price fluctuations and the socioeconomic relationships between pricing and different topics. Finally, two case studies were conducted to demonstrate the effectiveness and usefulness of FinaVistory in assisting users with different purposes to understand the stories behind Europe's unemployment rate after the 2008 financial crisis as well as the oil prices in 2014.

Keywords: narrative visualization, FinaVistory, socioeconomic effects, text mining.

Advisor: **QU Huamin/CSE**
Student: **DENG Bowen/CPEG** **UROP Course:** **UROP1100, Summer 2015**

Social network analysis is performed to investigate and analyze social networks through the use of various types of strategies such as graph theories, visualization, and data-mining skills. As a special type of social network, the ego network consists of a focal node, designated as the "ego," and "alter" nodes, with which the ego has a direct or indirect relationship. By using the ego network, we can discern the closeness between two people by analyzing the similarities between their ego networks. This report presents a technical tool called, "egoComp," which is an intuitive approach to analyzing and visualizing similarities between ego networks by identifying the common nodes between two such networks.

Visualization Techniques for 3D Urban Environments

Advisor: **QU Huamin/CSE**
Student: **CHEN Shaoyu/COMP** **UROP Course: UROP1000, Summer 2015**
ZOU Yuxuan/CPEG **UROP Course: UROP1100, Summer 2015**

It is crucial for university students to choose a major that fits their interest. Students whose majors fit their interest are more likely to do well in university and complete a degree. Numerous factors influence the choice in a major, such as gender, score, and whether a student is transferring. Certain organizations such as ACT have developed methods for predicting how well a major fits a student's interest, and the ideal fit of a major for a student. Certain differences exist between the self-reported interested major and the predicted ideal fit. We used different designs to visualize the impact of different factors on students, and we hope that our visualization can assist students in choosing their major.

Advisor: **QU Huamin/CSE**
Student: **HUANG Shan/SENG** **UROP Course: UROP1000, Summer 2015**

With the rapid expansion of the Internet and e-learning platforms, an increasing number of people are enjoying the convenience of learning through massive open online courses. When taking online courses, millions of users leave a substantial amount of data; specifically, their click streams, which can be used as valuable feedback for course instructors and learning analysts. Click stream analysis is designed to provide Web site owners information on how visitors are using their site. In this report, we visualize the correlation between user behaviors and the attributes of the course videos to identify and analyze certain patterns, and to predict user behaviors based on the video content.

Efficient Algorithms for Mining Biological Data Sets on Modern Graphics Processing Units

Advisor: **SANDER Pedro V/CSE** **Co-advisor:** **HUANG Xuhui/CHEM**
Student: **HON Wai Kin/COSC** **UROP Course: UROP1100, Spring 2015**

We implemented a mean shift algorithm on the graphics processing unit (GPU) in parallel to perform clustering on conformations from molecular dynamics simulations. The algorithm on the GPU is faster compared with CPU implementation by up to one order of magnitude. We tested the algorithm on alanine dipeptide. It groups 11 clusters in 16 seconds on 50,100 conformations in GPU implementation with optimization. This is achieved by parallelizing the algorithms effectively on the GPU and utilizing the distinct GPU features. Certain optimization techniques were employed to further accelerate the implementation of the algorithm. However, in the presence of optimization, the improvements from parallelizing the algorithm became void.

Advisor: **SANDER Pedro V/CSE** **Co-advisor:** **HUANG Xuhui/CHEM**
Student: **LAW Po Ming/COGBM** **UROP Course:** **UROP1100, Summer 2015**

Apart from appreciating the stunning details of a gigapixel panorama, that of panorama of extremely high resolution is known for its practical use. Because drones provide flexibility compared with land panorama, techniques in capturing panoramas using drones have been developed. Although well-developed systems exist for generating reasonably high-resolution sky panorama, creating panorama with an even higher resolution by using a DSLR camera and zoom-in lenses is difficult because of the instability of drones and the weight of DSLR cameras combined with a zoom-in lens. The heavy load and unpredictable wind conditions are likely to cause the drone to shake and leave holes in a panorama. A robust system is required to ensure that no holes emerge when the gimbal is controlling the camera to capture images in different directions. We propose a novel system that we implemented, which uses a drone that can carry a heavy load and a smartphone as a wide-angle camera for obtaining sky panorama without holes. The untested user interface revealed inherited problems in the system, and further experiments are necessary to increase its flexibility and degree of automation.

Large-Scale Visual Recognition Challenge 2014

Advisor: **TANG Chi Keung/CSE**
Student: **LAW Hei/COSC** **UROP Course:** **UROP1100, Fall 2014**

We present a system for learning from a large data set provided by Imagenet and for detecting objects in 200 categories. We used the R-CNN system by Girshick et al. as our baseline system. By capitalizing on R-CNN, we created our system based on advanced techniques used in object detection to conduct further improvements on the detection results. The foundation of our system is R-CNN. First, nearly 2000 regions of proposals were extracted from each image. Afterward, for each proposal, we extracted the CNN features with a model that was fine-tuned using ImageNet Large-Scale Visual Recognition Challenge (ILSVRC) 2014 image data. The features extracted from training and validation were used for training the SVM as well as for determining the optimal parameters. For object detection, each proposal was scored using the trained SVM, DPM, and IFV. For proposals with scores larger than the threshold, they were merged to produce a more precise bounding box. Our system was ranked fourth in the ILSVRC 2014 challenge, and won in 18 object categories, with a mean average precision of 28.8669% in object detection with the provided training data, and no additional training data were used.

Efficient Algorithms on Knowledge Data Set for Education

Advisor:	**WONG Raymond Chi Wing/CSE**	**Co-advisor:**	**HU Jishan/CSE**
Student:	**SUN Yushi/PHYS**	**UROP Course:**	**UROP1100, Fall 2014**

It has apparently become common among programmers to think of SQL when the word “database” is mentioned. By exploring the origins of SQL and current alternatives to SQL databases, I identified the strengths and weaknesses of each data model. I discuss and compare them in this article, specifically the relational model, object-oriented model, document-oriented model, and graph model. The findings indicated that the document-oriented model appears to be the ideal choice for application in education.

Knowledge Discovery over Databases

Advisor:	**WONG Raymond Chi Wing/CSE**		
Student:	**MA Quanbin/COSC**	**UROP Course:**	**UROP2100, Fall 2014**

Amazon Mechanical Turk (AMT) is an online marketplace introduced by Amazon Web Services, which aims to maximize human intelligence. “Workers” can participate in various human intelligence tasks (HITs), which involve image recognition, audio recording transcription, and data de-duplication. Humans are substantially more efficient at these tasks compared to a computer, and receive rewards from requesters, who may benefit from their services and achieve the same goals at a substantially lower cost. For this project, we plan to develop a model for requesters, so that they can determine the most appropriate price for a task. For the final stage, we collected a large data set of posted HITs and their relative information over a long period, and built a prototype of the model. Once we reach this stage, we plan to implement the model and validate it with the data collected, and tune the parameters to make further improvements to the model.

Advisor:	**WONG Raymond Chi Wing/CSE**		
Student:	**CHEN Liyu/COSC**	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**
	MIN Yiyang/MATH-ST	**UROP Course:**	**UROP1100, Summer 2015**
	WANG Tianci/COMP	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**
	ZHANG Xiang/MATH-CS	**UROP Course:**	**UROP1100, Fall 2014; UROP2100, Summer 2015**

The goal of our team is to develop business intelligence software based on the data provided by RADICA SYSTEMS LIMITED. We are currently at Stage 1: Develop a classification function for the software. Future analysis can be conducted based on the classification of our email data.

We completed the first version of the classification. We converted nonstructural textual data into a structural term-document matrix and used the classical random forest algorithm to train a classifier on the data. A user interface that allows users to classify new email data into appropriate categories was developed using PHP. To develop a more accurate and efficient classifier, we conducted research on the pre-processing and algorithm, and propose new directions.

Advisor: **WONG Raymond Chi Wing/CSE**
Student: **TU Jiayang/CPEG** **UROP Course: UROP1100, Summer 2015**

In this paper, entitled, "Viral marketing for dedicated customers," principally authored by Professors Raymond and Cheng, proposes three approximate algorithms for the IS-J-Min-Seed problem in under the LT and IC model, with the aim of identifying a minimized seed set that can influence at least J social network users interested in certain products. Based on this problem, I intend to study related knowledge including the LT model, IC model, and Monte Carlo simulation. In addition, I plan to design and implement the MS-Independent, MS-Incremental, and MS-Greedy algorithms, and analyze the results after running the algorithms on real social network data sets. Finally, I will implement an online demonstration system to present the work in its entirety.

Efficient Queries over Database

Advisor: **WONG Raymond Chi Wing/CSE**
Student: **CHEN Ziqi/CPEG** **UROP Course: UROP1100, Summer 2015**

This report proposes direction-preserving trajectory simplification (DPTS) as a novel mechanism for simplifying trajectory data by considering direction errors. In this project, an online system was implemented to visualize trajectory simplifications obtained using algorithms that use the direction-preserving mechanism. To achieve this goal, we reviewed research papers and codes on DPTS and learned Web languages, including basic HTML and CSS, the prevalent client-side language JavaScript, and the server-side language PHP. JavaScript as used to enable interactions in input forms and manage the trajectory display, and PHP was adopted to manage form inputs and execute an external C program. Google Maps JavaScript API was used to display trajectories, and hence, we explore its documentation.

Advisor: **WONG Raymond Chi Wing/CSE**
Student: **QIU Yuan/MAEC** **UROP Course: UROP1000, Summer 2015**

Trajectory data are useful because of the ubiquity of GPS devices. The simplification of trajectory data is necessary because raw data are usually too large and time-consuming to process. Among the many trajectory simplification methods, direction-preserving trajectory simplification has been found to exhibit excellent performance in many cases. This paper defines a problem that is similar to the Min-Error problem, but in which the simplification error is calculated by averaging the angular difference. We developed an exact algorithm to address the problem. It was designed for the movement of vehicles or objects that remain in approximately the same direction over time.

Advisor: **WONG Raymond Chi Wing/CSE**
Student: **WAN Jia/SENG** **UROP Course: UROP1100, Summer 2015**
ZEIGHAMI Sepanta/SENG **UROP Course: UROP1100, Summer 2015**

The k-regret query is an operation for multicriteria decision-making, which does not require users for the input of utility functions. Similar to extant queries such as skyline or top-k, it outputs a subset of points for maximizing satisfaction, but guarantees a small output. Based on extant papers considering the maximum regret ratio, our objective is to output k tuples from a database that can minimize the average regret ratio, which displays the average level of satisfaction over the entire database. By conducting improvements on the existing algorithm, we can identify a bound on the average regret ratio. Moreover, by using the concept of submodularity, we examine potential ways of identifying an approximation to the optimal output set for both the average regret and the maximum regret, which was proven to be NP-hard.

Deep Learning for Integrated Object Localization and Classification

Advisor: **YEUNG Dit Yan/CSE**
Student: **HU Anbang/MATH-AM** **UROP Course: UROP1100, Fall 2014**

With an image containing an object belonging to a predefined category, the objectives of object detection and classification are to determine whether a target object exists and to which category it belongs, respectively. Although a generic approach to addressing this problem has been established, this report examines a simpler method. Real-world imaging data of different toy car models were used for training and testing. Advanced models as well as techniques from machine learning and computer vision were also employed and adopted for solving this specific problem. The classification accuracy was as high as expected, whereas the detection accuracy warrants improvements. The second half of the report presents detailed analyses on the results, including the anatomy of accuracy for different cars and the extent of inaccuracies as well as misclassified cases. Improvements such as paralleling the computation of certain algorithms are posited at the end of the report.

Advisor: **YEUNG Dit Yan/CSE**
Student: **SUN Yushi/COSC** **UROP Course: UROP1100, Summer 2015**

Based on previous work by Zeiler et al. and Simonyan et al., this project involved employing a simpler backpropagation algorithm resembling the DeconvNet result in [1], and adapted the class saliency map in [2] for identifying the importance of feature maps in the final outcome.

Advisor: **YEUNG Dit Yan/CSE**
Student: **XIA Jiacheng/COSC** **UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**

With the widespread usage of convolution neural networks (CNNs), many other usages of CNNs remain to be explored. Previous studies on the project have found that CNNs can yield a relatively satisfactory performance in object classification tasks. The objective of this part of the continuing UROP is to identify a detection algorithm for building a more efficient algorithm in terms of object detection and localization techniques. Regarding our progress, the neural network toolbox CXXNET was used as well as a pretrained model of AlexNet. Throughout the research period, different methods were attempted, but the performance remains unsatisfactory. Details of our thoughts are presented in the report.

Rainfall Forecasting through Predicting Evolution of Weather Radar Images

Advisor: **YEUNG Dit Yan/CSE**
Student: **LEE Dexter/PHYS** **UROP Course:** **UROP1000, Summer 2015**

The purpose of this project was to predict the rainfall conditions in a short period in the future by using several weather radar images before that time. The main concept was to use machine learning to identify a pattern in the evolution of weather radar images from numerous records of the images of the past few years. The employed model was a convolutional LSTM, which takes advantages of both convolutional and recurrent neural networks to learn both the temporal and spatial aspects of images. It is a nonlinear model, and we hope it will perform better compared with the linear model ROVER used by the Hong Kong Observatory.

Office of the Dean of Engineering

Development of Upper-Limb Training Services for Stroke Patients

Advisor: **LING Carrie Hang-yin/DENG**
Student: **CHOI Hang Yan/MAE** **UROP Course: UROP1100, Spring 2015**

This project is the continuation of the BIEN3010 biodesign course. In that course, the methodology and approach for conducting product development were taught, and several site visits were conducted to collect first- and second-hand data on the conditions of stroke patient rehabilitation in Hong Kong. The main focus of this project was in developing a prototype of an upper-limb training device. The report introduces background information regarding the project, after which it presents the mission statement. The design generation process is then detailed, with a temperate design of the upper-limb training device. The benefits and possible further investigation into the new design are also discussed in this report.

Department of Electronic and Computer Engineering

Nanotransistor Modeling for Circuit Simulation

Advisor: **CHAN Man Sun/ECE** **Co-advisor:** **ZHANG Lining/ECE**
Student: **CHEN Lingxuan/ELEC** **UROP Course:** **UROP1100, Spring 2015**

This project involves exploring the methodology of a customized building of the open-source electronic circuit simulator Xyce, which was developed by Sandia National Laboratories. The general methodology for the incorporation of the new self-developed device models written in Verilog-A language is discussed. The incorporated new device models could hence also be used for circuit characterization and design purposes, in accordance with users' specific needs. This customized version of Xyce was tested and subject to a brief performance comparison with another open-source circuit simulator, NGSpice, by running the same benchmark circuit netlist, which in this project was a netlist of a 50-stage inverter-chain circuit. The conclusion offers a brief discussion on the potential integration of Xyce into the online simulation platform i-MOS.

Semiconductor Nanowire-based Sensors and Electronics

Advisor: **FAN Zhiyong/ECE**
Student: **LIU Xue/ELEC** **UROP Course:** **UROP1100, Fall 2014**

Anodization is a mature technique that is widely used in the aluminum industry. Anodized aluminum oxide (AAO) has properties of interest that render it the ideal template for the fabrication of various nanostructures. This article explores the detailed procedure involved in the formation of AAO nanotubes, and reports on our attempt to determine a computer-aided approach to achieving fast and controllable AAO nanotube template fabrication for potential massive industrial usage. A series of experiments were conducted, the results of which revealed that the depth of AAO and the area charge density follow a linear relationship, and that accurate growth prediction can be achieved using this model. In this project, we used LabView and MATLAB programming to develop our virtual instrument along with the graphical user interface. The anodization of AAO can be monitored and controlled instantaneously.

Advisor: **FAN Zhiyong/ECE**
Student: **CHEN Zhuo/ELEC** **UROP Course: UROP3100, Spring 2015**

The fabrication of 3D nanostructures has been widely conducted for the application of nanoscale devices. Specifically, the structures such as those of nanowires, nanopillars, and nanocones present considerable light-trapping features, which have garnered substantial attention in serving as templates for thin-film photonics. Perovskite materials have recently gained widespread attention because of its large absorption coefficient, high charge-carrier mobility, and long diffusion length. It has gained interest for investigation and for combining the advantages of both the nanostructured template and perovskite to fabricate an economical thin-film photodetector matrix. In this project, we use porous anodic aluminum membranes (AAMs) fabricated using a self-organized mechanism as a template for perovskite photodetectors, and by controlling the anodization and etching time, we fabricated different nanostructures with varying pitch and aspect ratios (pore depth divided by pore size). We also investigated the possibility of using polyimide (PI) as a flexible template by either peeling off solidified PI from nanostructured AAMs (PI cone) or by sputtering aluminum on PI and surface modification (ALPI). A mask for matrix patterning featuring up to 64 * 64 cells was also designed for future fabrication processes.

Keywords: 3D nanostructures, AAM, peroskite, photodetector matrix.

Advisor: **FAN Zhiyong/ECE**
Student: **WU Yue/SENG** **UROP Course: UROP1100, Summer 2015**

This report details the processes of the growth of anodic aluminium oxide (AAO) membranes, which were analyzed stepwise. AAO membranes are organized structures shaped akin to a nanotube, Nanonode, or nanocone, and is formed by a series of electrochemical reactions on the surface of aluminum. They are the fundamental elements in the fabrication of supercapacitors, which is the target of this project. This report introduces the concept of AAO, the background information regarding this invention, and future applications. Next, the necessary equipment we used in the laboratory is listed, and their functions are explained. Afterward, the conditions and formation of AAO are detailed. The preliminary analysis and achievements over the summer are presented in the conclusion.

3D Display

Advisor: **KWOK Hoi Sing/ECE**
Student: **YE Ziyu/EEIC** **UROP Course: UROP1100, Spring 2015**

For this project, we attempted to build a 3D display system by utilizing a smartphone and a pair of commercial active-shuttering glasses. The tasks included writing an app that can display frames of two videos alternatively at 60 fps and developing a mean of synchronization between the phone and the glasses. Our attempt was ultimately unsuccessful. During this project, we found that Android native-level programming is required to achieve the display target frame rate, and physical modifications to the commercial glasses are necessary for synchronization.

Development of MATLAB Graphical User Interface for Vertical Take-Off and Landing Aircraft Simulation

Advisor: **LI Zexiang/ECE**
Student: **WU Shangzhe/SENG** **UROP Course: UROP1000, Summer 2015**
ZHANG Zizheng/SENG **UROP Course: UROP1100, Summer 2015**

The objective of this project was to design a graphical user interface (GUI) for a vertical take-off and landing (VTOL) aircraft simulation using MATLAB. Because of an incomplete version of the MATLAB program using the command window, we had to design this simulation in accordance with the MATLAB GUI, with all of the functions from the previous version and required improved solutions. It necessitates basic programming knowledge and a familiarity with MATLAB languages. This project was conducted by two students under the supervision and with the assistance of a professor and his research assistant. The platform we constructed greatly facilitates the selection of propellers for VTOL aircraft, and provides a potential platform for future applications such as motor analysis and aircraft simulation.

Mechanical Design, Manufacture, and Aerodynamics Analysis of Vertical Take-Off and Landing Aircraft

Advisor: **LI Zexiang/ECE**
Student: **MAO Zhiyuan/ELEC** **UROP Course: UROP1100, Summer 2015**

Since the invention of fixed-wing airplanes, these machines have been limited by the take-off and landing process. Scientists and engineers have long been interested in the development of vertical take-off and landing (VTOL) aircraft. Quadrotors have recently become popular because of their VTOL characteristic. However, quadrotors are slow and not energy-efficient because of their low aerodynamic efficacy. Integrating the conceptual design of a fixed-wing airplane with quadrotors, we devised an idea on how to build a fixed-wing VTOL airplane. This report presents a discussion on certain primary considerations when designing an airplane, including reasons for building a flying wing as well as aerodynamic analysis results on the airfoils.

Pose Control of a Quadrotor

Advisor: **LI Zexiang/ECE**
Student: **LIU Yuchen/ELEC** **UROP Course: UROP1100, Summer 2015**
WANG Zhaoqing/ELEC **UROP Course: UROP1100, Summer 2015**

Quadrotors have gained increasing popularity in research as well as in daily application because they have recently garnered attention in the global market. Efficient and accurate control of the pose of a quadrotor is the basis of higher-level designs and secondary development. Four key points for the pose control of a quadrotor are discussed in the report, which are as follows: theoretical model, quadrotor hardware design, computer software tools, and the program running on the chip of the quadrotor. The theoretical model assists with the design of both the outlook of the quadrotor and the inner circuit from an ideal perspective. Keil can conduct the task of compilation and chip-burning, whereas the fly control software conducts quadrotor data collection and simulation. The C codes were used for programming.

Vertical Take-Off and Landing Aircraft Flight Control Software Development based on PIXHAWK AUTOPILOT

Advisor: **LI Zexiang/ECE**
Student: **ZHANG Jingyang/SENG** **UROP Course: UROP1000, Summer 2015**

PIXHAWK AUTOPILOT is one of the most successful and widely used open-source flight control systems. It provides support for all common type of flights in all layers, from the hardware to applications. For our VTOL flight, this system can help us establish an entire environment for developing a product prototype. Moreover, we plan to minimize the entire system and implement an application specific to one in the following generations. Therefore, the functionality principle for this system is necessary. The objectives of this project are to identify how this system functions, and to provide support to application developers. At this stage, the building management and operating system booting procedure have already been established. The building procedure is essential for us when we have to conduct modifications to certain parts of the system. The booting order is always a strong starting point for understanding the entire system.

3DTV

Advisor: **LIU Ming/ECE**
Student: **ZHU Ge/COMP** **UROP Course: UROP1100, Fall 2014**

The simultaneous localization and map-building (SLAM) problem questions whether it is possible for an object (typically an autonomous vehicle) to start in an unknown location, in an unknown environment, and then to incrementally build a map of this environment while simultaneously using it to compute absolute vehicle location. This technique has been applied to self-driving cars, autonomous underwater vehicles, domestic robots, and even mini-robots inside the human body. For this UROP, we are using large-scale direct monocular SLAM for exploring this field and are attempting to familiarize ourselves with the operations and codes.

Localization with UHF RFID tags

Advisor: **LIU Ming/ECE**
Student: **WU Tianhe/ELEC** **UROP Course: UROP1100, Fall 2014**

The simultaneous localization and map-building (SLAM) problem questions whether it is possible for an object (typically an autonomous vehicle) to start in an unknown location, in an unknown environment, and then to incrementally build a map of this environment while simultaneously using it to compute absolute vehicle location. This technique has been applied to self-driving cars, autonomous underwater vehicles, domestic robots, and even mini-robots inside the human body. For this UROP, we are using large-scale direct monocular SLAM for exploring this field and are attempting to familiarize ourselves with the operations and codes.

Advisor: **LIU Ming/ECE**
Student: **LU Yunan/ELEC** **UROP Course: UROP1100, Spring 2015**

Localization based on radio-frequency identification (RFID) technology has promising potential. By combining localization with the identification capability of RFID, extant applications can be enhanced, and new applications can be developed. To use a geometric method for locating target tags, two key issues are involved: translating the signal strength into distance, and choosing suitable methods for finding the location based on the distance. For this paper, I chose RF9315R Active RFID with received signal strength indication (RSSI) as my receiver, and RF8315T Active RFID as my transmitter. Based on the characteristics of wireless signal propagation and the principal of RSSI ranging, the relationship between the distance and RSSI value can be obtained through a lognormal distribution propagation loss model. Afterward, the location of the object is estimated using the centroid localization algorithm. In the conclusion, the paper presents the issues involved in this research, and future directions of this technology and its corresponding applications.

Advisor: **LIU Ming/ECE**
Student: **ZHU Ge/COMP** **UROP Course: UROP1100, Spring 2015**

Augmented reality (AR) is a type of technology that can analyze continuous images captured from a single camera, and can add virtual animations to the images according to real-world 3D geometry. The core part of AR is acquiring 3D information based on the real world from 2D images. The method used in this UROP is called parallel tracking and mapping (PTAM). PTAM is a graphic algorithm created in 2007 by Georg Klein and David Murray. Based on simultaneous localization and mapping (SLAM), PTAM overcomes the restriction of old SLAM algorithms that can only conduct tracking and mapping simultaneously for a single frame. By contrast, PTAM implements tracking and mapping separately for one frame, thereby improving the effect of the algorithm considerably. By dividing tracking and mapping into two cores, the program requires fewer computer processing units and runs faster.

Keywords: augmented reality, parallel tracking and mapping, simultaneous localization and mapping.

Next-Generation Video Coding

Advisor: **LIU Ming/ECE**
Student: **YU Chendi/ELEC** **UROP Course: UROP1100, Fall 2014**

The objective of this project was to conduct simultaneous localization and mapping on a robot by using PS camera images. When the robot moves, the motion sensor can estimate the position and pose of the robot relative to previous locations. A camera detects landmarks such as room numbers, and measures the distance to a landmark. Noise exists on both the motion sensor and the camera. Error accumulates, and position estimation becomes unreliable as the robot travels farther. Key frames with the same room number form a closed loop. These nodes and constraints are resolved by g2o, and therefore, graph relaxation occurs. For this process, I used tools such as ROS, caffe, and g2o.

Energy Harvesting Using Rainwater

Advisor: **MURCH Ross/ECE**
Student: **BAKSHI Pallav/ELEC** **UROP Course: UROP1100, Fall 2014**

The need for energy by microsystems depends heavily on batteries. An alternative to power sensors and microsystems is the use of energy derived from the environment. Various approaches are available for harvesting energy from the environment, such as solar energy and wind energy. However, the limitation of all such technologies is their dependence on the local climate. For this report, we studied another source of energy: rain. If we can combine solar, wind, and rainwater harvesting systems, then we may devise a system that can generate energy in most climates. This report presents two ways through which we can exploit rainwater for harvesting energy. The system uses piezoelectric sheets to convert the mechanical energy of falling raindrops into electrical energy, which can be used or stored for future use.

Optical Tweezers Using a Few-mode Fiber for Microparticle Trapping, Sizing, and Sorting

Advisor: **POON Andrew W O/ECE**
Student: **YIU Kin Tat/PHYS-PP** **UROP Course: UROP3100, Fall 2014**

We demonstrated 3.3-μm particle acceleration by using nonuniform optical lattices generated by SMART assisted by fluidic flow. The critical component is a 100-μm square-core silicon waveguide 3 mm in length. The waveguide mode fields operate at a wavelength of 1550 nm. We conducted the experiment with in single mode fiber. Next, we demonstrated the guiding of 3.3-μm particles with a flow assist of approximately 55μm/s. The launch power was tuned from 200 to 500mW. We also demonstrated 3.3-μm particle deflection in the experiment.

Keywords: multimode interference waveguide, few-mode fiber, particle acceleration, optical tweezers.

Control of Stable Flock of Multi-robots

Advisor: **QIU Li/ECE**
Student: **LIU Xue/ELEC** **UROP Course: UROP1100, Summer 2015**

Rapidly evolving sensors and effector technologies as well as smaller processing units are enabling the development of economical autonomous mobile devices that can perform several tasks. Investigations into how several individual agents can communicate and collectively perform tasks, or simply maintain a stable formation, are warranted. Similar problems are studied in the fields of ecology and biology, and computer models are built to explain the flocking behavior of birds. Based on these theories, we may find ways of constructing multi-robot systems that can cluster in formation.

This progress report explores a basic understanding of mobile agent control. The report begins by detailing the modeling of an individual agent, and then presents our attempt of building a model by using both centralized and decentralized control methods.

Building Multimedia Apps for Smartwatch

Advisor: **SHE James/ECE**
Student: **TA Ngoc Linh/SENG** **UROP Course: UROP1000, Summer 2015**

Smartwatches are becoming popular. Several smartwatch models are equipped with accelerometer sensors, which can be used for detecting different arm gestures, and thus, for developing a control system based on such gestures. This report presents a similar system, which continuously collects and processes accelerometer data from a Pebble watch to recognize different arm gestures and use the data to control either a mouse cursor on a computer screen (a 2D object) or a quadcopter (a 3D object) based on the user's selection. First, raw accelerometer data are transmitted from the Pebble watch to a computer before they are smoothened using the moving average method. Second, for the cursor control module, changes in X- and Y-axis acceleration are scaled into the cursor's vertical and horizontal movements, respectively. For the quadcopter control module, the changes in X-, Y-, and Z-axis acceleration are simultaneously considered and classified under seven of the quadcopter's movements: upward, downward, leftward, rightward, forward, backward, and no movement.

Keywords: smartwatch, gesture recognition, accelerometer, data-smoothing techniques, moving average.

Survey and Experiments on Applications Using Mobile-display Interaction Technologies

Advisor: **SHE James/ECE**
Student: **JONG Michelle/ELEC** **UROP Course: UROP1000, Summer 2015**

This research was conducted to find a convenient and interactive approach to delivering information on a museum's artifacts and events held by galleries by using the CyPhy Drag system, so that the technology could be utilized optimally. To achieve such results, a series of experiments were conducted to gain insight into users' experiences followed by surveys and a literature review. Toward the end of the report, we provide the Likert assessment score for the CyPhy Drag applications, which was 7.86 of 10, implying that both applications yielded satisfactory user experiences. The CyPhy Drag system was also found to have advantages compared with certain related technologies.

Vision-based Formation Flight of Micro-aerial Vehicles

Advisor: **SHEN Shaojie/ECE**
Student: **SETHI Gursimran Singh/ELEC** **UROP Course: UROP1100, Fall 2014**

This report provides a tentative detailed explanation on the challenges and mitigation of the formation flight of unmanned aerial vehicles (UAVs). The basic problem of communication between multiple UAVs for formation flights was resolved using a novel vision-based technique; that is, April tags. This report details how April tags can be used to communicate between multiple micro-UAVs (MAVs) in a localized region. It elaborates on the software-level programming code for programming April tags to use them for MAVs. Practical procedures for camera calibration as well as position and angle estimation are discussed, in addition to the current results and future steps.

Advisor: **SHEN Shaojie/ECE**
Student: **LI Zimo/ELEC** **UROP Course: UROP1100, Summer 2015**

The objective of this UROP is to build a single-camera visual odometry system with inertial sensors based on the ROS. I mainly focus on the implementation of the multistate constraint Kalman filter and the processing of feature flow and inertial measurement units data. However, because I am a beginner in this domain, I am first working with the simulated data. Compared with the actual environment, simulated data simplify the noise and data. To date, I achieved the basic settings. The program can propagate estimated positions and rotations, and then determine real-world positions through triangulation. My next step is to complete error propagation and updates, which I am currently working on.

Smartphone-enabled Quadrotor Helicopter Control

Advisor: **SHI Ling/ECE**
Student: **LIU Yixing/CPEG** **UROP Course:** **UROP1100, Spring 2015**
WEN Ruilin/CPEG **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**
WU Aoyu/CPEG **UROP Course:** **UROP2100, Fall 2014; UROP3100, Spring 2015**

The objective of this project is to implement a smartphone-/pad-enabled control system to manipulate the flight of a quadrotor helicopter (i.e., unmanned aerial vehicle). A comprehensive range of knowledge in engineering is required to realize this goal. The project participants require demanding knowledge of the hardware, mechanical design, object-oriented programming, and control algorithms.

This report provides the most up-to-date progress on the project. As mentioned in the previous report, we plan to implement the system from a comparatively low level of the hardware design until the advanced levels such as coding and peripheral function design. The introduction provides an outline of the main content of the report.

Wireless Localization

Advisor: **SONG Shenghui/ECE**
Student: **LEE Hyun Seung/ELEC** **UROP Course:** **UROP1100, Spring 2015**

Localization has been undergoing development with advancements of many network applications such as cellphones and computers. At present, people can use GPS applications on their cellphones to identify their location and navigate to their destination. However, limitations were present in past localization, which was the large range of uncertainty. For example, it is difficult to identify the location of a person inside a building. Consequently, wireless localization theory was proposed. In brief, it is used to measure people's position by using data on the intensity of the signal they receive from the many wireless access points nearby. This paper focuses on the techniques of wireless localization, introduces the code used for measuring the intensity of the nearby access points, and advances the theory of how to implement the code on a new wireless localization system.

Advisor: **SONG Shenghui/ECE**
Student: **LIU Zhaoyu/ELEC** **UROP Course:** **UROP1100, Spring 2015**

Indoor wireless localization systems that use probability calculation for estimating a person's location are not always accurate because of certain small-probability events. We developed a probability pattern to express the relationship of all probability values. If a certain probability value does not obey the pattern, we assume that this is an outlier and eliminate it. This research involves finding the types and mathematical expressions of this pattern. We generally develop this pattern based on different numbers of Wi-Fi access points.

Advisor: **SONG Shenghui/ECE**
Student: **WANG Zhaoqing/ELEC** **UROP Course: UROP1100, Spring 2015**

Wireless localization is a technology used for detecting a person's position in an indoor environment. It works in a similar manner to GPS. It is useful because people often have difficulty finding a specific room or office in a building. By measuring and analyzing the radio condition of the user, the position information can be obtained for the user, which can be used to guide them to their destination. However, the signal condition is relatively complicated, and thus, a special model is required for analysis to ensure accuracy. This report presents my algorithm for determining a person's position and my use of MATLAB for estimating its accuracy.

Aerial Smartphone Acrobat

Advisor: **WONG Man/ECE** **Co-advisor:** **QIU Li/ECE**
Student: **WANG Zixuan/ELEC** **UROP Course: UROP1100, Fall 2014**

The purpose of this project is to design and build a cheap quadcopter product by using smartphones, which can be employed to control the quadcopter and monitor the real-time camera view. To fulfill this objective, an Android app was created based on an audio and video solution provided by AnyChat. With this app, the user can access the real-time camera view, capture images or record videos, and browse these images and videos from within the app. In addition, by changing the parameter settings, the app can satisfy different requirements regarding the real-time view. Moreover, to conduct further improvements to this app in the future, a list of methods that can be used for this purpose are listed at the end of the report.

Advisor: **WONG Man/ECE** **Co-advisor:** **QIU Li/ECE**
Student: **JI Tony Wai Sum/SENG** **UROP Course: UROP1000, Summer 2015**
JING Qinghe/ELEC **UROP Course: UROP1100, Summer 2015**
LI Zimo/ELEC **UROP Course: UROP1100, Spring 2015**
SHEN Changsheng/CPEG **UROP Course: UROP1100, Spring 2015**
ZHANG Yuanzhao/ELEC **UROP Course: UROP1100, Spring 2015; UROP1000, Summer 2015**

At present, smartphones are ubiquitous and equipped with sensors that are underutilized. The objective of this project is to use the inertial measurement unit and the powerful microprocessor inside smartphones to design a robotic system based on them. The project involves, for example, dynamic system modeling, sensor fusion and control algorithm design, user interface development, and communication channel design. The expected result is a quadcopter equipped with two smartphones, one acting as its brain and the other as the controller. The finalized quadcopter will be able to operate in two control modes through an Android app, and can return a real-time video stream and be controlled through an RF channel.

Advisor: **WONG Man/ECE** **Co-advisor:** **QIU Li/ECE**
Student: **MALIK Ujjwal/SENG** **UROP Course:** **UROP1000, Summer 2015**

The major objective of this project is to find a solution to the problem of deducing the speed (angular velocity) of the motor from the Back EMF without using spec sheets. Further implementation involves the input of revolutions per minute into the PID system for feedback control.

Development of Localization System for Robotics

Advisor: **WOO Kam Tim/ECE**
Student: **LIU Jie/SENG** **UROP Course:** **UROP1000, Summer 2015**

This report details my UROP, including my objective, working process, final results, and reflections. This project concerned an orientation system for a small car through the use of several sensors, where the IMU and encoder sensor were prioritized. This report details my investigative experience, (e.g., struggling with the IMU and encoder sensor, continuously devising different ideas to assist the IMU sensor in detecting linear movements, and comparing all of my ideas carefully to determine the ideal and most practical idea). Moreover, this report presents several debugging reports. In the reflection portion, I clearly state my own sentiments and considerations after the project was completed. Overall, this report is a good summary of my UROP experience of this summer.

Advisor: **WOO Kam Tim/ECE**
Student: **PRANATA Christian Edwin/SENG** **UROP Course:** **UROP1000, Summer 2015**
WICAKSANA Jeffry/SENG **UROP Course:** **UROP1000, Summer 2015**

Localization is crucial for autonomous robotic applications, and identification can be difficult, especially in environments without access to satellite-based signals. For this research, servo, an IMU, and ultrasonic sensors are used to facilitate determining the location. Two methods are used: an ultrasonic radar and finding an object as a reference point to identify the displacement and direction of the robot. The experimental results revealed that the radar system has lower accuracy with higher versatility, whereas the second approach had a higher accuracy but detected less radial movement. Improving the quality of the system requires implementing other types of sensors such as an encoder, a higher-level MCU, and a more flexible servo.

Advisor: **WOO Kam Tim/ECE**
Student: **TANG Yiyang/SENG** **UROP Course:** **UROP1000, Summer 2015**

This study was conducted to find to an approach to localize a robot, so that the robot could be controlled with greater precision and enable automatic movements. Considering the level of research, the student identity, and the cost of the high-tech sensors, I conducted the research using a economical sensor. The sensor itself is inadequate for precise localization, but the experience I gained from using the sensor benefited me in developing an improved system with a more reliable sensor.

Scalable Nanofluidic Electronic Devices for Biomolecular Analysis

Advisor: **YOBAS Levent/ECE**
Student: **CHEN Liqi/ELEC** **UROP Course: UROP1100, Spring 2015**
HU Litao/ELEC **UROP Course: UROP1100, Spring 2015**

This report first introduces the background and details related previous studies before elaborating on the experiment equipment and procedures. This report then introduces our data analysis, which involved measuring the I-V relationship, before it finally presents a brief discussion on our primary conclusion. Basically, the experiments are based on a nanofluidic device, a type of nanopipette that can sense the electric properties of molecules in a solution. The shape of this device is that of a pipette, with one of its openings having a diameter smaller than 100 nm. It utilizes the rectification effect of nanoscale opening and functions in a similar manner to diodes when different voltages are applied to its ends. This is the reason it is also called a nanofluidic diode (Liu and Yobas). In the experiments, we mainly focused on the I-V properties across the tip of a nanopipette. With its surface coated by layer, we can obtain several data sets, which are then plotted on graphs, so that we can analyze the rectification effects by conducting observations of the I-V curve. We hope that this device can help quantify nucleic acids in polymerase chain reaction in real time without requiring a label, and even facilitate the miniaturization of current nucleic acid detection devices.

Keywords: nanofluidic diode, rectification effect, real-time polymerase chain reaction.

High-Performance CMOS Transimpedance Amplifier Design for Short-Range Optical Communications

Advisor: **YUE Chik Patrick/ECE**
Student: **TJON Kai Chun Eddie/ELEC** **UROP Course: UROP1000, Summer 2015**

With the wide adoption of white LED lights for illumination purposes, the possibilities of using these LED lights as a tool for transmitting information warrant interest. The concepts of visible light communication (VLC) and visible light indoor positioning (VLIP) have recently emerged. The goal is to transmit information in the E&M domain without compromising the primary function of the LED lights; that is, energy-efficient illumination. By using LED lights to transmit information, it opens an entirely new domain for information transfer, and can provide additional bandwidth and enhanced system capacity without exacerbating interference in the RF domain.

Department of Industrial Engineering and Logistics Management

Improving Precision in 3D Printing

Advisor: **JONEJA Ajay/IELM**
Student: **JING Donger/IEEM** **UROP Course: UROP1100, Spring 2015**

Although 3D printing has been widely employed in fashion, architecture, and product design, precision remains a critical concern. Because the 3D printer is designed to print by layers, an error results from layer discontinuity, especially when the surface is inclined. Another potential source of error is the trace at the turning corner because of the tradeoff of material accumulation and precision, specifically where the angle is small, and the extruder must extend further to reach the endpoint. Through mathematical analysis and a comparison between the printed and original model in 3D modeling software, the main focus of this project is on investigating the method for calculating and further attenuating these two errors.

Finding Useful Patterns in Traveling Salesman Problem

Advisor: **QI Xiangtong/IELM**
Student: **LEE Enoch/IELM** **UROP Course: UROP1000, Summer 2015**

The traveling salesman problem is a classic, simply-defined yet changing, optimization problem in operational research. One metaheuristic for finding a local optimal solution of this problem is Tabu search. This paper is a summary of the observations and findings based on attempting to find certain patterns by using one possible Tabu search implementation involving swapping the order of two nodes. Finally, we observed that the number of iterations was insufficient, and found a pattern showing that before the minimal cost of iteration, the deleted path would involve certain repeated sub-paths

Advisor: **QI Xiangtong/IELM**
Student: **LI Huizhong/IEGBM** **UROP Course: UROP1000, Summer 2015**

The traveling salesman problem has been addressed using the genetic algorithm (GA), but substantial principles are unavailable for setting the parameters of the GA. In this project, we explored the patterns in GA performance with varying parameter inputs, and discovered general rules that improve GA efficiency. Because of the limitation in the particular design of the GA as well as the spectrum of values of the variables and sample size, the results obtained from this project cannot be generalized, but nevertheless provide a direction for developing methods that can be used to improve overall GA performance in the future.

Department of Mechanical and Aerospace Engineering

Nanofluid Heat Transfer

Advisor: **CHAO Yu Hang Christopher/MAE**
Student: **ROTANSON Jason/MAE** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

Nanofluids are engineered colloids that are fabricated by suspending nanoparticles in base fluid. Nanofluids have recently drawn more attention because of their exceptional heat transfer performance. This property can be used in many engineering applications for a wide range of cooling systems such as the cooling of electronics, engine cooling, and refrigeration. Numerous studies have been conducted for evaluating this property. One challenge in using nanofluids as a working fluid of a cooling system is that when it operates for long periods, the deposition of nanoparticles occurs during the flow. This project focuses on the analysis of particle distribution because it affects the fluid flow, which affects the performance and efficiency of the cooling system. We found that the deposition of nanofluids with different sizes and concentrations results in changes to the particle distribution pattern.

Advisor: **CHAO Yu Hang Christopher/MAE**
Student: **TSANG Kam Fai/MAE** **UROP Course:** **UROP1100, Spring 2015**

For this project, we investigated the cooling performance of newly developed nanofluids, namely Al_2O_3/water and TiO_2/water nanofluids with different concentrations and volume flow rates. We also attempted to enhance the cooling performance of the coolant in the automobile radiator. The Nusselt number was the main focus of this investigation regarding the different flow rates, hence, the Reynolds number as well as the concentrations. We found that under the experimental conditions and with the tested parameters, the best TiO_2/water nanofluids can yield a 115.6% higher Nusselt number compared with pure water, and 6.38% higher than Al_2O_3, exhibiting great potential in replacing water as a coolant in automobile radiators.

Double-perovskite Sensors for the Automotive Industry

Advisor: **CIUCCI Francesco/MAE**
Student: **JIANG Chunli/MAE** **UROP Course:** **UROP1100, Fall 2014**

In modern automobile engine-controlling systems, it is crucial that oxygen sensors are developed in a closed-loop and fuel-efficient manner. In the past 20 years, perovskite structure materials have exhibited satisfying properties, with the advantages of element flexibility, high-temperature stability, and well-developed fabrication processes.

To ensure that the research adheres to a scientific structure, we commenced with a literature review to learn future research trends in their entirety as well as the characteristics of different structures with diverse components. The review will support our future material investigation and be used to amend the limitations of the previous experimental design. This progress report covers reviews on the experiment methodology and electrochemical symptom analysis.

Graphene Aerogel/Polymer Composites

Advisor: **KIM Jang Kyo/MAE** **Co-advisor:** **WANG Zhenyu/MAE**
Student: **HAN Ne Myo/MAE** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

A novel unidirectional freeze-casting method was used to produce graphene aerogels (GA) with highly aligned graphene sheets. The GAs have an ultralow density of 0.41 mg/cm^3 and an excellent electrical conductivity of 0.172 S/cm. Solid GA/epoxy composites was fabricated by infiltrating liquid epoxy into the porous structure of the GA under vacuum, followed by curing of the polymer. These composites have high electrical conductivity (as high as 0.023 S/cm), an ultralow percolation threshold (0.0076 vol%) resulting from the 3D interconnected graphene network. Besides, the anisotropic structure of GAs gives rise to significant anisotropic electrical conductivities of GA/epoxy composites, making them a great potential to be used in various novel applications.

Graphene/Polymer Composites

Advisor: **KIM Jang Kyo/MAE** **Co-advisor:** **WU Ying/MAE**
Student: **TSANG Kam Fai/MAE** **UROP Course:** **UROP1100, Fall 2014**

The purpose of this project was to investigate and attempt to enhance the thermoelectric performance, namely to achieve high Seebeck coefficient, high electrical conductivity and low thermal conductivity, of reduced graphene oxide/carbon nanotube/polyaniline (rGO/CNT/PANI) composites, which can be manufactured easily at a low cost. This report focuses on the study of electrical conductivities of rGO/CNT with different reduction conditions and rGO:CNT ratios. A discussion on the synthesis, processing, and characterization of rGO/CNT/PANI, as well as an analysis on their competitive advantages over other nanocomposites are given. The rGO/CNT/PANI composite paper with a 1:2 rGO:CNT ratio was found to have the best and most balanced result among all of the tested ratios, achieving an electrical conductivity of approximately 810 S/m at room temperature.

Developing a "Body Double" to Study the Failure in Thermal Barrier Coating of Turbine Blade

Advisor: **KWAN Charles Chi-Fong/MAE**
Student: **SZE Chung Hang/MAE** **UROP Course:** **UROP1000, Summer 2015**

The purpose of this project was to form a diffusion bond between the magnesium alloy AZ61 and pure magnesium foil, so that the product could be used as a “body double” to investigate the failure in thermal barrier coating of a turbine blade. Two methods were attempted in this project: (1) the heat press, but because of equipment limitations, no bond could be formed using this method; and (2) steel plates for clamping the sample and placing it in a furnace. Use of this method resulted in the successful formation of a diffusion bond between the AZ61 alloy and Mg foil. Different conditions for the formation of the diffusion bond were attempted. We found that a strong diffusion bond can be obtained at a high temperature and long heating duration.

Arduino-based Nano-bioimpedance Sensor System for Cancer Cell Detection

Advisor: **LEE Yi-Kuen/MAE** **Co-advisor:** **RIAZ Kashif/MAE**
Student: **KIM Dohoon/SENG** **UROP Course:** **UROP1000, Summer 2015**

Bioimpedance analysis in health tech can be conducted for identifying cancer cells. However, modern measurement equipment is heavy and expensive, and measuring impedance requires a long time. Therefore, a fast, economical, and portable bioimpedance sensor is required for physicians and researchers in the field. For this research, we began by developing an Arduino-based impedance sensor by using IC AD5933 with additional analogue frontends. A clear goal was established, so that the device would function well within the range of cell impedance, and was tested with different calibration circuits. The results are promising, with accurately measuring resistor values and an error rate of less than 4% for RC circuits exceeding 20 kHz. However, further research is warranted for achieving accurate measurements for all frequency ranges.

Design and Fabrication of a Microfluidic CTC Chip for Cancer Diagnostics

Advisor: **LEE Yi-Kuen/MAE**
Student: **KUMAR Mayank/MAE** **UROP Course:** **UROP1100, Fall 2014**

Circulating Tumor Cells (CTCs) are cells that detach from primary cells and circulate in the bloodstream. The detection of these CTCs is a crucial step in making cancer diagnostics effective and efficient. Although various detection methods are available in practice, one of the most recent and effective approaches to detection is based on the size of the tumor cells. Because these cell types are larger compared with normal cells, the difference in their areas may be helpful for further research and diagnostics. Because cells have a similar color to their medium, it becomes difficult to demarcate and calculate the area of these cells. This research focuses on calculating the surface area of tumor cells by making the fewest possible errors. We used Photoshop for clearly demarcating the cell boundaries, and Image J for the threshold and calculations of the cell area.

Advisor: **LEE Yi-Kuen/MAE**
Student: **JEONG Shin Young/MAE** **UROP Course: UROP1000, Summer 2015**

Microfiltration is a critical microfluidic technique that is suitable for the enrichment and isolation of circulating tumor cells (CTCs). However, cell lysing can occur because of hydrodynamic damage incurred during the flow in a microfluidic chamber, which may be detrimental to medical diagnostics. Therefore, we designed several models for flow distribution to maximize cell viability while minimizing the shear stress on the cells and offering a uniform flow field along the distribution chamber. To provide a uniform velocity of the microfluids over a microfilter, a traditional tree-like or "rhombus" design was selected as a basic strategy. The design was validated by performing a hydrodynamic flow simulation using computational fluid dynamics (CFD) software. The CFD simulations displayed the velocity of the fluid in the flow and distribution chambers. Based on the velocity profile, shear stress on CTCs can be achieved, and cell viability could be examined by referring to the correlation between cell lysing and the applied shear stress. Finally, with a simple modification to the rhombus microfluidic architecture, a uniform velocity at the outlet chamber was achieved, and cell viability over the entire chamber was measured. Because of time limitations, an experiment with the actual model was not conducted.

Advisor: **LEE Yi-Kuen/MAE**
Student: **LEE Jeng-hun/MEGBM** **UROP Course: UROP1100, Summer 2015**

Circulating tumor cells (CTCs) have recently been acknowledged to be the key to understanding, diagnosing, and treating cancer. Various types of CTC separation devices have been developed in both academia and across industries, including magnetic-based and dielectrophoretic CTC separation devices. Of these, our group focused on the microfluidic separation technique system. Throughout UROP 1100, the following three tasks were completed for developing such a system*:*

1. The development of a silicon microfilter holder;
2. analysis of CTC count versus different stages of cancer; and
3. analysis of white blood cell size for microfluidic filter design.

Economical Microfluidic Chips using Transparency and a Laser Printer

Advisor: **LEE Yi-Kuen/MAE**
Student: **BELLAMY Orvin/SENG** **UROP Course: UROP1000, Summer 2015**

This paper investigates the functionality of a paper-based microfluidic chip using transparency based on the Ouyang et al. (2013) study. Simplification of the microfluidic chip has been of interest because of its widespread use, specifically in PeT devices. A microfluidic chip with a transparent film as a substrate and black toner was designed using L-edit software, and it was fabricated mainly by using a laser printer and a hot plate. The difference in hydrophobicity between the transparency and the toner allows the fluid to flow via a microchannel through capillary force. However, further study and improvement are warranted for the consistent fabrication of the paper-based microfluidic chip, which functions solely on capillary force.

Development of a 3D-Printing Pen for Producing Metallic Objects

Advisor:	**LI Larry/MAE**	**Co-advisor:**	**KWAN Charles C F/MAE**
Student:	**CHENG Ho Yu Jacky/MAE**	**UROP Course:**	**UROP1100, Spring 2015**
	TANG Hin Yan/MAE	**UROP Course:**	**UROP1100, Spring 2015**

This project focuses on the development of an economical full-color 3D-printing device. Drawing on and combining concepts from PolyJet and ColorJet printing technologies from Stratasys and the 3D system, respectively, the proposed prototype involves a piezo print head with a powder bed, UV-curable ink, and gemstone powder as the build and supporting materials. A prototype of a powder bed was built by using standard mechanical components and acrylic boards. An experiment was conducted to identify the ideal curing time as well as to examine the performance of the composite mixture. The piezo print head was retrieved from an Epson printer, and modifications on the printer are currently being conducted.

Development of an Unmanned Aerial Vehicle for Agricultural Spraying and Monitoring

Advisor:	**LI Larry/MAE**		
Student:	**KUMAR Mayank/MAE**	**UROP Course:**	**UROP1100, Spring 2015**
	SETHI Gursimran Singh/ELEC	**UROP Course:**	**UROP1100, Spring 2015**
	TRIPATHI Siddhant/MAE	**UROP Course:**	**UROP1100, Spring 2015**

For this project, as a multidisciplinary team, we designed and built a new class of unmanned aerial vehicles (UAVs) for agricultural spraying and monitoring. This new class of UAVs are based on an airship platform, and can offer several advantages over traditional agricultural aircraft, such as improved maneuverability (reduced overspray), improved fuel efficiency (reduced costs), and the possibility of autonomous operation. We participated in various stages of the design and building process, including aerodynamic analysis, structural design and simulation, and user-interface development. The final prototype will be submitted to the 3rd International UAV Innovation Grand Prix, a biennial competition that will be held in Beijing in August 2015.

Advisor:	**LI Larry/MAE**		
Student:	**JHA Animesh Kumar/SENG**	**UROP Course:**	**UROP1100, Summer 2015**
	LIU Yuefeng/MAE	**UROP Course:**	**UROP1000, Summer 2015**
	REN Da Wei David/SSCI	**UROP Course:**	**UROP1000, Summer 2015**
	TANG Chloe/SENG	**UROP Course:**	**UROP1000, Summer 2015**
	XIONG Shuai/MAE	**UROP Course:**	**UROP1000, Summer 2015**
	YU Sencheng/SENG	**UROP Course:**	**UROP1000, Summer 2015**

Because of the increasing global population, pressure on farmers to deliver higher crop yields at a lower cost has never been greater. By taking advantage of the decreasing cost of drone components, creating a UAV to spray crops appears to be an ideal solution. To further improve the efficacy of agricultural drones on the market, a helium balloon was used because no energy is required to maintain the lift. However, the large balloon introduces perturbations and drag, meaning that controlling it is more difficult. This report presents the design of a UAV that takes advantage of helium's lifting capabilities while reducing sloshing, instability, and drag to improve efficiency.

Biomimetic Design of Flexible Flapping Wings for Micro-Air Vehicles

Advisor:	**QIU Huihe/MAE**		
Student:	**LV Guanda/MAE**	**UROP Course:**	**UROP1100, Fall 2014**

This paper presents a discussion on the current understanding of the flapping-wing mechanism, and our aim was to determine the advantages of a biomimetic design of flexible flapping wings for the application of micro-air vehicles. We analyzed the basic possible research directions and experiments as well. The flapping-wing system is the most common form of aerodynamics in biological form in nature. It has developed and evolved over millions of years, and has the most efficient thrust and lift production. Although modern research on aircraft considers the flexible flapping wing to be an improper choice for standard-sized air vehicles because of energy consumption and the complex structure, it still has potential advantages for microflight. The challenges to understanding and applying flapping-wing aerodynamics mainly involve the materials, structures, and assessment standard of the wings. To achieve better results in micro-air vehicles adopting a flexible flapping-wing system for certain objectives, the experimental methods listed in this paper may prove beneficial.

Advisor:	**QIU Huihe/MAE**		
Student:	**LIU Xi/MAE**	**UROP Course:**	**UROP1100, Spring 2015**

Because of the increasing interest in micro-aerial vehicles, this project involved investigating the biomimetic design of flexible flapping wings. We were inspired by the flight of a hovering humming bird. To facilitate the understanding of our study, the complex wing dynamics of a hovering humming bird was simplified into a combination of simpler motions. This project focuses on one such motion, the forward stroke. To simulate this motion, a rectangular planform wing at a fixed attack angle of 45° was rotated in a tank filled with water. To further our understanding of the effect of wing flexibility on the formation and behavior of the leading edge vortices, we used a set of wings with varying flexibility.

Flexible-Wing Kinematics of a Free-Flying and/or Controlled-Flying Dragonfly

Advisor: **QIU Huihe/MAE**
Student: **YU Pengkang/MAE** **UROP Course: UROP1100, Fall 2014**

The dragonfly was examined for the construction of flapping-wing micro-aerial vehicles. The research involved analyzing the flapping patterns of the live dragonfly, which was controlled in a fixed location. For our research, we employed particle image velocimetry and high-speed cameras to study the motion and air flow generated by the dragonfly. We obtained various results, including on forward-flying and take-off flying modes. The interactions between the forewings and hindwings as well as the generated vortices were the main points of discussion and warrant worth further research.

Advisor: **QIU Huihe/MAE**
Student: **HUANG Qifen/SENG** **UROP Course: UROP1000, Summer 2015**

This report was written to fulfill the requirement of the UROP1000 course (Summer 2015), and details the current progress and presents the results. The first part of the research involved the kinematics of the tandem flapping of dragonfly wings, including the varying phase differences between the forewings and hindwings as well as the frequency and amplitude during initiation and later on in the stable stage. High-speed cameras were used to take high-frequency, high-resolution images of the dragonfly throughout the take-off stage. For the second part, we conducted a particle image velocimetry experiment on the microflow behaviors, especially the near-wing vortices and the wake around the dragonfly, which contribute to the utilization of additional aerodynamic force and greater efficiency. The conclusion offers an evaluation of the results and recommendations for future research.

Design and Development of Soft Robotics for Locomotion in Complex Terrain

Advisor: **TANG Kai/MAE** **Co-advisor: NI Feng/MAE**
Student: **TANG Chen/MAE** **UROP Course: UROP1100, Spring 2015**

For this project, a new soft robotic hand platform was designed. It consisted of a robotic hand with five fingers of various lengths and a palm the size of an average human hand with a refined shape. The design of the thumb was especially improved, thereby allowing it to simulate the motion of the human thumb with greater dexterity. Moreover, flex sensors were embedded to the soft actuators. Combined with a data glove worn by the operator as well as the Arduino board, they provide feedback control on the robotic hand. Moreover, a 3-degree of freedom platform controlled by an IMU attached to the operator's wrist was affixed to the robotic hand to demonstrate its functions.

Condensation Dynamics in Microchannels with Superhydrophobic Nanostructures

Advisor: **YAO Shuhuai/MAE**
Student: **YAO Yuan/MAE** **UROP Course:** **UROP2100, Fall 2014**

This report presents our continued development of our analysis for a detailed experimental setup design as well as the following experimental procedure after establishing the primary experiment equipment, which can be basically divided into leakage detecting, device cooling, and vapor condensation. Based on the observational outcomes and experimental conditions, we proposed that a larger temperature difference is required to better visualize a flow pattern with condensation. Moreover, a buffer prototype was designed to control the vapor flow rate, which can also function as an integrating system of pressure and temperature measurement in the future.

Keywords: leakage detection, temperature difference, flow rate buffer.

Defrosting on Nanostrucuture Surfaces under Acoustic Effect

Advisor: **YAO Shuhuai/MAE**
Student: **ZHOU Peng/MAE** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

This report presents a discussion mainly on physical models in droplet growth and the icing process. This paper proposes a piecewise calculation method for droplets on a hybrid surface. We compared the bottom temperatures of the droplets on a flat hydrophobic surface, nanograss surface, and hybrid surface. When the droplet grows to a certain extent, coalescence may occur, and the resulting jumping dynamics were analyzed by focusing on energy. Classical nucleation theory was incorporated into the droplet growth model to identify the expected nucleation point. Finally, a vacuum chamber was designed to enhance the performance in the subsequent experiment.

Advisor: **YAO Shuhuai/MAE**
Student: **FENG Chenxi/MAE** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015; UROP3100, Summer 2015**

The superhydrophobic surface has drawn considerable attention since its discovery because of its advantages in heat transfer. Previous work has found that its performance is mostly degraded after long-term condensation in an ambient environment because of the lack of coalescence with droplets in a Wenzel state. However, recent studies have reported significant condensation heat transfer enhancements on the superhydrophobic surface in a pure vapor environment. We present the design of a novel setup for achieving the pure vapor condition for further experiments, not only for superhydrophobic surfaces but also for other new rationale surfaces. This progress report focuses on the preparation of the experimental setup and test run.

SCHOOL OF BUSINESS & MANAGEMENT

Department of Accounting

Global Macroanalysis

Advisor: **LI Xi/ACCT**
Student: **CHUI Siu Ming/ECOF** **UROP Course: UROP1100, Fall 2014**
YEUNG Yu Pang/ECOF **UROP Course: UROP1100, Fall 2014**

This study examined the interactions between the price level in Hong Kong and the corporate revenue of specific companies, and further study on the factors on this phenomenon may be warranted.

We examined if the debt ratio and concentration in regional revenue in Hong Kong were attributable to the correlation, both of which were found to be critical factors inducing a high likelihood. In other words, a higher debt ratio and concentration of revenue in Hong Kong led to a greater likelihood that the revenue was sensitive to the price range. However, limited by many factors, our correlation between the concentrations of revenue in Hong Kong requires verification.

In addition, the methodologies adopted by our research team coupled with the limitations are discussed in the report.

Advisor: **LI Xi/ACCT**
Student: **JIANG Yihong/QFIN** **UROP Course: UROP1100, Fall 2014**

Regarding Krugman's argument on whether an economy being based on a floating- or fixed-currency regime is of considerable importance in determining the likelihood that the economy will face a decrease in confidence over its debt, we would like to verify if his statement is applicable to emerging markets as well. We list the major years of crisis for most emerging countries, how obtained each variable, and basic regression results. Our results supported the argument that a fixed-exchange regime in emerging markets had a stronger relationship between debt and borrowing cost; that a country's level of cumulative current deficit contributes to its vulnerability to crises; and that foreign currency debt can effectively remove monetary autonomy and leave nations vulnerable to severe damage from sudden stops in emerging markets.

Advisor: **LI Xi/ACCT**
Student: **CHAN Ying Kwan/ACCT** **UROP Course: UROP1000, Summer 2015**

For this project, we conducted observations and analyzed the rollover patterns of futures in the categories of the foreign exchange, index, and commodities, and estimated the holding cost incurred when using them to replicate the returns of their underlying securities. The first part of this report provides an explanation of the methodology; that is, to search for the regular rollover schedule hidden from the trading data. The second part details our extractions of the samples of bid-ask spreads of the expected rollover dates to obtain the total transaction costs required to hold the futures for 1 year, regardless of the duration of each contract.

Advisor:	**LI Xi/ACCT**		
Student:	**CHEN Yucheng/SBM**	**UROP Course:**	**UROP1000, Summer 2015**
	LIU Xiaoyan/SBM	**UROP Course:**	**UROP1000, Summer 2015**
	YAN Shucai/SBM	**UROP Course:**	**UROP1000, Summer 2015**

The project on global macroanalysis comprised three minor projects, including the impact on Hong Kong company stock prices caused by the decreasing number of mainland tourists, finding the lead venture capital of IPO companies, and the effect of the bubble in the Shanghai and Shenzhen stock exchange on the price of China-related Hong Kong companies (Red chips and H shares). In this 2-month period, our team investigated approximately 1000 Hong Kong stocks, and found the relevant data and presented analytical recommendations. Throughout this course, we became familiar with the use of certain databases and financial terminology, including Thomson Reuters Eikon, SDC Platinum, Yahoo Finance, and Visual Basic for Applications. Moreover, we enhanced our knowledge on how to complete a thorough analysis and evaluation of a specific company through time series and among its competitors.

Advisor:	**LI Xi/ACCT**		
Student:	**FENG Shuo/SBM**	**UROP Course:**	**UROP1000, Summer 2015**
	HUANG Xiaoyi/SBM	**UROP Course:**	**UROP1000, Summer 2015**
	ZHANG Yilei/SBM	**UROP Course:**	**UROP1000, Summer 2015**

This project concerns mainly a fund, in which Professor Li's team cooperated with another team from the Department of Finance at HKUST. One part of our work involved collecting data from different relevant industries, including on trends in Chinese tourism to Eurozone countries, the WS chairman and the CEO separation policy, as well as All-America Stars institutional investor information. Moreover, we conducted preparation work for the fund project, including fund subscription forms, investor information collection, eVestment system manipulation, and the creation of detailed reports. This work is more academic instead of practical. The collected data can be used to assist the fund, which is being developed through the collaboration, as well as further analyses on the global economy.

Department of Economics

Firms in Globalization: Evidence from China

Advisor: **LI Yao/ECON**
Student: **CUI Yiye/MAEC** **UROP Course: UROP4100, Fall 2014**

We conducted data processing in preparation for Professor Li's further study. Our research consists mainly of two parts. The first part involved finding the missing location code for firms from 1996 to 2003. We planned to conduct the process in three stages, and this report chiefly focuses on the first and second stages. We ultimately managed to complete the location code for 242,884 observations. The second part involved filling in the missing information in the development area distribution form. We identified four cases and completed the entire form, missing only minor values.

Advisor: **LI Yao/ECON**
Student: **HAO Zaijie/ECOF** **UROP Course: UROP1100, Fall 2014**
LEO Sai Yin Allan/ECOF **UROP Course: UROP1100, Fall 2014**

This paper examines Chinese firms' behavioral patterns in different years: 1995, 2004, and 2008. First, the accuracy of two criteria, the company registration code and enterprise name, were tested to track firms over time. Second, two data sets, the census and CIE, were analyzed for 2004 and 2008 to obtain the most comprehensive data. Lastly, firms' entry and exit behaviors were summarized based on their combined information in these 3 years. Our findings revealed that firms that existed only in 2004 accounted for 58.95% of all firms; firms that continued to exist from 1995 to 2008 only accounted for 0.99% of all firms; and the entry rate and exit rate were 13.31% and 15.57%, respectively, from 1995 to 2004. The rates from 2004 to 2008 were 9.19% and 2.05%, respectively. The relatively higher entry and exit rates can be partially explained by the longer timespan from 1995 to 2004. Over six times more firms exited from 1995 to 2004 compared with the 2004–2008 period, which cannot be explained only by the relatively longer timespan.

Advisor: **LI Yao/ECON**
Student: **LI Chi Ho/ECOF** **UROP Course: UROP2100, Fall 2014**
YAN Mingyang/ECOF **UROP Course: UROP1100, Fall 2014**
ZHOU Sitong/MAEC **UROP Course: UROP1100, Fall 2014**

The trade type as well as export and import values of a firm are data that are critical for analyzing a firm's operations.Detailed export and import product-level data of Chinese enterprises are collected and organized by Chinese customs, whereas detailed firm information is listed in the Chinese Industrial Enterprise (CIE) database. This report is a summary of our group's findings for UROP 2100 (Fall 2014). Based on the Chinese custom and CIE data from 2007 to 2009, our group aims to link the two types of data through modifications and matching.

Advisor: **LI Yao/ECON**
Student: **HUANG Yuan/MAEC** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**
XU Wentao/MAEC **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

This report investigates the determinants affecting firms' survival rate, such as the globalization level and company size, by conducting an empirical study of Chinese manufacturing firms over 3 consecutive years (i.e., 2007 to 2009). The census data were complemented by the custom date for examining firms categorized by their export and import activities. The firms were divided into types based on their global trading behavior as well as the number of employees. A comparison among the different firms and probit regression analysis revealed strong evidence for a positive correlation between a firm's trading activity and firm size and survival when other control variables were fixed.

Advisor: **LI Yao/ECON**
Student: **LI Xiudi/MAEC** **UROP Course:** **UROP1100, Spring 2015**
YAO Naijia/MAEC **UROP Course:** **UROP1100, Spring 2015**

This report investigates factors potentially contributing to the survival of foreign-invested firms. This progress report is a summary of the proceeding and findings to date. Using the data of Chinese industrial enterprises and foreign direct investment (FDI) combined with Fortune 500 firm lists, we constructed a data panel for further analysis. We investigated primarily the survival rates of foreign-invested firms in various manufacturing sectors and the effect of the country of origin on firm survival. We found that the survival rate was higher in light industries, and an absence of a systematic pattern of the survival rate for FDI firms based on the country of origin.

Advisor: **LI Yao/ECON**
Student: **ZHANG Chuyue/ECOF** **UROP Course:** **UROP1100, Spring 2015**

China has undoubtedly become one of the most prominent nations in the foreign direct investment (FDI) inflow environment, and has a booming economy. The sustained growth boosts its export-driven market vitality and draws attention to its FDI spillover effects.

We aimed to understand the association between FDI inflows in manufactory industries and manufacturer productivity. Through data mining and categorizing, we expected to discern a positive association that could help people delve into manufacturing FDI inflows. The first stage and main focus of this paper involved data management and survival rate analysis.

Advisor:	**LI Yao/ECON**		
Student:	**CAI Yu/IELM**	**UROP Course:**	**UROP1100, Spring 2015; UROP1000, Summer 2015**
	HAO Yijun/ECOF	**UROP Course:**	**UROP2100, Spring 2015; UROP3100, Summer 2015**
	ZHANG Ye/MAEC	**UROP Course:**	**UROP2100, Fall 2014; UROP3100, Spring 2015**

Throughout the development of China's economy, exporting zones have played a critical role in the state's preferential policies, and have become a tool for attracting firms and benefiting the local economy. The objective of this project was to enhance our understanding of the influence of exporting zones from various aspects, supported by empirical evidence. The data used as evidence included firm information from 1998 to 2009 and zone information from China. Using the available data, we conducted an analysis with a control group by using econometric techniques to examine the differences between towns with zones and towns without zones as well as the performance before and after the establishment of zones.

Advisor:	**LI Yao/ECON**		
Student:	**KAN Chen/ECOF**	**UROP Course:**	**UROP3100, Summer 2015**
	OUE Kai Chung/ECOF	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**
	QU Yang/ECOF	**UROP Course:**	**UROP1100, Summer 2015**
	XU Jun/ECOF	**UROP Course:**	**UROP1100, Spring 2015; UROP2100, Summer 2015**

This study examines the behavior, especially that of trading, of Taiwan-invested firms in mainland China. Using data from the Chinese Industrial Enterprises database, Chinese customs, and Taiwanese sources, a panel data set was constructed for analysis. The panel data set included a sample of 4,766 Taiwan-invested firms operating in mainland China from 2000 to 2009. The key findings in this study indicated that the magnitude of Taiwanese investment in China was generally increasing during the sampled years, and that Taiwanese companies had more affiliates. More than 80% of the firms engaged in exporting and importing, with most in processing or hybrid trading modes. Coastal regions were found to have more processing firms compared with non-coastal regions.

Advisor: **LI Yao/ECON**
Student: **LEE Tsz Him/ECOF** **UROP Course: UROP1100, Summer 2015**
PAN Yingru/QFIN **UROP Course: UROP1000, Summer 2015**
XING Eva/MAEC **UROP Course: UROP1000, Summer 2015**

Patents, protecting the property rights of inventors, have played an increasingly crucial role in garnering firms' interest in developing more refined goods and producing inventions. In this project, we used information on firms operating in China (1996–2009) and the patent records (1985–2009). After preprocessing the data, we merged the two data sets to observe the matching rate, and studied companies that applied for a patent. We calculated the number of patent applications each year to observe the development of patent applications in a more specified scope. Lastly, we used econometrics techniques to examine the relationship between research and development (R&D) expenses and patent data as well as the pattern of R&D intensity of firms for a comparison against U.S. firms.

Advisor: **LI Yao/ECON**
Student: **YANG Muqing/ECOF** **UROP Course: UROP1100, Summer 2015**

The Chinese economy is becoming increasingly technology-oriented, where firms are staying up to date with innovative trends. The objective of this project was to discern the current conditions of patent applications in Chinese firms and the effects of the establishment of special zones on the patent application practice. The influence of R&D investments on firms' innovative behavior was examined as well. The data sets used for analysis comprised firms' patent information from 1985 to 2009, Chinese Industrial Enterprises data from 1996 to 2009, and firms' R&D investment information from 2001 to 2007. By employing Stata and performing econometric analysis, we conducted our research and present our findings in this report.

Understanding the Strategic Behavior of Economic Forecasters

Advisor: **LU Xun/ECON**
Student: **PAN Wenang/ACCT** **UROP Course: UROP1100, Spring 2015**
YANG Chunpu/QFIN **UROP Course: UROP1100, Spring 2015**

Our project was composed of three main parts: company data extraction and consolidation; in-depth research and analysis on the "herding" phenomenon; and data collection and interpretation. For the first part, we familiarized ourselves with the IBES database, from which we extracted data by following certain procedures outlined by the professor, before finally consolidating and ranking them in Excel for analysis. For the second part, we conducted a literature review on herding and anti-herding by retrieving studies that were available on Google Scholar, and analyzed each paper based on its period, scope, the method used, and the conclusion. For the last part, we first searched for the required data set online (i.e., the U.S. Data Sharing for Demographic Research), and devised a program to "translate" the results, which were lines of numbers comprising 120 characters for each line containing information to be decoded from the database (e.g., race and age). The results obtained by completing the first two parts were used in the analysis on the herding behavior of analysts, whereas the results obtained after completing the last part is useful for studying instrumental variables estimators, a common tool in the study of economics.

Middle-income Trap, Structural Change, and Economic Growth

Advisor: **WANG Yong/ECON**
Student: **KANG Ran/ECOF** **UROP Course: UROP1100, Spring 2015**

Empirical facts have shown the patterns of income convergence in middle-income countries under the chasing effect of low-income countries, which is defined as middle-income traps, a topic that has generated considerable discussion recently among economists. During this project, we found supporting evidence from empirical data under the model of income distribution by researching three countries across several years. The work this year was conducted by two students based on previous research, which involved identifying the universal characteristics of global income distribution, and we further defined the conditions of middle-income countries in accordance with those presented by Felipe et al. (2012), who examined whether a country is trapped, and attempted to find the relations between characteristics such as the growth rate and productivity.

Advisor: **WANG Yong/ECON**
Student: **CHEUNG Wai Ho/ECOF** **UROP Course: UROP1100, Summer 2015**
MA Yuanxiang/ECOF **UROP Course: UROP1100, Spring 2015; UROP2100, Summer 2015**
ZHOU Guangliang/ECOF **UROP Course: UROP1100, Summer 2015**

This report presents the work conducted by the Micro Group in the summer of 2015 under the project name, "Middle-income Trap, Structural Change, and Economic Growth." One part of our works involved verify motivating facts for this project, including whether the production services share of middle-income trapped countries is less than that of middle-income escaped countries, as well as whether basic manufacturing requires less production input compared with high-quality manufacturing and consumption services. We also provide insight into the real-world conditions of structural change and countries with different income levels, including the relationship between the ratio of basic manufacturing to non-agriculture GDP and the income of countries as well as the level of parameters (α and β) in the production functions of countries with different income levels.

Advisor: **WANG Yong/ECON**
Student: **GUO Zhihui/ECOF** **UROP Course: UROP1100, Summer 2015**
LIU Zining/ECOF **UROP Course: UROP1100, Spring 2015; UROP2100, Summer 2015**

This report presents a research summary from the Macro Group under the project title, "Middle-income Trap, Structural Change, and Economic Growth" for the summer of 2015. Our work mainly involved conducting an international comparison on production service shares and country transitions. The transition probability matrix shows the existence of middle-income traps, indicating that middle-income countries face greater difficulties in attaining a high-income status. A comparison of production services revealed the crucial role of production services in escaping the middle-income-trap, whereas the correlation between production service shares and GDP might be negative with a high-income status. These motivating facts were established to support further research and model construction on the middle-income trap.

Regional Inequality and Economic Growth: An Open-Economy Perspective

Advisor: **WANG Yong/ECON**
Student: **CHUNG Wai Chu/ECOF** **UROP Course: UROP1100, Summer 2015**

The purpose of this project was to examine the interactions between urban land-use planning and structural changes within cities in China. We studied whether an effective price of land exists and changes in optimum land allocation at different stages (from manufacturing to services), focusing on three types of land use: residential land, manufacturing land, and service land. The main task was to calculate the area and average price of the three land-use types in cities in China. To date, we summarized and calculated the land data on 12 cities from 1999 to 2011. The data file on land transactions in Beijing from 2000 to 2014 has been translated from simplified Chinese to English.

Department of Finance

Measuring the Risk Premium of Environmental, Social, and Governance Factors

Advisor: **BENZ Entela/FINA**
Student: **WANG Ying/RMBI** **UROP Course: UROP1100, Fall 2014**

In an effort to enhance our understanding of sustainable and responsible investment, we further elaborated on the plan presented in the progress report for UROP1000, with a focus on the implementation of a propensity score-matching model by using R statistical software, which has provided a solid foundation for further studies.

Top Management Turnover and Corporate Policy Decisions

Advisor: **GOYAL Vidhan Krishan/FINA**
Student: **CHENG Hok Kan/SBM** **UROP Course: UROP1100, Spring 2015**
HUNG On Kat/SBM **UROP Course: UROP1100, Spring 2015**
YEUNG Lok Sum/ACCT **UROP Course: UROP1100, Spring 2015**

The following report focuses on the reasons for the changes to the Chief Executive Officer (CEO) of companies under the S&P 500 from 2009 to 2011. We found that the majority of management changes are routine changes that contribute to approximately 70% of all CEO changes. In other words, many CEOs have retired with succession plans. Those classified as forced management changes, which contribute to approximately 10% to 15% of all changes, were due to termination, mergers, liquidation, and refinancing. These findings were consistent across the years, from 2009 to 2011.

Advisor: **GOYAL Vidhan Krishan/FINA**
Student: **CHOW Ho Ming Henry/QFIN** **UROP Course: UROP1100, Summer 2015**

To investigate the association between CEO power and entrenchment and key enterprise retention plan (KERP) adoption, we collected 135 samples of companies filing for bankruptcy. For the sample companies with KERP adoption, we identified the executive when the KERP was adopted, in addition to other demographic details pertaining to the individual. For sample companies with no KERP adoption, we identified the executive immediately before the companies filed for Chapter 11. We may continue with further analysis in the next stage of our research.

Corporate Investment and Politicians' Career Incentives: Evidence from China

Advisor: **LIU Laura Xiaolei/FINA**
Student: **KA Chun Hang/SBM** **UROP Course: UROP1100, Fall 2014**
NG Tsz Tung/ECOF **UROP Course: UROP1100, Fall 2014**
XIA Yicong/ECOF **UROP Course: UROP1100, Fall 2014**

Politics and finance are known to interact at an aggregate level, and each of them is a key factor to influence the other. Most studies focus on macro-level data, examining how political stability, political turnovers, or other factors in political science have affected the economic behavior at the state or provincial level, but micro-level data on individual firms is lacking. This study primarily examined how politicians' incentives in China have influenced firm-level decisions, and how such decisions have affected the economic conditions in China in the past few years. Moreover, if possible, we want to examine trends in consideration of China's ongoing transition and structural change.

Role of Securitization during Financial Crisis

Advisor: **LIU Laura Xiaolei/FINA**
Student: **CHENG Hok Kan/SBM** **UROP Course: UROP1100, Fall 2014**

Before and during the financial crisis of 2008, corporations needed liquidity for their business operations and expansions. However, as banks tightened their credit because of the widespread risk of businesses and a lack of confidence in the economy, corporations required alternative sources of liquidity to supplement their own. Asset-backed securitization (ABS) was relatively widely used by businesses, defined as when corporations sell or create credit agreements with banks by using their liquid assets (e.g., accounts receivables) as collateral. In return, banks provided short-term liquidity to corporations.

The student in this UROP assisted the faculty in performing a preliminary screening and classification of corporations in terms of whether they performed ABS in the periods under examination, especially during the 2008 financial crisis.

The faculty subsequently performed quantitative analysis to determine whether ABS benefited the financial performance of these corporations.

Advisor: **LIU Laura Xiaolei/FINA**
Student: **GUAN Chun/ECOF** **UROP Course: UROP1100, Fall 2014**

This project was a follow-up project to Professor Liu's former research, entitled, "Securitization and capital structure in nonfinancial firms: An empirical investigation" (2011), which investigated the mechanism and benefits of securitization for nonfinancial firms. My task for this UROP, "The Role of Securitization during Financial Crisis," was to identify whether firms had engaged in securitization during the financial crisis by reading their financial reports, which were collected by former students as text paragraphs. I also separated them into more accurate types based on factoring and asset-backed securitization, and laid the foundation for further investigation.

Corporate Risk Management Practices: Global Survey of BRICS-country Firms

Advisor: **MACKAY Peter/FINA**
Student: **BI Minwen/RMBI** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

This report presents a discussion on the second stage of work in our global survey of BRICKS-country firms on their risk management practices. Based on our sample selection in the first stage, we are currently seeking a proper online platform to facilitate conducting our survey. This report presents a comparative selection process between Survey Monkey and Wen Juan Xing based on the criteria we believe significantly influence the quality of the global survey. Specifically, we plan to evaluate each platform according to their performance in the presentation of the questionnaire, accessibility, multi-language support, data collection, and cost.

Advisor: **MACKAY Peter/FINA**
Student: **LEE Yeon Jae/SBM** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

For this project, we conduct a comparative analysis on risk management practices at firms in BRICS countries (i.e., Brazil, Russia, India, China, and South Africa). In addition to these five countries, we decided that South Korea should be included in the sample. At the current stage of our research, we formed a few questionnaires for our survey. After finishing our formulation of the questions, we translated the original copy into Korean and Chinese Mandarin, so that it is more language-friendly for some of our subjects, who are employed in regional companies in South Korea and mainland China. These questionnaires will be distributed, and the collected responses will be used for further research.

Advisor: **MACKAY Peter/FINA**
Student: **ZHANG Yanjia/QFIN** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015**

For this project, we conducted the first large-scale comparative analysis on the corporate risk-management practices of firms operating in the BRICS countries. A survey in several benchmark countries is essential for a comparison. This progress report presents the follow-up work conducted during the survey-planning stage of the project, and mentions the assistance of participants in this period, including with the questionnaire design and the translation, so that it was a match to the local business culture. Thus far, the questionnaire has been completed, which is composed of four major questions concerning corporate risk management in emerging markets. A Chinese Mandarin version of the questionnaire was also prepared for the next stage of the project, in which the questionnaires will be distributed to corporate employees, and the responses will be collected.

Advisor: **MACKAY Peter/FINA**
Student: **HE Xue/SBM** **UROP Course:** **UROP1100, Summer 2015**

This report presents a discussion on the third stage of our global survey of BRICS-country firms on their risk management practices. At this stage, we focused mainly on cleaning the data collection, specifically the contact information of our stratified sample firms. Moreover, we adopted the mixed-survey approach, where both hard and soft copies of questionnaires are used, and we found the online survey platform Qualtrics, which betters suit our needs for the global survey compared with Survey Monkey and Wen Juan Xing, which were proposed in the previous stages. Future work will involve generating hard copies of letters, distributing the questionnaires, and receiving feedback.

Emigration of Controlling Shareholders on Firm Value and Corporate Decisions

Advisor: **WEI Kuo-chiang/FINA**

Student:	**CHIM Hoi Ching/FINA**	**UROP Course:** **UROP1100, Spring 2015**
	GAO Baiwen/QFIN	**UROP Course:** **UROP1100, Spring 2015; UROP2100, Summer 2015**
	KIM Jae Woo/QFIN	**UROP Course:** **UROP1100, Fall 2014**
	LIN Yiwei/QFIN	**UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015; UROP3100, Summer 2015**
	YANG Chunpu/QFIN	**UROP Course:** **UROP1100, Fall 2014**
	YUNG Wai Ting Winnie/QFIN	**UROP Course:** **UROP1100, Summer 2015**

The globalization trend “flattens the world” and affects the economy through different channels, such as by integrating the market and promoting multivariate free trade. By contrast, the evolution of certain human behaviors in the new environment can also have subtle yet critical implications for the commercial world, of which emigration could be a typical example. In many developing countries, emigrants are generally considered affluent cohorts with a strong financial background who can afford major expenditures in the process and life abroad, and in which a large proportion of people even own enterprises. Apart from seeking a better-regulated investment environment, a higher life quality, and greater educational resources for their children, emigrants are occasionally accused of unfavorable motivations such as avoiding obligations and engaging in corporate fraud. We examined relevant policies in several countries toward companies with controlling shareholders with foreign residence information, and attempted to find whether such privileges actually exist as well as the implications of such policies. In addition, we collected information on the time of emigration of the controlling shareholders and the behaviors of the firms, and explored the correlation between them. In estimating the relationship, the effects of immigration on firm value and other aspects are expected to be found, which might also affect the firm value.

Department of Information Systems, Business Statistics and Operations Management

Online Tie Formation and Persistence on an Enterprise Social Media Platform

Advisor: **KIM Yongsuk/ISOM**
Student: **CHEUNG Chun Wai/EVMT** **UROP Course: UROP1000, Summer 2015**
KIM Byung Yeon/ACCT **UROP Course: UROP1000, Summer 2015**

Enterprises use social media platforms as a tool to encourage knowledge sharing across organizational boundaries to boost innovation. However, it remains unclear whether such platforms would create the desired cross-boundary connections, because people tend to connect with those similar to themselves. Therefore, this study investigates whether the cross-boundaries connections is encouraged, and hence, whether innovation would be enhanced by enterprise social media. A social network platform used at a large organization was examined, and we provided some groundwork for the research by conducting data analysis and queries. We found that people tend to connect with others who are organizationally similar, and online interest groups are likely to lead to new connections, which is a critical factor for cross-boundaries connections.

Dynamics in Crowd-based Contests

Advisor: **KOH Tat Koon/ISOM**
Student: **ZHANG Qian/FINA** **UROP Course: UROP1100, Fall 2014**

Crowd-based contests provide firms with an opportunity to obtain solutions for complex problems from crowds, and thus, they have become popular in recent years. This paper investigates how solutions vary in such contests regarding the knowledge domains of participants and problems. This study proposes a multi-domain model to delineate the relationship with precision, which is based on the assumption that participants have knowledge in more than one domain, and the problems also fall under more than one category. We provide four recommendations based on the model results. Our findings could contribute to improving the efficiency of crowdsourcing platforms in a manner that selects a favorable outcome (e.g., a larger quantity or higher quality of solutions can be achieved using the model).

Integrated Learning Platform for Online Course Delivery

Advisor: **KWOK James Sai Ho/ISOM**
Student: **FOEAD Emily/ECOF** **UROP Course: UROP1000, Summer 2015**

This paper examines the different factors that contribute to student learning on an MOOC platform. Based on an overview of the features of existing platforms such as Coursera and edX as well as on a literature review, we present a number of key features associated with student attraction and retention. These features include the use of discussion forums, interactive video quizzes, machine grading, and course recommendations. Based on these features, a course platform prototype was designed by utilizing Microsoft Access to establish a preliminary database. In addition, recommendations on teacher actions and the role of students were compiled. Recommendations for further expansion of the scope are provided.

Advisor: **KWOK James Sai Ho/ISOM**
Student: **NIU Yutong/EEGBM** **UROP Course: UROP1000, Summer 2015**

This paper examines the different factors that contribute to student learning on an MOOC platform. Based on an overview of the features of existing platforms such as Coursera and edX as well as on a literature review, we present a number of key features associated with student attraction and retention. These features include the use of discussion forums, interactive video quizzes, machine grading, and course recommendations. Based on these features, a course platform prototype was designed by utilizing Microsoft Access to establish a preliminary database. In addition, recommendations on teacher actions and the role of students were compiled. Recommendations for further expansion of the scope are provided. This paper is the second part of the project, which focuses on the design and implementation of the proposed system.

Opinion Mining on Big Data

Advisor: **KWOK James Sai Ho/ISOM** **Co-advisor:** **TAM Kar Yan/ISOM**
Student: **SHI Chao/ELEC** **UROP Course: UROP1100, Fall 2014**
WONG Tsz Yan/ECOF **UROP Course: UROP1100, Fall 2014**

Comment-posting on Facebook has become an increasingly popular channel for people to express opinions and sentiments toward a movie they watched. By analyzing the large volume of comments available on Facebook, and by examining how one's comments influence others within a social network, we obtained useful actionable knowledge that could be of financial value to filmmakers and other interested parties. This report proposes a framework for analyzing the opinions and comments on a specific movie on Facebook to predict sales performance. We also incorporated a methodology for predicting the relationship strength of people on Facebook in the framework, so that the influence of the word-of-mouth marketing strategy could be discerned for people included in the analysis. The information can be used for predicting the sales performance of movies.

Keywords: opinion mining, movie, Facebook, movie sales.

Advisor:	**KWOK James Sai Ho/ISOM**	**Co-advisor:**	**TAM Kar Yan/ISOM**
Student:	**CHAN Shing Hei/RMBI**	**UROP Course:**	**UROP1100, Spring 2015**
	HERMANEK Stefan Johannes/GBUS	**UROP Course:**	**UROP1100, Spring 2015**

In recent years, the number of comments expressing opinions and sentiments on a movie the poster has watched has been increasingly rapidly on social media platforms such as Facebook and Twitter. The reason we chose Facebook as our target of investigation is that the comments are unevenly and rapidly distributed; it appears to be the best platform for influencing others; and because of their marketing strategies. However, few opinion-mining algorithms have considered Facebook data, specifically user-to-user relationships. Moreover, certain researchers have focused only on the positive impacts generated by the prevalence of Facebook comments regarding movies, and such researchers have neglected the negative impacts on movie piracy, usually driven by Bittorrent. Therefore, this topic is the subject of our investigation. This report mentions the types of Facebook and movie data that are to be collected, and presents our reasoning regarding why these data are useful for our opinion-mining algorithm. After data collection, we outline existing opinion-mining techniques. Moreover, we highlight the challenges and complexities of opinion mining on Facebook for this research. Furthermore, we propose a framework for analyzing opinions or comments for a specific movie on Facebook, which incorporates both linguistic considerations and user-to-user relationships for predicting the sales performance of a movie. We incorporated a methodology for predicting the relationship strength of people on Facebook. Lastly, we implemented the framework and conducted a test on the developed framework, and the report concludes with the key challenges associated with formulating a framework for our opinion-mining algorithm on Facebook comments.

Big-data Analytics

Advisor:	**SO Mike Ka Pui/ISOM**	**Co-advisor:**	**TAM Kar Yan/ISOM**
Student:	**LIU Wing Ki/MATH**	**UROP Course:**	**UROP1100, Spring 2015**

The issue of how we should observe dependence among random variables is of great concern to many people. The Sklar theorem (Sklar, 1959) posits that any cumulative multivariate probability function can be expressed in terms of a copula and cumulative univariate probability functions. Nelsen (2006) and Joe (1997) have further analyzed how copulas could be used to investigate dependence among random variables. Smith (2011) explored the methods to derive parameters in copula models.

This report is divided into four chapters: the properties of a copula, dependence, Bayesian estimation, and vine copulas. Chapter 1 introduces copulas. Chapter 2 presents a discussion on how dependence can be measured. Chapter 3 details how the Bayesian approach can be used for estimating the parameters. Finally, in Chapter 4, I delineate the structure of a vine copula.

Risk Management

Advisor: **SO Mike Ka Pui/ISOM**
Student: **LI Xiaoyue/RMBI** **UROP Course:** **UROP2100, Fall 2014; UROP3100, Spring 2015**

The modeling dependence structure of a random field remains a challenging issue. Whereas the traditional modeling method of the variogram may function well under the Gaussian assumption, the variogram modeling method generates unreliable predictions when extremes occur more frequently compared with the Gaussian process. Moreover, under this construction, the modeling of the marginal distribution of the underlying random field can influence that of the dependence structure. To address these two weaknesses, we propose a copula-based modeling approach for analyzing the dependence of spatial data. Copula-based modeling is sufficiently flexible to explain non-Gaussian dependence, even in high dimensions. Moreover, copula-based modeling can allow separate modeling for marginal distributions and the strength of association between variables. Although the Gaussian copula has been utilized in an excellent manner, it cannot explain asymmetric tail behavior. Thus, in this paper, we considered a skewed version of the multivariate t copula. This study explores the use of the skewed version of a t copula in modeling spatial data dependence by using geostatistical properties. Specifically, when spatial covariance in the random field is a function of distance instead of direction (isotropic), we attempt to construct such a copula according to the variogram or other functions of spatial distance. In addition, related topics involving the adjustment of the nugget effect are addressed. We tested our method using simulated data and pollution data from Hong Kong.

Big-data Analytics for E-Commerce

Advisor: **ZHANG Xiaoquan/ISOM**
Student: **LI Jiachen/SBM** **UROP Course:** **UROP1100, Summer 2015**

Under the main topic of the formulation of a trading strategy for the Chinese stock market, this project can be divided into the following several parts. First, after referring to the relevant literature, Petro China and Sinopec were chosen to represent the Chinese stock market. Second, a typical indicator and oscillator for technical analysis were chosen. In this project, we determined the positive and negative DI as well as MACD as indicators and the oscillator, respectively. Third, we conducted our analysis on R software, and applied the code on these two stocks. Finally, we evaluated the performance through a comparison of trading signals and the corresponding close return. If the trading data suggested by the strategy corresponded adequately with the return, then the strategy was deemed effective to an extent.

Advisor: **ZHANG Xiaoquan/ISOM**
Student: **LI Yuan/SBM** **UROP Course: UROP1100, Summer 2015**

The first part of this paper details the testing of one of the simplest trading strategies: simple moving average crossovers. The main concept concerns the training set, where short-term and long-term moving averages are first constricted in a specific interval and selected through parameter optimization based on a particular metric. Afterward, the performance of the trading strategy is evaluated by applying it to the testing set, and by examining the annual return and a few other metrics. The second part of the paper presents a discussion on the knowledge and experience gained during the processes of designing, building, and modifying the strategy and our reflections. Lastly, potential improvements and the plan for the next stage are discussed.

Advisor: **ZHANG Xiaoquan/ISOM**
Student: **RUAN Ting/SBM** **UROP Course: UROP1000, Summer 2015**

Big data have great potential for assisting companies in making more informed decisions. The main focus of this project was to develop an automated decision tool to enable participation in trading in the financial market. The tool can be used for analyzing real-time data feeds and generating reports and strategies as decision aids. This report presents a discussion on sectors and stock evaluation, trading strategies, and a strategy performance evaluation. The tool comprises two parts, the first of which concerns company and stock evaluation and stock selection. The second part is the trading strategy. The strategy involves using the relative strength index as an indicator for making trading decisions in the financial market.

Advisor: **ZHANG Xiaoquan/ISOM**
Student: **WANG Xiangjia/RMBI** **UROP Course: UROP1100, Summer 2015**

The inefficiencies of the Chinese stock market enable profiting from special trading strategies. For this UROP, we examined two simple strategies. The first strategy was the maintenance of records on how many days have passed since the last highest point in a fixed period. This strategy is direct, yet it yielded impressive results after 2009. It was also helpful in learning how to use R for developing a trading strategy. The second strategy concerned calendar anomalies in A stock. We used the daily data of the SSEC index ETF to trade during each Chinese festival, and the returns were found to be steady and remained positive, even when the benchmark yielded a negative return. Moreover, we tested the performance of different industries during festival periods. This part is still in progress, and to date, we found that the retail and transportation industries exhibited obvious advantages during the spring festival. Further research can be conducted to optimize a complete trading calendar strategy.

Advisor: **ZHANG Xiaoquan/ISOM**
Student: **YUAN Xinyu/ECON** **UROP Course: UROP1100, Summer 2015**

For this quantitative finance research project, I developed a trading strategy focused on the biotechnology industry by using R software, and compared the strategy's cumulative returns against a simply strategy holding SPY500 index. I also performed textual analysis on a particular stock in the stock market, and this part is still in progress. During development, I have learned how to use R software to conduct basic analyses as well as about the stock market.

Application of Topic Modeling in Recommender Systems

Advisor: **ZHENG Rong/ISOM**
Student: **SHANG Hang/CPEG** **UROP Course: UROP1000, Summer 2015**

The aim of this project was to apply topic modeling in a recommender system by implementing collaborative filtering. To extract a movie topic, I used the latent Dirichlet allocation algorithm to extract the content of a movie from a topic. I hypothesized that the distribution of these topics influences the audience on whether they like a particular movie. The topic of the movie was mainly extracted from the subtitles. During research, most of the experiments were conducted using Python software. I used common Python machine-learning libraries such as NumPy, Skilearn, Spark Mlib, and Pandas as well as the lda package for latent Dirichlet allocation to extract the topic.

Large-portfolio Management

Advisor: **ZHENG Xinghua/ISOM** **Co-advisor:** **LI Yingying/ISOM**
Student: **XU Shiyao/EVMT** **UROP Course:** **UROP1100, Spring 2015**

As a team, we read two papers related to the high-dimensional optimization problem. The main paper was by Professor Zheng Xinghua, Professor Li Yingying, and Ms. Ao Mengmeng, in which they presented a novel approach of combing sparse regression and random matrix theory. Through their research, they found that a new estimated portfolio, under the condition of sparsity, can asymptotically achieve the maximum expected return and with the risk constraint satisfied. Furthermore, "it is the first time that these two goals are simultaneously achieved in the high-dimensional setting."

At first, we examined the paper in depth and identified the main concepts in the paper as well as the major theory. In the beginning, we deemed that it might be too difficult for us to understand the entire process, thus, we started with the traditional theories to learn the changes and progress made in statistics and the financial world in the last 50 years. We used R statistical software to perform simulation and extensive empirical studies. We used numerous real-world data to assess the performances of traditional methods and the improved method. We wrote and executed a series of R codes to conduct large-portfolio management.

In the final stage, we studied another notable paper on the least absolute shrinkage and selection operator. "It enjoys some of the favorable properties of both subset selection and ridge regression. It produces interpretable models like subset selection and exhibits the stability of ridge regression. This lasso idea is quite general and can be applied in a variety of statistical models: extensions to generalized regression models and tree-based models are briefly described."

Keywords: shrinkage, high-dimensional portfolio selection, random matrix theory, regression, quadratic programming.

Department of Marketing

Luxury Marketing in Emerging Markets

Advisor: **HELSEN Kristiaan/MARK**
Student: **TANG Yin Ming/SBM** **UROP Course: UROP1100, Spring 2015**

This study examines Asian people's perception of the selling and flash sales of online luxury goods. Based on the results obtained from a small sample of 43 people from Asian countries, we suggest that people want to try online shopping; however, they are likely to encounter problems, which are related mainly to quality issues, and they typically find it difficult to have sellers or online retailers respond to these issues. The findings also suggested that such unpleasant experiences would have a negative effect on their future online shopping decisions. After gaining insight from their responses, we provided corresponding recommendations, which might be a useful reference for running a successful online luxury business.

SCHOOL OF HUMANITIES & SOCIAL SCIENCE

Division of Humanities

Twentieth-century China in Photographs

Advisor: **CHANG David Cheng/HUMA**
Student: **MA Yujia/BIOL** **UROP Course: UROP2100, Fall 2014**

The death of Zhou Enlai was a prelude to the collapse of the Cultural Revolution. Although Mao Zedong's death marked an end to the revolutionary era, in 1976, the passing of these two "great men" left a deep impression on the Chinese people. The aim of this report is to present everyday people's reflections on the death of Mao and Zhou. The interviewees were all teenagers or youths who had not been purged, but had been psychologically influenced by the Cultural Revolution.

Advisor: **CHANG David Cheng/HUMA**
Student: **CHEN Mengxue/SBM** **UROP Course: UROP1000, Summer 2015**

During the project, I perused thousands of old photographs of China, mostly from the 1960s, and near the end of the project, I focused on photographs taken by Hedda Morrison in the 1933–1946 period in Beijing. During the project, I learned how to sort photos methodically, according to the time taken, location, themes, or photographers, and where and how to find the sources, for which I used various approaches. In addition, I learned more of the city that is my birthplace, and how it has changed over several decades, especially regarding the streets of Beijing in the 1930s.

Division of Social Science

Examining Implicit Attitudes across Cultures and Lifespan

Advisor: **CHEN Eva E/SOSC**
Student: **TONG Kong Yan/MARK** **UROP Course: UROP1100, Spring 2015**

This study examines the malleability of cultural identity in Hong Kong by using an experimental approach. The malleability of identity is defined as multiple identities within an individual changing in saliency when exposed to contextual cues. The malleability of implicit and explicit identities was measured using the Implicit Attitude Test (IAT) and through self-reported explicit measures, respectively, after priming the participants with a culture-related script. We anticipate that the cultural identities of Hong Kong residents are malleable under priming, where implicit identities are more malleable compared with their explicit counterparts. These findings support further research on malleability under naturalistic conditions (e.g., traditional festivals) and the feasibility of enriching cultural education in Hong Kong.

Single Women in Hong Kong Media

Advisor: **GROVES Julian Mcalli/SOSC**
Student: **LEE Tsz Yan/GCS** **UROP Course: UROP1100, Fall 2014**

This project, entitled, “Single Women in Hong Kong Media,” was an investigation into the response of single women in Hong Kong toward the reality show series “Bride Wannabe,” for which we conducted a focus-group study. Discourses on romantic relationships, marriage, and singlehood were also conducted. The project remains in progress, and themes for further discussion have been identified and will be used in future research.

Advisor: **GROVES Julian Mcalli/SOSC**
Student: **LIU Chun Pok/ACCT** **UROP Course: UROP1100, Spring 2015**

This progress report is a summary of the responses from female participants in the focus groups for the Bride Wannabe television show. To summarize the comments in a more systematic manner, I categorized them under the following sections: Impressions of the show; viewing habits; reasons such social issues arise; views toward the opinions expressed in the show; representativeness of the show; views on speed dating; values portrayed in the show; and future expectations.

How was the New Territories Electoral System Developed?

Advisor: **PATCHELL Gerald Roe/SOSC**
Student: **CHEUNG Ka Man Carmen/EVMT** **UROP Course:** **UROP1000, Summer 2015**

Indigenous villagers in the New Territories have been granted many special rights compared with urban dwellers (e.g., the right of land, the right of burial in rural areas, and special grants on relocation). Their special identity and interests were even protected under basic law. This report is a summary of the academic papers on indigenous people in Hong Kong, specifically in the New Territories. We also present a comparison of their viewpoints. For example, how the authors have defined the term "indigenous," what rights they have or should have, the issues they are facing at present, their views on the classification of indigenous people, and how they believe the system compares with other systems for indigenous populations.

China–Africa Links Project

Advisor: **SAUTMAN Barry Victor/SOSC**
Student: **KEVIN ./GCS** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015; UROP1000, Summer 2015**

China–Africa economic interaction is one of the most widely discussed issues in international relations, and it intensified in the twenty-first century. Although Chinese participation in the continent's economic development offers substantial benefits, as showcased by the active and ongoing involvement of Chinese state-owned enterprises in various infrastructure projects, concerns have arisen regarding the quality of these projects, the discourse on the "influx of Chinese workers and goods," and the impact on local communities affected by the Chinese presence. In the third part of the UROP course in Professor Barry Sautman's project, entitled, "China–Africa Links Project," I would like to summarize the additional findings that Professor Sautman and I obtained throughout the summer of 2015 regarding the discourse on Chinese–African economic relations, with an emphasis on the qualitative aspect of our research, specifically concerning the interactions, communication, and differences in perception between the Chinese and African people.

Advisor: **SAUTMAN Barry Victor/SOSC**
Student: **LI Yishuang/GCS** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Spring 2015; UROP3100, Summer 2015**

The Chinese presence in Africa has always been a popular topic in the media and among politicians, both in the West and in Africa. Over the past several decades, it has also drawn the attention of many Chinese and Western scholars. This summer, I continued the "China–Africa Links Project" and approached the topic from two major perspectives: documentary research on the discourse of "China's Neocolonialism in Africa" and interviews with the employees of Chinese construction companies on their localization practices in Africa. This report is a summary of my findings on the representation of "China in Africa."

Advisor: **SAUTMAN Barry Victor/SOSC**
Student: **ZHOU Weixuan/SBM** **UROP Course: UROP1100, Summer 2015**

The China–Africa relationship has a long history dating back to the fourteenth century. It has undergone dramatic changes in the past 600 years, and perhaps the most noticeable changes have taken place since the 1970s, when both China and Africa experienced crucial transformations in political ideology, their economic model, and in social perspective. Changes in the China–Africa relationship can be reflected in various ways, including through official document locution, non-governmental contacts, and trade partnerships, among which bilateral investment is a most intuitional index. This essay focuses on Chinese investment in Tanzania, an exemplary third-world African country, and by examining two typical projects—the Tanzania–Zambia railway and the Chinese sisal farm in Tanzania—we expect to discern several implications regarding further Chinese–African cooperation.

The Hong Kong Anti-mainlandization Movement

Advisor: **SAUTMAN Barry Victor/SOSC**
Student: **CHEN Pinzhu/ACCT** **UROP Course: UROP1100, Spring 2015**

This article explores the anti-mainlandization movement in Hong Kong, with a focus on the anti-parallel trader protest that occurred in the first half of 2015. We present our findings on the features of localist movements as well as the objectives and opinions of the leaders and participants through documentary research, interviews, and onsite observations. Despite the negative influences of the protest, the localist groups involved have insisted that the government's action to amend the visa scheme is the solution to this issue. Media that are closely connected with the localists publish commentaries on political discussions that provided implicit support to the movements during the protest. Chin Wan, one ideological leader, also laid the theoretical foundations for localist movements. Interviews with the activists and political leaders revealed many common agreements among localists, which might include the view that the people of Hong Kong and in the mainland are ethnically different.

Advisor: **SAUTMAN Barry Victor/SOSC**
Student: **LIN Yinghui/GCS** **UROP Course: UROP1100, Summer 2015**

The Hong Kong anti-mainlandization (i.e., “localist") movement has emerged recently. Among the drivers of the movement, the claim that the number of mainland visitors and immigrants to Hong Kong is overwhelming this highly populated city appears to be mentioned frequently. However, as analyzed by Professors Barry Sautman and Yan Hairong (2015), if a synchronic (simultaneous) approach, rather than a diachronic approach, is used, Hong Kong is not overwhelmed compared with relatively similar cities such as New York City, London, and Paris. Despite the results of the synchronic (simultaneous) comparison, anti-mainlandization sentiment remains prevalent, and Hong Kong localism is forming a stronger trend, which, to an extent, has intensified the conflicts between the mainland and Hong Kong. Thus, the first part of our report presents a discussion on a number of more plausible reasons behind the movement other than the objectively increasing number of Mainlanders. The second part covers the main topics that were documentarily researched in the project. The last part presents several crucial elements that could potentially lead to the alleviation of tensions in the Hong Kong–mainland relationship.

Advisor: **SAUTMAN Barry Victor/SOSC**
Student: **WONG Sze Ching/SSCI** **UROP Course: UROP1000, Summer 2015**

Localism has become a heated topic in recent years because of a number of protests that have been held by “aggressive localists.” The major source of information was obtained from interviews conducted with different localism organizations from diverse backgrounds and with varying ideologies. Newspapers (printed and online), magazines, and official statistics from the Hong Kong government were also used as a reference. I summarized the development of localism, the outcome, and its impact, and present recommendations in the report for moving toward a “win–win scenario” based on the perspectives of the localists, scholars, the Hong Kong government, and the Hong Kong population. Based on the results, I surmise that localism is not an entirely negative concept for Hong Kong.

Evaluating the State of Innovation and Technology in Hong Kong and the Region

Advisor: **SHARIF Naubahar/SOSC**
Student: **LIU Yuhong/ECOF** **UROP Course: UROP2100, Fall 2014**

This research is based on previous studies that have examined research and development (R&D) centers in Hong Kong. With a more in-depth research into the technology transformation programs and the financial status of these R&D centers, more evidence from the analytical portion is provided to present a tentative evaluation of the status of these R&D centers. Advancing toward a more macro-representation of how the R&D centers function as promoters of innovation in society, we evaluate its impact and effectiveness on building a relationship between technology and its commercialization platform.

Democratic Development in Asia and Worldwide

Advisor: **SING Ming/SOSC**
Student: **CHEUNG Chun Yat Julian/GCS** **UROP Course:** **UROP1100, Fall 2014**

In Taiwan, protests have been held since 2009 against the potential monopoly of the media industry. The announcement of Tsai Eng-Meng purchasing the China Times Media Group in 2008 generated numerous controversies. The National Communications Commission (NCC) had followed the case and investigated whether Tsai had violated any laws. Protesters, including students, scholars, professors, journalists, and the public, marched on the streets, organized protests in the commission, or cosigned to oppose to the merger. The movement gradually faded in 2013, and the media market was saved. This paper presents a discussion on how Chinese factors affected the emergence and the continuation of the anti-media monopolization protests in Taiwan, and how the movements had a successful impact on the decisions of the NCC and Fair Trade Commission in Want Want Group's attempt to purchase Next Media and cable television.

Hong Kong Government and Politics

Advisor: **SING Ming/SOSC**
Student: **CHIU Yin Shan/IS** **UROP Course:** **UROP1000, Summer 2015**

An onsite survey conducted during the Umbrella Movement revealed discontent with income inequality and social mobility as a significant reason for people participating in the protest. For this report, we reviewed and summarized 10 major studies to examine the subjective circumstances and subjective perceptions of income distribution and social mobility from 1971 to 2014 in Hong Kong. The first two sections of this report address income distribution and social mobility, followed by two sections detailing our examination of people's perceptions on income distribution and social mobility. The last section presents a discussion on the political implications, with the aim of relating income distribution and social mobility to the Umbrella Movement.

Advisor: **SING Ming/SOSC**
Student: **LAM Tin Wai Grace/GBUS** **UROP Course:** **UROP1100, Fall 2014; UROP2100, Summer 2015**

To enhance our understanding of the Umbrella Movement, our report presents a comparison of this movement with other mass mobilization movements worldwide, including Occupy Wall Street (OWS), Greece's "Indignant Citizens Movement," and Spain's "Movimento 15-M." Specifically, a comparison of their backgrounds, goals, discussion platforms, the means of reaching a consensus, leadership, and tactics are delineated. We found that all of the movements attempt to impose a direct democracy in making collective decisions regarding the occupied sites, with the hope of creating a fair ground for everyone to voice their concerns. However, subtle differences still exist among the three movements, as discussed in the report.

Internet Finance and Microcredit in China

Advisor: **TSAI Kellee Sing/SOSC**
Student: **HE Yangyang/SBM** **UROP Course: UROP1000, Summer 2015**

Established in 2014, gaero.com is an emerging Internet company that provides a vertical portal service for general aviation aircrafts. It mainly provides information on the market prices and performance parameters of private aircrafts, helicopters, and business aircrafts. Regular maintenance tips and assessments of new released aircrafts are also available on its Web site. It also serves as a platform for trading second-hand aircrafts, through which it can earn a commission fee.

Advisor: **TSAI Kellee Sing/SOSC**
Student: **HU Anqi/SBM** **UROP Course: UROP1000, Summer 2015**

With the occurrence of the financial crisis, hundreds of companies in China were gravely affected. As the origin of microcredits, Wenzhou was one of the worst-affected areas, with the departure of 24 main executives. However, the supervisory departments and banks responded swiftly, and many peer-to-peer (P2P) platforms were established at this critical moment. Upon the end of the second quarter of 2015, these P2P platforms exhibited excellent performance, with profound impacts. “Wenzhou Loan” is one of the most influential P2P platforms, which has typical frameworks and operational canals in the new private-loan domain.

Advisor: **TSAI Kellee Sing/SOSC**
Student: **TANG Sitie/ECOF** **UROP Course: UROP1100, Summer 2015**

Equity crowdfunding is a common form of crowdfunding that is gaining increasing market popularity and drawing policy interest in China. Platforms such as JD Finance have achieved remarkable growth in terms of the number of project listings and the money raised from crowdfunding within a relatively short period, despite their respective characteristics and specialties. The Beijing government has left equity crowdfunding almost legally blank, and official announcements mention only “recommendations” and “announcements.” Market, scholars and policymakers/advocates are studying policies from other countries for references and inspiration. The final customized regulation for China's equity crowdfunding market remains uncertain, and yet, it continues to draw substantial interest.

Advisor: **TSAI Kellee Sing/SOSC**
Student: **WU Suo/RMBI** **UROP Course: UROP1100, Summer 2015**

Internet finance is growing rapidly in the Chinese market. Third-party payments, Internet banking, equity crowdfunding, and P2P, P2B, as well as B2B platforms have become new trends that present a challenge to the traditional banking industry. However, compared with the United States and the United Kingdom, which have the most developed Internet finance markets, the regulation model and structure have yet to be adequately established in China. The Internet finance industry is typically free from regulation and has a high default rate. The People's Bank of China, Securities Association of China, and the China Securities Regulatory Commission have recently issued a series of regulatory recommendations. This report examines the U.S. and U.K. regulation structures, and presents a comparison against the most recent regulatory guidelines in China.

Somatization and Culture

Advisor: **YIK Michelle/SOSC**
Student: **LAU Hiu Kwan/GCS** **UROP Course: UROP1100, Spring 2015**

Based on past research regarding cultural influences on emotion expression, Chinese people were found to favor the use of somatic phrases in describing their psychological conditions. The tendency of replacing emotional words with somatic phrases is called "somatization." Somatization can be understood as the expression of psychological distress in primarily physical ways, and has been commonly used for explaining the comparatively lower depression rate among Chinese people compared with Westerners. This paper examines and presents a comparison of the different methods used for measuring the levels of somatization. It also provides an evaluation of the discrepancy in results obtained from structured clinical assessments and spontaneous reports, as well as a discussion on the role of language and early exposure to language in somatization.

Coping with Unpleasant Affect among HKUST Students

Advisor: **YIK Michelle/SOSC**
Student: **LAW Siu Yee/ACCT** **UROP Course: UROP1100, Summer 2015**

When facing everyday challenges and obstacles, people require different coping strategies to manage these adversities, and to regulate the resulting negative emotions. By understanding the strategies currently used by students, more effective strategies may be developed for enhancing wellbeing. Coping strategies have been investigated in the past using close-ended questionnaires and predetermined categories. In this study, we used an open-ended questionnaire to identify the coping strategies used by the HKUST students. In total, 239 students completed a survey on reporting their negative experiences and coping strategies; 1195 strategies were identified, which were coded using a bottom-up analytic approach. Five groups of coping strategies were mapped, among which several (e.g., avoidance and seeking social support) have been reported in previous studies. Others (e.g., self-reflection and calming down) were newly identified in the current study. Future research should be directed towards investigating the effectiveness of these coping strategies.

INTERDISCIPLINARY PROGRAMS OFFICE

Division of Environment

Real-Time Measurements of Particulate Pollutants

Advisor: **CHAN Chak Keung/EVNR**
Student: **WANG Hao/EVMT** **UROP Course: UROP1100, Spring 2015**

The objective of this project was to determine whether the ion mass data from high-resolution time-of-flight AMS can be used for predicting visibility. The scattering coefficient (bsg), which is a coefficient characterizing the ability of aerosol particles in scattering light, was calculated using Mie scattering theory. Because of the lack of elemental carbon data in HKUST and the relatively low contribution of EC (approximately 10%) in the total aerosol loadings onsite, light absorption by particles (by EC) was assumed to be 0. Thus, the scattering coefficient was approximately equal to the extinction coefficient. We then compared the calculated visibility based on the calculated scattering coefficient against the measured visibility. To complete this calculation and comparison, inputs including the size distribution of the particles after hygroscopic growth, the average wavelength of visible light, and the complex refractive index of the aerosol particles are required. The ion mass data of chemical species from HR-ToF-AMS were used to back-calculate the density and number concentration of particles in each size bin based on the ion-pairing scheme proposed by Gysel et al. (2007), under the assumption that the chemical species in the particles are internally mixed, and that all of the particles are spherical without an internal void. Regarding the density, the volume-weighted density of each component in the particles was used to present the density of the entire particle, and the density values published in the literature were used as the density of each corresponding species (i.e., ammonium sulfate, ammonium bisulfate, sulfuric acid, ammonium nitrate, and organics). The size bins in AMS, which were measured as the vacuum aerodynamic diameter, were converted into the volume-equivalent diameter. The volume-equivalent diameter was then multiplied by the growth factor, calculated using the regression model proposed by Cheung (2013) to obtain the volume-equivalent diameter after hygroscopic growth. The complex refractive indices of each component in the particles were retrieved from the literature, and the volume-averaged complex refractive index was used to represent the RI of the entire particle. We used 550 nm as the averaged wavelength of visible light. To date, the inputs mentioned are readily prepared, and in the future, a MATLAB code will be used to calculate the scattering coefficient (bsg) by using Mie scattering theory. The calculated scattering coefficient will then be used to predict the visibility based on the Koschmeider equation, after which the predicted visibility will be compared against the measured visibility to test the accuracy and reliability of this prediction method.

Interdisciplinary Programs Office

Comparison on A-H Pair Trades Before and After Shanghai HK Connect

Advisor: **LAU Sau Mui/IPO**
Student: **CHUNG Chi Kit/QFIN** **UROP Course: UROP1100, Spring 2015**
LAM Chun Kit/QFIN **UROP Course: UROP1100, Spring 2015**
MA Jie/QFIN **UROP Course: UROP1100, Spring 2015**
WANG Xiangjia/RMBI **UROP Course: UROP1100, Spring 2015**

Pair trading is one of the most popular quantitative methods of speculation used by hedge fund managers on Wall Street. It is a trading or investment strategy that exploits the financial markets, which are unstable. In this research, our focus was on China A-H pair stocks, and it as been evidenced in numerous studies in the pair trading arbitrage field. To further investigate arbitrage opportunities, four factors, including the market index premium, the price fluctuations of A shares 1 h before market closure, the Hang Seng China AH Premium Index, and the stock turnover rate, were used for A-H pair stock-trading predictions. We compared their accuracy, in which five stocks with a large market capitalization were used as examples for evaluating the performance of each factor. Among all of the factors, we found the Hang Seng China AH Premium Index to be the best factor because the regression result of this factor had the highest R-squared overall, and its variable coefficient was statistically significant.

Financial Service/Product Development Framework and Taxonomy

Advisor: **LAU Sau Mui/IPO**
Student: **SHIU Wing On Michael/RMBI** **UROP Course: UROP1100, Spring 2015**

Financial planning has undergone a radical transformation over the past 50 years, as indicated by Parrish (2014). With the popularization of information technology such as the personal computer and the Internet, financial services and products have become increasingly diverse. Apparent examples include life insurance and investment funds. A more sophisticated classification or framework for these numerous products is believed to be required to provide detailed information regarding the product to investors, and to help risk managers design new portfolio fund products based on existing ones. Therefore, this paper proposes a financial product development taxonomy. The research question is on how to construct this framework to devise the financial product development taxonomy. The objectives are to review the current product development lifecycle, and to devise the framework for taxonomy development.

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Please visit : urop.ust.hk
Facebook : HKUST's UROP
Inquiries : urop@ust.hk
UROP Office : Room 4592, Academic Building
The Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong

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