



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



# UROP

**Undergraduate Research  
Opportunities Program**



**Proceedings 2013-14**



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## Summary of UROP Courses

<b>UROP 1000</b>	Undergraduate Research Opportunities Program (0 credit, offered in summer session only)
<b>UROP 1100</b>	Undergraduate Research Opportunities Program Series 1 (1 credit, offered throughout the year)
<b>UROP 1200</b>	Undergraduate Research Opportunities Program Series 2 (1 credit, offered throughout the year; prerequisite is pass in UROP1100, with approval by project advisor)
<b>UROP 1300</b>	Undergraduate Research Opportunities Program Series 3 (1 credit, offered throughout the year; prerequisite is pass in UROP1200, with approval by project advisor)
<b>UROP 1400</b>	Undergraduate Research Opportunities Program Series 4 (1 credit, offered throughout the year; prerequisite is pass in UROP1300, with approval by project advisor)

*# Starting from Fall 2014, the course series have been recoded to UROP1000/1100/2100/3100/4100.*



# Message from the President

Launched in 2005, the Undergraduate Research Opportunities Program (UROP), as a HKUST signature program, has gained recognition from both participating faculty members and undergraduate students over the years. During the 2013-14 academic year, 148 faculty members served as project supervisors for 370 students offering more than 300 research projects in their areas of interest.

Thriving as a unique research experience at HKUST, UROP supports the university's undergraduate education framework by allowing students to apply the knowledge gained through academic study while working alongside world-class researchers. UROP also provides participants with opportunities to utilize the most advanced and pioneering facilities that are typically only available to postgraduate students. These proceedings clearly showcase the endeavors and sound achievements of our undergraduate students through the guidance of our faculty members in a wide range of research projects. I would like to express my sincere gratitude to the faculty members for shouldering additional responsibilities beyond their routine teaching. With the stimulating and invaluable research opportunities provided by UROP, I wish to support and encourage all undergraduate students to engage in this program as the beginning of the journey of discovery, and I believe doing so will greatly enhance the research culture within the university community and further fortify HKUST's reputation as a source of world-class academic research.



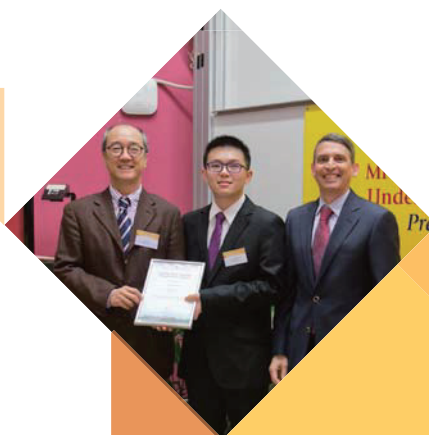
**Tony F Chan**  
President  
HKUST

# UROP Overview 2013-14

During the 2013-14 academic year, the Undergraduate Research Opportunities Program (UROP) continued to shine on the Clear Water Bay campus. The buy-in rate among faculty members rose by 6%, while that among undergraduate students rose by 5%. One hundred and forty-eight supervisors from four schools and IPOs contributed to the program by offering 321 projects that brought together 370 students from 22 departments. The UROP serves very well as a platform on which both faculty members and students have cultivated a popular research culture among HKUST undergraduates.

## 2014 Mr. Armin and Mrs. Lilian Kitchell Undergraduate Research Award

In response to the call for nominations, 44 students were put forward for the 2014 Mr. Armin and Mrs. Lilian Kitchell Undergraduate Research Award, among whom 12 candidates were shortlisted and invited to give a final presentation of their research findings to the UROP Advisory Board (composed of 7 members). After a thorough and careful selection process, 1 Champion, 2 First Runner-ups and 3 Second Runner-ups were chosen as the 2014 awardees. The award presentation ceremony was held April 10, 2014 on campus during the UROP Weeks, when a UROP Showcase Corner was held at the Atrium. Each of the 12 finalists presented a poster sharing their research achievements and, best of all, demonstrating the infinite possibilities an undergraduate can imagine.



School of  
**Science**

Undergraduate Research  
Opportunities Program



## Department of Chemistry

### Modeling Protein-ligand Interactions Using Docking and Other Computational Tools

**Advisor:** HUANG Xuhui/CHEM

**Student:** YANG Yun/CHEM

**(UROP Course: UROP1100, Spring 2014)**

The melanocortin-4 receptor gene (MC4-R) has been implicated in weight regulation, and the interaction between human MC4R and its peptide and non-peptide agonists has drawn significant research attention. These ligands could enhance the function of hMC4R and provide tools to clarify the molecular mechanism. The purpose of this study was to find more potential agonists of hMC4R. Molecular docking software called AutoDock Vina was used to test the known agonists of hMC4R and obtain the binding modes. A similarity search was then used to find other molecules sharing a similar structure with the known agonists. The potential agonists of hMC4R were identified by testing similar molecules with the docking method.

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

**Advisor:** LI Xiaoyuan/CHEM

**Student:** LAI Wing Sze/CHEM

**(UROP Course: UROP1100, Summer 2014)**

The dimension–activity relationship between the down scaling of platinum working electrodes and methanol oxidation reaction (MOR) activities was investigated using cyclic voltammetry. Current density, onset potential and peak current ratio were studied to evaluate the catalytic activities. For various sizes of electrodes, the MOR pathway undergone can involve either the formation of formyl-like intermediates, or carbon monoxide adsorption. The methanol oxidation route selection between the parallel reaction pathways was also monitored with electrode size decreasing. The introduction of direct methanol fuel cells (DMFCs), the latest interpretation of MOR mechanisms, the cyclic voltammetry technique and the significance of using ultra-small electrodes were also explored.



## Division of Life Science

### Molecular Regulation of Muscle Stem Cell Quiescence by Non-Coding RNAs

**Advisor:** CHEUNG Tom/LIFS

**Student:** YE Ying Kit Jacky/BIOT

**(UROP Course: UROP1100, Fall 2013)**

Adult mammalian muscle stem cells have the ability to remain in the quiescent state for prolonged periods and are responsible for tissue repair after muscle damage. Moreover, it has been suggested that the microRNA (miRNA) pathway is important for regulating adult stem cell quiescence. This research revealed the role that miRNA-489 (miR-489) plays in maintaining the quiescent state of adult muscle stem cells. Adult mouse muscle stem cells (satellite cells) from the extensor digitorum longus muscles of mice were used as a model system along with immunofluorescence and transfection to determine whether the transfection of miR-489 into adult muscle stem cells represses the activation of the satellite cells, entailing the essential role of miR-489 in regulating the quiescent state in satellite cells.

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

**Advisor:** CHOW King Lau/LIFS

**Student:** PARK Byung Min/BIOL

**(UROP Course: UROP1100, Fall 2013)**

Signal transduction detection in vivo frequently requires complex purification processes, and the results often take time to obtain. This project developed an indirect quantitative visual indicator of cellular differentiation caused by signal transduction through the monitoring of the BMP-pathway activity; more specifically, the *dbl-1* gene, in *Caenorhabditis elegans*. This was achieved through the microinjection of *C. elegans* *him-5* mutant (CB4088) with a plasmid containing the promoter region of *lon-3*, a gene regulated by *dbl-1* activity, to regulate the expression of green fluorescent protein with a nuclear localizing signal. The transformed worms were crossed with a *dbl-1* null mutant male to verify that *lon-3* was transcriptionally regulated by *dbl-1*. They were then crossed with various *dbl-1* pathway null or loss-of-function mutants for the quantification of signal strength.

## Death Toll by Categories in Developed Countries: its Association with Government Research Funding and Strategy

**Advisor:** CHOW King Lau/LIFS

**Student:** JIANG Jingfu/ECOF

(UROP Course: UROP1000, Summer 2014)

Arguments about which diseases should be prioritized for study have existed for decades. This research explored how the seriousness of diseases should be measured and subsequently considered in research funding systems. This report provides an overview of the top causes of death in different regions and their underlying trends from 2000 to 2011. The analysis addressed epidemics for each of the top 10 human killers, broken down by Millennium Development Goal region. The subsequent discussion explores how disease research categories affect funding decisions. U.S. data are used to show the relationship between deaths caused by a certain disease and the research funding invested in it. The report closes with a notion that government funding decisions were not supported by solid data of social benefit.

## Monitoring Endoreduplication Events in Epithelial Tissues

**Advisor:** CHOW King Lau/LIFS

**Student:** CHIU Man Chun/BISC

(UROP Course: UROP1100, Summer 2014)

Endoreduplication is the replication of a nuclear genome in the absence of cell division, which results in elevated nuclear gene content and polyploidy. To discover when endoreduplication occurs and how it is regulated, a molecular reagent was constructed that was indicative of the ploidy in cells. Fluorescent fusion protein was used 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, were constructed and injected into the model organism, *Caenorhabditis elegans*. The successful deployment of the indicator reagent in live tissues is expected to offer a useful tool for live animal study and tissue ploidy analysis.

**Advisor:** CHOW King Lau/LIFS

**Student:** GU Bida/BIOL

(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

In this research, the timing of the production and requirement of a glypican signal molecule LON-2 that controls body length in *C. elegans* was studied through the spatiotemporal rescue of the *lon-2* gene in transgenic *C. elegans* by a repression Q system. Stable transgenic animals carrying constructs for verification of the functionality of the Q system were generated, from which an unexpected reporter signal pattern was observed. An illegal cutting site was detected on the construct in a subsequent restriction digestion experiment, prompting the sequencing of the construct's suspected regions. Based on the available information, the possible causes of the unexpected signal pattern are discussed in this report.

**Advisor:** CHOW King Lau/LIFS  
**Student:** YANG Cylene/BICH (UROP Course: UROP1100, Spring 2014)

In many organisms, DNA replication occurs without preceding cytokinesis, resulting in polyploidy cells. The reason for and function of this phenomenon remains ambiguous, as it sits between potentially conferring new cellular advantages and a dangerous overgrowth promoting cancer. This research designed a construct that proportionally marks the amount of DNA in a nucleus, thus monitoring the temporal and spatial control of Endoreduplication in *C. elegans*. For this purpose, heterochromatin-like protein 1, HPL-1, the *C. elegans* homologue of *D. melanogaster* heterochromatin protein, was fused to a GFP reporter and is believed to bind DNA proportionally reflective to the actual cell ploidy.

### Self-Image, Body Mass Index and their Link to Controlled Caloric Consumption in a Sample of Students in Chinese Cities.

**Advisor:** CHOW King Lau/LIFS  
**Student:** HAN Tianwei/RMBI (UROP Course: UROP1000, Summer 2014)

This project analyzed the perceptions of Chinese people living in urban areas of China about caloric consumption to analyze the potential for eating disorders in China. One hundred and twenty-one residents living in major Chinese cities were asked to fill out the survey, and their perceptions about caloric consumption were recorded to analyze their eating attitudes. The results showed that the female group generally preferred to eat less, regardless of their body mass index. Even the underweight female group wanted to consume fewer calories. The results led to a reflection on the potential danger of an increase in the number of eating disorder cases in China in the future.

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

**Advisor:** LAU Stanley Chun Kwan/LIFS  
**Student:** NGAN Tsun Tat/SSCI (UROP Course: UROP1000, Summer 2014)

*E. coli* has long been used as an indicator of water sanitary. It is believed that *E. coli* cannot withstand the external environment for long, yet some studies have suggested that there may *E. coli* populations that are adapted to the external environment. This research genetically characterized different *E. coli* strains in Hong Kong by examining their house-keeping genes using polymerase chain reaction (PCR) and agarose gel electrophoresis. The gene markers were then sequenced and compared to the samples in a database. A bioinformatics analysis of the evolutionary relationship between the *E. coli* strains was also conducted. This report introduces the authors' hands-on experiences in PCR and gel electrophoresis and presents the results of the different *E. coli* strains examined. The paper closes with the authors' reflections.

**Advisor:** LAU Stanley Chun Kwan/LIFS

**Student:** PANG Yu Hin/SSCI

**(UROP Course: UROP1000, Summer 2014)**

*Escherichia coli* is a microorganism commonly found in the digestive tracks and hence the feces of warm-blooded animals, and is believed unable to survive in external environments for an extended period of time. As a result, *E. coli* is widely used by government agencies around the world as an indicator of recent fecal contamination in water resources. However, a recent study has provided evidence of a distinct population of *Escherichia* that closely resembles *E. coli* but is native to the external environment. This questions the credibility of using *E. coli* count as a fecal indicator. The objective of this research is to survey the genetic diversity and evolutionary relationships between *E. coli* strains found at different sites in Hong Kong. This report outlines the methodology used, the current progress of the project, and the personal reflections generated.

**Advisor:** LAU Stanley Chun Kwan/LIFS

**Student:** YEUNG Ka Wai/BCB

**(UROP Course: UROP1000, Summer 2014)**

This project compared the genetic diversity of *E. coli* strains isolated from marine water in Hong Kong and other parts of the world. *E. coli* strains isolated from environmental samples were after extracted for DNA. After that, seven housekeeping genes in the DNA samples were amplified and sequenced. Using the DNA sequence data, a phylogenetic tree was constructed for the identification of the population structure of *E. coli* in Hong Kong's marine water.

## Study of DNA Replication in Human Cells

**Advisor:** LIANG Chun/LIFS

**Student:** LOK Tsun Ming/BCB

**(UROP Course: UROP1000, Summer 2014)**

Factor for adipocyte differentiation 24 (FAD24), the human homolog of nucleolar complex-associated protein (Noc3p), is one of the DNA replication initiation proteins. In *S. cerevisiae*, Noc3p is required for recruiting Cdc6 and MCM proteins to the origin to form a pre-replication complex (Pre-RC) (Zhang et al., 2002). It was proposed that FAD24 plays a similar role in DNA replication in human cells, and that its knock down may cause apoptosis and growth inhibition (Hu Yun, 2006). This research explored the effect of knockdown duration on the knockdown effectiveness of FAD24. Future research will investigate the effect of knocking down FAD24 in relation to different aspects such as the degree of apoptosis, growth rate inhibition and cell cycle progression disruption.

**Advisor:** LIANG Chun/LIFS  
**Student:** ZHU Ronghui/BICH (UROP Course: UROP1100, Fall 2013)

The yeast cell-division cycle protein 14 (Cdc14p) has been shown to play an important role in the cell cycle and DNA replication. hCdc14B is a human homologue of Cdc14p, and its functions in the human cell cycle remain largely unknown. We applied a GST pull-down assay and found that human origin recognition complex 2 (hORC2), human minichromosome maintenance complex 2 (hMCM2) and human minichromosome maintenance complex 4 (hMCM4) are potential binding partners of hCdc14B. Previous studies have shown the importance of the phosphorylation of hMCM2 and hMCM4 in the formation of the MCM complex in humans (Fujita, 1998), and the phosphorylation of ORC2p in the dissociation of the ORC complex in yeast (Lee et al., 2012). Our observations suggest that hCdc14B as a phosphatase may reverse the above process and could be involved in the resetting of DNA replication by dephosphorylation.

### Study of DNA Replication-initiation Proteins in Budding Yeast

**Advisor:** LIANG Chun/LIFS  
**Student:** SUN Shuyan/BCB (UROP Course: UROP1000, Summer 2014)

In a yeast two-hybrid screening system, a molecular biological technique used to determine protein–protein interactions, a bait protein and libraries of prey proteins are expressed as fusions to the DNA-binding domain (DNA-BD) and the activation domain (AD), respectively. This can activate transcription of the downstream reporter genes only when they are assembled and interacting. In this report, two of the major preparation processes of a yeast two-hybrid system—bait expression checking via Western blot and SCM/-Leu/-Trp/-His plate making with growth test—are presented in detail, along with the experimental results and interpretations of the two tests. In addition, some concluding remarks are made to close the preparation procedures and the two-hybrid screening was continued to initiate the mating process.

**Advisor:** LIANG Chun/LIFS  
**Student:** TAM Ka Man/SSCI (UROP Course: UROP1000, Summer 2014)  
TANG Lok Yi/SSCI (UROP Course: UROP1000, Summer 2014)

Nucleolar complex–associated protein (Noc3p) has been identified as a DNA replication initiation protein in budding yeast (Zhang et al., 2002). Noc3p acts as a link between the ORC complex, initiation proteins and the MCM complex (Zhang et al., 2002), and has been found to be highly conserved in eukaryotes. Recent experiments in the UROP Liang, Chun host lab have identified Noc3p as having physical self-interactions in budding yeast and human cells by yeast two-hybrid (results not published). This study determined the nature of this interaction by dissecting the full-length Noc3p into smaller fragments based on secondary structure predictions to identify the Noc3p self-interacting domain in human cells by yeast two-hybrid.

**Advisor:** LIANG Chun/LIFS  
**Student:** ZHOU Chuying/BCB (UROP Course: UROP1100, Spring 2014)

Nucleolar complex-association protein (Noc3p) serves an essential role in the initiation of DNA replication and minichromosome maintenance for budding yeast during the cell cycle. However, the architecture and detailed characterization of the interactions between Noc3p and other replication-initiation proteins such as Cdc6p and MCM proteins remain unknown. This research focused on how the yeast two-hybrid method can be used to map interactions between 10 selected domains of Noc3p in a budding yeast system to further reveal the role that Noc3p plays in DNA replication. Progress is currently being made in the plasmid construction and yeast transformation period.

### Water Quality Survey for Hong Kong's Marine Fish Farming Zone

**Advisor:** LIU Hongbin/LIFS  
**Co-advisor:** LAU Wing Keung/LIFS  
**Student:** CHEUNG Wing/CHEM (UROP Course: UROP1000, Summer 2014)  
                  CHOW Yi Hung/CHEM (UROP Course: UROP1000, Summer 2014)  
                  KONG Mingpeng/SSCI (UROP Course: UROP1000, Summer 2014)

A monthly water quality survey of 32 marine culture zones was conducted with the Agriculture, Fisheries and Conservation Department in Hong Kong's coastal waters. The water samples were collected at three levels in each marine farming zone at more than 6 meters deep. In most locations, the water samples were collected both inside and outside the zones for water quality comparison. The hydrographic data were measured by YSI EXO2 *in situ*. The chemical and biological parameters were measured back at the lab. BOD5, nutrients analysis, total chlorophyll *a* and bacteria counts were all covered. The physical parameters, particularly chlorophyll *a* and suspended solids, were the focus of this study.

**Advisor:** LIU Hongbin/LIFS  
**Co-advisor:** LAU Wing Keung/LIFS  
**Student:** LEE Wai Hin/CHEM (UROP Course: UROP1100, Fall 2013)

In Hong Kong's coastal waters, fish culture activities are monitored by the government. However, water quality is presented through a variety of parameters. Sea water samples were collected both inside and outside of all of the fish culture zones along the water column, including surface, middle and bottom, and biweekly or monthly. In this research, the focus was on the suspended solids in sea water in September, October and November 2013 to determine and analyze the water quality in the sampling locations.

## Targeting Mitotic Regulators in Cancer Cells for Potential Treatment

**Advisor:** POON Randy Yat Choi/LIFS

**Student:** LIU Julio/BISC

**(UROP Course: UROP1100, Spring 2014)**

Mitosis is a brief but critical time during the cell cycle. Many anticancer therapies are based on targeting the mitosis of cancer cells. In this project, several novel mitotic regulators were investigated to evaluate whether the small-molecule inhibitors of key mitotic components are useful as anticancer agents. Two potential anti-tumor drugs, PAC-1 and Chloroquine, were tested for their effects on mitosis. Although these drugs could potentially be useful clinical drugs, further investigation is needed to prove their effects and mechanisms. In this project, HeLa cells that expressed an infrared reporter were used as a model. The infrared reporter facilitated the measurement of cell proliferation after drug treatment. Further analysis using fluorescence-activated cell sorting (FACS) and immunoblotting analysis (Western blotting analysis) revealed the cytotoxicity of these chemicals during mitosis. Understanding of the effects and actions of novel anti-cancer drugs may help further development of anti-cancer therapies.

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

**Advisor:** QIAN Peiyuan/LIFS

**Student:** CHENG Yuk Ying/CHEM

**(UROP Course: UROP1000, Summer 2014)**

This research focused on the isolating techniques used to mine potential candidates of bioactive marine natural products from the genus *Bacillus*, including the fermentation process and chemical analysis of potential candidates by HPLC and LC-MS.

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

**Advisor:** QIAN Peiyuan/LIFS

**Student:** LAI Chung Yan/BICH

**(UROP Course: UROP1100, Fall 2013)**

According to Ryland (1965), the majority of bio-fouling in temperate and tropical waters around the world is caused by the bryozoan *Bugula neritina*. This type of fouling has significant economic and environmental costs and thus the life cycle, especially the reproduction, of *B. neritina* has been intensively studied (e.g. Wollacott and Zimmer, 1971). One important process in the reproductive cycle is the light-induced release of larvae, which causes the dispersion of the bryozoan. Keough (1983) reported a phenomenon of con-specific settlement during settlement of the larvae. This research was initiated to investigate the biochemical basis of this phenomenon.

**Advisor:** QIAN Peiyuan/LIFS

**Student:** LAI Lok Hang/SSCI

**(UROP Course: UROP1000, Summer 2014)**

The barnacles *Tetraclita* can be commonly found on the rocky shores in Hong Kong. They are able to combat heat stress and survive a thermally hostile environment during the daytime low tide in summer. The shells of these barnacles have very tiny pores that are suspected to function as evaporative cooling channels. The effect that blocking these pores has on the barnacles' temperature is reported. The hypothesis that water travels through the channels and pores to the shell surface was tested and the relationship between the environment and the density of the barnacles is discussed.

### Hair Testing in Drug Abusers

**Advisor:** TSIM Karl Wah Keung/LIFS

**Student:** KHORLOO Michidmaa/CHEM

**(UROP Course: UROP1100, Fall 2013)**

There are several types of drugs that leave their traces in human hair after consumption. One drug with a relatively high intake that is often compared to other drugs is alcohol. After the consumption of alcohol, ethyl glucuronide (EtG) is formed and deposited in the hair. This research established a method for detecting EtG in hair samples. During the project, three experiments were conducted to determine the optimal extraction and detection method among various approaches, amounts of hair and ultrasonication times.

**Advisor:** TSIM Karl Wah Keung/LIFS

**Student:** TSANG Tsz Hong/BIOT

**(UROP Course: UROP1100, Spring 2014)**

Nimetazepam is a drug with strong hypnotic, anxiolytic, sedative, skeletal muscle relaxant and anticonvulsant properties. It is renowned for being subject to abuse, especially by persons addicted to opiates or amphetamines. Three types of human specimens, urine, hair and saliva, are commonly used in drug testing. This research used hair as the specimen due to its long window of detection, difficulty to adulterate, high stability, potential to determine time of drug exposure and higher drug to metabolite ratio. A hair test to identify Nimetazepam in hair was developed using liquid chromatography/mass spectrometry. Human hair was collected and seven concentrations (50-50000 pg/mg of hair) were used to establish a calibration curve. Linearity, sensitivity, interference and recovery were determined.



## G Proteins and Their Regulators in Cancer Biology

**Advisor:** WONG Yung Hou/LIFS

**Student:** LAU Shun Fat/BCB

**(UROP Course: UROP1100, Fall 2013)**

Regulator of G protein signaling (RGS) performs essential functions in the GTP-binding protein (G protein) signaling pathway, such as accelerating the hydrolysis of the GTP attaching alpha subunit of heterotrimeric G proteins to GDP, an inactivated form. Apart from functioning as GTPase for signal termination, RGS was also found to coordinate the phosphorylating activities of other kinases. Regulator of G protein signaling 19 (RGS19) has been shown to suppress the neoplastic transformation and tumorigenesis induced by Ras. In this research, we investigated the signal pathway of Src, a proto-oncogene tyrosine-protein kinase, to induce cell proliferation and the RGS19's effect on it. However, due to the limited project duration and cell-line instability, we only obtained part of the complete set of experimental data for analysis. We showed that RGS19 can be a phosphorylate kinase suppressor of Ras (KSR), and only suppresses the kinase activity of Src<sup>YF</sup>, a mutated form of Src, but not Src.

**Advisor:** WONG Yung Hou/LIFS

**Student:** LIU Jijun/BICH

**(UROP Course: UROP1200, Fall 2013)**

RGS19 is a regulator protein of G-protein signaling. Previous studies have shown that the expression of RGS19 upregulates the protein expression of metastasis suppressor Nm23 in the MDA-MB-231 human breast cell line, suggesting that RGS19 expression may be correlated to cancer cell metastasis. This research determined the role played by RGS19 in regulating MDA cell migration. In a wound healing assay, RGS19 slightly enhanced the MDA cell migration rate. The epithelial-to-mesenchymal transition marker, vimentin, was slightly upregulated in MDA/RGS19 stable cells compared to parental MDA cells. These results suggest that RGS19 may be involved in the regulation of cell migration in MDA cells, but that RGS19 expression may not significantly influence the phenotypic cell migration rate.

**Advisor:** WONG Yung Hou/LIFS

**Student:** YU Ho Yan/BIOL

**(UROP Course: UROP1200, Fall 2013)**

G protein coupling receptors (GPCRs) constitute one of the largest families of transmembrane receptors that detect extracellular signals and induce the regulation of intracellular cascades in signal transmission. On the stimulation of different receptors, multiple biological responses can be regulated and fine-tuned with the integration of signals. In this research, we examined the integration of different GPCR signals and their effects on Interleukin-8 (IL-8) production using HeLa cells (human cervix adenocarcinoma), HepG2 cells (human hepatocellular carcinoma) and SH-SY5Y cells (human brain neuroblastoma). We confirmed that the synergistic production of IL-8 in HeLa cells was PTX-sensitive. However, differential results were obtained from the HepG2 and SH-SY5Y cells. The results suggest that the modes of IL-8 production and chemokines utilization may vary in different cancer cells.

**Advisor:** WONG Yung Hou/LIFS

**Student:** ZENG Xiaohui/CHEM

**(UROP Course: UROP1100, Summer 2014)**

Heterotrimeric guanosine nucleotide-binding proteins, also known as G proteins, are a large family of proteins that play a key role in transmembrane signaling systems. Together with G protein-coupled receptors, G proteins are involved in the regulation of ion channels, metabolic enzymes and other cell function through the transmission of neurotransmitters, hormones and other extracellular signals. It is generally accepted that the activation of G proteins is accompanied by the dissociation of  $\alpha$  subunit and G $\beta\gamma$  subunit complexes. However, the model has been questioned by increasing experimental evidence indicating that G proteins can function through the rearrangement rather than the dissociation of subunits. To reexamine this hypothesis, we built a fusion G protein construct in which the  $\alpha$  and  $\beta$  subunits were artificially linked and a cyan fluorescent protein (CFP) was inserted into the  $\alpha$  subunit; that is, a G protein  $\alpha$ -CFP fusion protein. The transient transfection of human embryonic kidney (HEK) cells was performed to investigate the location and behavior of the G proteins *in vivo* under basal and mutant conditions. Moreover, further developments, such as a fluorescence resonance energy transfer (FRET)-based assay, can be expected to measure the subunits interactions with the G proteins in living cells.

## Human Complex Disease Genomics and Bioinformatics

**Advisor:** XUE Hong/LIFS

**Co-advisor:** LIANG Chun/LIFS

**Student:** LIM Sunjung/SSCI

**(UROP Course: UROP1100, Fall 2013)**

This class introduced fundamental laboratory skills along with the knowledge required to proceed to the next step of the project, to be conducted the following year, entitled 'How do genes influence the occurrence of Alzheimer's disease?' This semester was spent conducting a simple practice experiment with the genes from schizophrenic patients using the polymerase chain reaction method. I denatured and sequenced the DNA in the genes using high-technology machines and the results revealed how the schizophrenic's genes were different from those of normal people.

## Biochemical Studies of Neuronal Scaffold Proteins

**Advisor:** ZHANG Mingjie/LIFS

**Co-advisor:** LU Qing/LIFS

**Student:** LIANG Siqi/BICH

**(UROP Course: UROP1200, Fall 2013)**

Sharpin is a protein widely expressed in various tissues, and it is one of the reported binding partners of the Shank family, which plays pivotal roles in postsynaptic density. Previous studies have mapped the interactions within the ankyrin repeat region of Shank. However, it was shown recently that the region N-terminal to the ankyrin repeats of Shank3 form a structural domain. We showed that Sharpin cannot bind to the ankyrin repeats of Shank3 directly, yet the binding between Sharpin and the N-terminal domain of Shank3 provided interesting data. Therefore, we identified Sharpin as a potential binding partner of the N-terminal domain of Shank3.

## Department of Mathematics

### Lunar Study Based on Data Obtained by the Chang'E Spacecraft

**Advisor:** CHAN Kwing Lam/MATH  
**Student:** CHEN Minjian/MAEC (UROP Course: UROP1000, Summer 2014)  
SUN Guanhao/PHYS (UROP Course: UROP1100, Spring 2014;  
UROP1000, Summer 2014)

In this project, we analyzed images of and data on the Moon, based on data from Chang'E and previous satellites. We compared the features of the pictures of the moon and other data sent from these satellites, noting similarities and differences, to compile a comprehensive understanding. We used the image processing tools in MATLAB to analyze images of the moon. The main method was blob detection, which finds distinguishing spots within the images, which we then compared.

### Space Orbit Design

**Advisor:** CHAN Kwing Lam/MATH  
**Co-advisor:** WONG Michael K Y/PHYS  
**Student:** HEIMONEN Hermanni Juuso Elias/PHYS-PM  
(UROP Course: UROP1300, Fall 2013)

In this project, the behavior of the solutions to low-thrust two-point boundary value problems with different boundary conditions was studied. The limits of the possible launch and arrival velocities were examined in a simplified two-dimensional transfer analogous to the Lambert problem from Earth to Mars using large grid searches over possible velocities with a local optimizer. The solutions were then generalized to a three-dimensional problem and the low-thrust solutions were compared to the ballistic solutions to the Lambert problem. In the low-thrust boundary value problem the launch velocities formed an elliptic region around the ballistic solution in which the size of the region depended linearly on the thrust of the spacecraft. This also implied that variations in the launch velocity were not uniform in all directions. Finally, the same method was applied to a hyperbolic flyby near Callisto that could be used to design capture trajectories for Jupiter. This indicates that the method is applicable to a range of mission analysis situations. The results clarify the nature of the boundary value problems and could potentially improve the techniques for designing low-thrust trajectories.

*Keywords—Low-thrust; Boundary value problem; Optimization; Lambert problem.*

## Wind Bands on the Giant Planets

**Advisor:** CHAN Kwing Lam/MATH

**Student:** YANG Hannan/MATH

**(UROP Course: UROP1100, Spring 2014)**

The wind bands on the outermost four planets in the solar system have been observed to have different zonal wind profiles, indicating that the equatorial winds on Jupiter and Saturn move in the same direction as the planets' rotations, whereas those on Uranus and Neptune move in the opposite direction to the planetary rotations. This report discusses the abovementioned phenomenon in a simplified rotating fluid occasion to introduce one relevant factor, the Rossby wave, and its conditions of occurrence. Through the rigorous derivation of the key properties of the Rossby wave, its properties are connected with the aforementioned phenomenon through the numerical simulation results.

*Keywords—wind bands; rotation; Rossby wave.*

**Advisor:** CHAN Kwing Lam/MATH

**Student:** YUEN Wai Yin/PHYS-PP

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Our solar system has four "giant" planets: Jupiter, Neptune, Saturn and Uranus. They have many similarities and a few differences. The most distinct and notable similarity is that they all have thick gaseous atmospheres with very strong east-west winds and a large, long-lived "spot," which were the main focus of this project. Various models of these planets were studied using a computer program to investigate and predict the properties of these planets. As mentioned, we focused on the strong winds in these planets' atmospheres and found that a dimensionless quantity, a Rossby number, is of utmost importance. Rossby numbers are widely used in fluid dynamics and their reliability is reflected in describing fluid flows in various ways.

## Special Functions Approach for Economic Dynamic Models

**Advisor:** CHIANG Yik Man/MATH

**Coadvisor:** WANG Susheng/ECON

**Student:** CHAN Tin Wai Rodney/MATH-PM

**(UROP Course: UROP1000, Summer 2014)**

Special functions have long been used to solve engineering and science problems. Economists have traditionally used the theory of dynamical systems and the Hartman-Grobman theorem to solve a local equilibrium solution. However, such a solution loses information about the dynamics of the economic model because the behavior may differ when the input variables are not near equilibrium. It also does not work under certain situations described in the passage. Mathematical economists have adopted the special functions approach to obtain the so-called closed-form solutions of the variables in which they are interested. The model itself is complicated, and we primarily studied the theory of the famous Gaussian hypergeometric functions and, more briefly, the tools used to examine the economic dynamics. This report provides a survey of the related materials in the paper entitled "Special functions for the study of economic dynamics: The case of the Lucas-Uzawa model."

## Scientific Computing and Flow Visualization

**Advisor:** FUNG Jimmy Chi Hung/MATH

**Student:** LAI Yiu Ting/MATH

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

WONG Tsz Fung/MATH-AM

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

This research investigated the large range of atmospheric transport processes for particle flow, emphasizing the importance of understanding atmospheric pollutant movement across the Pearl River Delta (PRD) region in southern China. The larger project to which this research belongs has been active for almost a year. In the previous phase, the preliminary optimization of the particle tracking algorithm and visualization program through Google Earth was completed. The current phase focuses on shortening the simulation time for nowcasting, capturing and visualizing the history of air pollutant dispersion over several hours. A derivative system was developed based on the Flex weather research and forecasting (WRF) model, which had demonstrable skills to track a few million particles traversing a numerical wind field generated by the mesoscale WRF model. This project phase entailed:

1. Adaptation to the Linux platform for better memory control and calculation speed;
2. Examination of the FlexWRF model with its demonstration sample, which tracked particle flow across Sacramento Valley, California;
3. Adjustment of the existing WRF I/O to suit the specified requirements of the FlexWRF program, and performance of the verified FlexWRF program again over the PRD region;
4. Modification of KML toolbox to favor contour plotting; and
5. Automation of the program to perform nowcasting without heavy dependence on manual instruction.

## E-Learning Tutorial System

**Advisor:** HU Jishan/MATH

**Student:** MIN Yiyang/MATH

**(UROP Course: UROP1000, Summer 2014)**

The Internet plays an important role in modern education, and while several online learning systems have shown potential, none have provided a perfect path to a self-sustained online knowledge dataset. Identifying the problems behind those pre-existing cases, the STeP team set out to create a better system capable of helping students think for themselves and develop their problem-solving abilities. We based our website on CodeIgniter for server-side and database connection, and on Bootstrap and jQuery for client-side user interface and logic. The team members conducted tentative research into the implementation of forum, data security and server- and client-side code optimization.

## Asymptotic Methods for High Frequency Wave Phenomena

**Advisor:** LEUNG Shing Yu/MATH

**Student:** CAI Geyue/SSCI

**(UROP Course: UROP1100, Summer 2014)**

This research was conducted under the supervision of professor LEUNG Shingyu's project entitled "Asymptotic Methods for High Frequency Wave Phenomena." The first part introduced the background of the problem and the second proposed a method for obtaining an offset curve of one given curve in an isotropic medium in two dimensions. The report discusses some of the specific problems facing the study, including finding the norm direction, deleting unnecessary points and specific cases such as traveling inward. However, this report focuses on the method's algorithm, as my strength did not lie in programming skills, although the project did involve some coding.

**Advisor:** LEUNG Shing Yu/MATH

**Student:** KWAN Wing Fai/MATH

**(UROP Course: UROP1100, Summer 2014)**

A fast Huygens sweeping method was used to evaluate the Schrödinger equation in the semi-classical regime. The method combined short-time Wentzel–Kramer–Brillouin–Jeffreys propagators into the Huygens' Principle. The analytic approximations formula was developed using a Taylor expansion. The method we focused on set the problem in the position space. An integral equation was formed, but it did not have an analytical solution. It had to be solved numerically using fast Fourier transform (FFT). Previous work has been conducted using the explicit scheme, the implicit scheme and the Crank-Nicolson scheme. They had lower bounds for the time-mesh size, such that it could not be arbitrarily chosen. The final results were not available within the study period. In this project, a numerical algorithm was proposed to determine a time-mesh of arbitrary size.

**Advisor:** LEUNG Shing Yu/MATH

**Student:** MAK Hugo Wai Leung/MATH-MP

**(UROP Course: UROP1100, Summer 2014)**

Offset curves are normally defined as envelopes of congruent circles centered at a planar curve, and mathematically speaking, they are the locus of points with a fixed distance from a given curve. The evolved curve can typically be found using Huygen's principle, and in this research, we explored some graphical techniques for such offsetting curves to compute related approximations. De Casteljau's algorithm provided a tool for determining the number of subdivision segments to ensure accuracy. Moreover, in general, self-intersections occurred in the interior offset curves and surfaces. We discuss how to eliminate the overlapping regions through a trimming process using simple techniques and provide examples for reference.

## Efficient Numerical Methods for Dynamic Interface

**Advisor:** LEUNG Shing Yu/MATH

**Student:** CHAU Fai Tsing Ronson/MATH-AM (UROP Course: UROP1100, Fall 2013)

This research built on the work of Zhao Liu under the supervision of Professor Leung Shing Yu. The original work evolved curves based on Huygen's principle. The results were quite accurate, as all of the cells were checked to determine whether they contained a solution. However, due to the checking of all of the cells, the algorithm was relatively slow. In addition, both the evolved curves inside and outside the original curve were shown. In this report, we briefly describe the methodology used in Zhao Liu's previous work and then describe how the algorithm could be amended so that the curves evolve outward and less computational time is required.

## Arbitrage Pricing of Equity Derivatives

**Advisor:** WU Li Xin/MATH

**Student:** JIE Wenting/MATH (UROP Course: UROP1100, Fall 2013)

In this report, we mainly focus on constructing the Black-Scholes Merton model and providing a closed form solution. This model is based on the basic financial principle of arbitrage-free pricing. We discuss the limitations of the Black-Scholes-Merton model; specifically, that the model assumes that the underlying stock price follows a log normal distribution, and thus does not allow the stock price to "jump" during option pricing. Yet in reality, the stock price often jumps in response to new information.

To improve the Black-Scholes-Merton model in terms of this problem, two more factors were added into the model: the occurrence of jumps by a Poisson process, and the jump magnitude by a log normal distribution. This is the basic idea behind the jump diffusion model. We also provide the closed form solution for the jump diffusion model, which can be directly used to price a European call option. Because all of the model's inputs are observable parameters (except volatility), the formula is convenient and reliable for traders to use. To test the effectiveness of the jump diffusion model, we used the new model to determine option prices and reversely determined which volatilities corresponded with each distinct strike price. The implied volatilities showed a "smile" curve versus different strike prices, which reflected the success of the jump diffusion model over the original Black-Scholes-Merton model, based on the agreement between the historical data and the smile curve.

Further work on this report lies mainly in assuming the volatility of stock price following a certain distribution, and studying the models and solutions presented by Heston (1993). In the jump diffusion model, the volatility was assumed to be constant, which was an obvious limitation. Future researchers can also focus on other limitations of the original Black-Scholes-Merton model, such as considering taxes and transaction costs.

## Combinatorial Tiling of the Sphere by Pentagon

**Advisor:** YAN Min/MATH  
**Student:** CHAN Tsz Wing/MATH-PMA (UROP Course: UROP1100, Fall 2013)  
WONG Tin Chun Ken/MATH-PM (UROP Course: UROP1100, Fall 2013)

Based on Min Yan's work, "Combinatorial Tilings of the Sphere by Pentagons," we know that there cannot be a sphere with only one high-degree vertex (a vertex with a degree  $>3$ ). However, if there are only two high-degree vertices, then the sphere must be an earth map tiling. Thus, we pursued the results of the next case; that is, three high-degree vertices in the sphere. Here, if the distance between each of two high-degree vertices is not 3, then the sphere must also be an earth map tiling. We discuss a case in which the distance between all three high-degree vertices is 3, and provide suggestions for how to solve the case. In fact, the other case (e.g., the distances between two high-degree vertices being 3, 3 and 4) could also be solved using this idea. We solved the problem and developed a new theorem; that is, if there are three high-degree vertices in a sphere, and all of them have a mutual distance of 3 between them, then the tiling has 12 familial possibilities.

**Advisor:** YAN Min/MATH  
**Student:** WANG Sili/MATH-PMA (UROP Course: UROP1100, Fall 2013)  
ZHOU Yue/MAEC (UROP Course: UROP1100, Fall 2013)

There have been studies on spherical pentagon tiling with a fixed small number of high-degree vertices. In this report, we explore the tiling patterns when the number of high-degree vertices is not fixed, and could be very large. We discuss some of the possible patterns of combinatorial spherical pentagon tiling under two circumstances where different assumptions about high-degree vertices are made. The report comprises two parts, each of which concerns one circumstance. In the first part, we study the tiling in which one and only one vertex has a large degree, and there are no other vertices of a degree larger than 4. In the second part, we study tiling when each tile has a unique high degree.

## Category Theory

**Advisor:** ZHU Yong Chang/MATH  
**Student:** HUANG Yifeng/MATH-PMA (UROP Course: UROP1100, Fall 2013)

Under the guiding idea that algebraic categories are usually in contravariant equivalence with geometric categories, we proved that under some conditions, the category of finite coverings (denoted  $\text{Cov}_X$ , which was the focus of this research) and the dual category of finite dimension separable algebraic extension without nontrivial nilpotent (denoted  $\text{Alg}_k^{op}$ ) satisfy some striking common properties; specifically, they are both Galois categories. Finally, we expected that the two categories would be equivalent for some examples of  $X$  and  $k$ .



**Advisor:** ZHU Yong Chang/MATH

**Student:** LI Ruofan/MATH-PMA

**(UROP Course: UROP1100, Fall 2013)**

This research was part of the larger project entitled “Category Theory” (2013 Fall HKUST UROP). The objectives of this report were to provide examples and find the properties of abstract terms related to category theory. Definitions, examples and properties related to category theory are discussed in part 1. Part 2 defines most of the basic categorical terms such as category, factor, product and coproduct. Part 3 deals with the Galois category and part 4 covers the automorphism group. Numerous examples, with verification of some of them, are provided.

## Department of Physics

### Quantum Optics and Atomic Physics

**Advisor:** DU Shengwang/PHYS

**Student:** SHU Chi/PHYS

(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014;  
UROP1300, Summer 2014)

This report describes the theory and the experimental realization of an approach to measuring the biphoton temporal wave function generated from a spontaneous four-wave mixing process in cold atoms. We provided a proof-of-principle demonstration of probing the two-photon state wave function that can be further extended to more general cases. It is also an alternative to the Franson interferometer for verifying the time-frequency entanglement of the photon pairs. The method may find wide applications in quantum communication and quantum information processing.

### Characterize Single-Molecule Electronic Properties Using Low-Temperature Scanning Tunneling Microscopy

**Advisor:** LIN Nian/PHYS

**Student:** CHEN Shen/APHYS-ST

(UROP Course: UROP1200, Fall 2013;  
UROP1300, Spring 2014)

The purpose of this project was to simulate the behavior of Br atoms on a Cu (111) surface using a Monte Carlo algorithm, and a modified version of this algorithm called simulated annealing. The experiments revealed that when the Br atoms on a Cu (111) surface were slowly cooled down to a low temperature, steady Br islands were formed. Then, the size distribution and pair correlation functions of these islands were studied and used to determine the parameters in the simulation model. After setting up the model, we further studied the system under different temperatures and observed the phase transitions in simulation.

*Keywords—Monte Carlo algorithm, simulated annealing, Br atoms, Cu (111) surface, phase transition.*

**Advisor:** LIN Nian/PHYS

**Student:** DU Zhiqian/PHYS-PM

(UROP Course: UROP1200, Fall 2013)

The analogue of artificial amorphous graphene was realized by depositing organic molecules on a metal surface, which was then placed under grid mode scanning tunneling spectroscopy. The data were processed so that the finite-size-scaling behavior could be investigated to seek evidence that the amorphous system is an Anderson insulator. The previous results did not provide concrete evidence of localization, as the method used was very sensitive to noise. In this report, the focus was on unifying the sample sizes to eliminate undesired variables and trying high-order IPR as the localization indicator for a new experimental data processing result.

**Advisor:** LIN Nian/PHYS

**Student:** WU Qi/PHYS

**(UROP Course: UROP1100, Summer 2014)**

We investigated the metalation reaction of Pb with self-assembled 5,10,15,20-tetra(4-pyridyl)porphyrin (H<sub>2</sub>TPyP) on both an Au(111) and an Ag(111) surface using varied-temperature scanning tunneling microscopy. H<sub>2</sub>TPyP was found to be able to perform a similar scheme with Pb, as with other lighter metal atoms, through the porphyrin core. On the Au(111) surface, the formation of a new tetrapyridylporphyrin, proposed to be Pb-H<sub>2</sub>TPyP, was observed at room temperature. Then, the complex significantly disappeared after annealing at ~430 K with an intermolecular structural transition. On the Ag(111) surface, some similar reaction processes were detected without the structural transition. The new tetrapyridylporphyrin was relatively more stable on the Ag(111) surface than on the Au(111) surface, and the Au(111) atoms might provide an alternating reaction scheme for TPyP in high-temperature regions.

*Keywords—Self-assembly; Lead; Au(111); Ag(111); Metalation.*

## Monte Carlo Simulation of 2D Supramolecular Assembly

**Advisor:** LIN Nian/PHYS

**Student:** KAO I-hsuan/SSCI

**(UROP Course: UROP1100, Summer 2014)**

YANG Tianyi/SSCI

**(UROP Course: UROP1000, Summer 2014)**

New programs were designed to realize the KMC method applied in the two-dimensional (2D) supramolecular self-assembly process. The object of study was TPyP molecular and Pb metal two-dimensional supramolecular self-assembly on an Au(111) surface. The influences of the important factors, such as reaction temperature, molecular density, bonding energy and experimental operation in the program were investigated and compared with the experimental results. Several of the phenomena discovered in the experiments, such as metal and molecular islands, coordination and the connections among coordinates, metal bond energy and the formation of coordinate networks, were successfully simulated. It might be possible to predict the same molecular aspects for different metals in the 2D supramolecular self-assembly process.

**Advisor:** LIN Nian/PHYS

**Student:** WU Qi/PHYS

**(UROP Course: UROP1100, Fall 2013)**

Several types of Monte Carlo methods were introduced to illustrate some of the unexpected results obtained from the scanning tunneling microscopy experiments. By combining previous scholarly works, some of the thermodynamic properties of different two-dimensional (2D) self-assembly systems were concluded. Generally, systems of different dimensions exhibit different energy, or stability, which usually plays a significant role in competition with kinetic trapping. The curve of heat capacity or specific heat was computed to determine that a low dimensional system such as a 0D close structure or a 1D strip structure usually has broad  $C_v$  curves, and that the peaks of those curves in most cases appear in relatively low temperature regions. As the structure becomes more complex, such as through increasing the dimensions of the molecular structure or enlarging the molecular coverage, it should be possible to strengthen the stability of the system and make the designed structure survive under high-temperature annealing.

*Keywords—self-assembly; 0D; 1D; Quasi-2D; 2D; Monte Carlo method; simulation.*

## Damage Spreading in Networks

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** LAM Ho Tat/PHYS

**(UROP Course: UROP1100, Fall 2013)**

We investigated the spread of damage prompted by the Ising model on a lattice. We introduced a new updating scheme and focused on the magnetization differences exhibited by damaged systems. We discovered that the spread of damage behaved similarly to diffusion. At equilibrium, we discovered that magnetization differed most significantly around the critical temperature. We related the critical behavior of damage to other critical exponents. In terms of dynamics, we discovered that damage approaches equilibrium exponentially. With the introduction of an oscillating source, the magnetization difference followed the damage and created an oscillating signal that generated interference. The entire discovery was explained through the evolution equation of damage spreading.

## Evolutionary Computation for Optimization

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** WU Qixian/SSCI

**(UROP Course: UROP1100, Summer 2014)**

This project consisted of two parts: a genetic algorithm and a Parrondo's game, mainly using computer simulation to observe relevant phenomena. The first part focused on a genetic algorithm that provided an example of the original method for finding the maximum of a function, followed by several other methods attempted during the research. In the second part, the Markov chain was applied to analyze the game, and we added a period check to make more information flow into the game.

*Keywords—genetic algorithm; Parrondo's game; Markov Chain.*

## Prisoner Dilemma Game on Complex Networks

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** AMEND Andre Eugen Bernhard/PHYS-PP

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Equal populations of nice and cheating players interacting via the Prisoner's Dilemma game were distributed on a square lattice. Every player was engaged in iterative Prisoner's Dilemma games with his neighbors, and could partially imitate their strategies. It was observed that the players on the lattice converged to a population of exclusively nice players. The dependence of the speed of this convergence on the size of the initial player groups was investigated.

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** KIM Minsam/COSC

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014;  
UROP1300, Summer 2014)**

Each player in the original iterated Prisoner's Dilemma game has a one-step memory, and his/her strategy can be identified by 5 binary values taking either 0 or 1. In the probabilistic version, each value can be any real number between 0 and 1 to construct the strategy space as a 5-dimensional cube;  $[0, 1]^5$ . Resembling binary systems, two players adapt to each other by gradually changing their states. Players are modeled as intelligent learners who evolve their strategy states based on a hill-climbing algorithm, similar to the way objects move through potential fields. The probability provides continuity of the agents' state to construct a rich and natural system. Finally, an analysis of the mutating strategies determines which alleles are most significant in the resulting mutual cooperation or other stable states.

*Keywords—artificial life; chaos and dynamical systems based computing; reinforcement learning.*

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** LEUNG Sze Ching/SSCI (UROP Course: UROP1000, Summer 2014)

Parrondo's games consist of two losing games named game A and game B, respectively. Game A involves tossing a coin, but there is a slightly higher chance of losing. Game B uses two coins, of which one is favorable and the other is not. A parameter  $M$  is involved in Game B that when the capital is a multiple of  $M$ , the bad coin is used; otherwise, the good coin is used. Parrondo's games illustrate a counter-intuitive phenomenon by which combining two losing games (A and B) can generate a winning result. Parrondo's games can be analyzed using a Markov chain model. This report summarizes the characteristics of the Markov chain and Parrondo's games to investigate some interesting results by changing the parameters of the original Parrondo's games.

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** LO Wai Leuk/SSCI (UROP Course: UROP1000, Summer 2014)

The purpose of this research was to verify the classic Parrondo's games and to look further into the information transfer between the imitating and original Parrondo's games. The capital gain was collected using Python programming to run the games 100/500 times and average them over 50,000 trials. It was found that two losing games could be combined to form a winning game, but the imitating games did not necessarily behave the same. Thus, the classic Parrondo's games were verified but the implications of the results regarding the imitating games require further study.

## Quantum Random Walker on Networks

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** CHERN Li Ern/PHYS-PP (UROP Course: UROP1000, Summer 2014)

We studied a single-particle quantum walker on various graphs and generated the probability distribution for a given initial condition using a computer simulation. In particular, we considered a quantum random walker whose motion was governed by the Hadamard Transformation on a line, a ring, a simple ring band and a twisted ring band. We also investigated how the number of nodes in a graph with cyclic configuration could affect the probability distribution. We observed that the inconsistency of the odd/even parity of each node in certain graphs caused the distribution pattern to differ characteristically from their static counterparts. However, the Fourier analysis proved to be useful in obtaining the general wave function of a quantum particle on a line or ring.

*Keywords—Quantum walk; graphs; probability distribution; Fourier analysis.*

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** KANDEL Dinesh/PHYS-PM (UROP Course: UROP1100, Spring 2014)

The discrete time quantum random walk is an intriguing topic due to its many properties, such as an exponentially fast hitting time, quadratically faster variance on a line and quadratically faster mixing time on a circle compared with the classical counterpart. In this report, we discuss the effects of introducing double-phase defects on a line on the quantum random walker. In particular, the number of bound states (dependent on the phase defects) for the case when both the phase defects have a value of  $-1$  was found to be numerically equal to half the separation between the two defects. This phase defect also introduced a strong localization effect on the walker.

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** LAM Ho Tat/PHYS (UROP Course: UROP1100, Summer 2014)

Quantum random walks are one of the foundations of quantum information theory and quantum algorithms. In this research, a quantum random walk was investigated from three different perspectives. In the first section of the report, the effects of a single defect and multiple defects on the wave function of the quantum random walker are studied. Specific phenomena were discovered and possible applications are suggested. In the second section, the formulation of a mechanism of multiple quantum random walkers, including distinguishable and identical particles, is proposed. The probability of finding at least one quantum random walker at position  $n$  was calculated and the result indirectly shows that the Fermionic quantum random walk yields the best search.

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** SORN Sopheak/PHYS-PM (UROP Course: UROP1100, Summer 2014)

We studied the probability of finding a single quantum random walker on two topologies: a band structure of degree three, and that of degree four. The standard procedure for computing the probability of finding the random walker began by defining a unitary transformation, analogous to the unitary transformation in Hadamard's walk, and determining the iteration relations between wave functions at different sites on the graph. The rest was accomplished by solving the iteration relations in Fourier space and converting back to real space. However, the project's progress stopped at the conversion from the Fourier back to real space, as the computations became increasingly complicated, despite being done with numerical works.

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

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** BU Qi/PHYS-PM

(UROP Course: UROP1100, Spring 2014)

The “random walk” model was raised to understand the dynamic properties propagating on a complex network. The mean first passage time (MFPT) and mean first passage speed (MFPS) are important quantities of random walk problems, and can be calculated through the adjacency matrix of the complex network. For networks with twisted band or Mobius ring structures involving the number of nodes fixed, the MFPT and MFPS varied with the number of “twists.” A numerical analysis revealed that a larger MFPT typically implied decreased communicability, in agreement with the definitions of the two properties.

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** YU Yue/PHYS

(UROP Course: UROP1000, Summer 2014)

This project involved the mean first passage time (MFPT) of one walker in a classical random walk. The first phase of the research provided the theoretical solution for the average of MFPT on a band network with twist  $M$  using eigenvalues of the transition matrix. We also calculated the MFPT of the walker with memory 1 on the same network. Using the exponential decay behavior in a summation of calculating AMFPT, we provided a new approximation for AMFPT in a random network with a small number of links  $L$ .

## Sequence Analysis in Multi-agent Games

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** CHEUNG Ka Wai/PHYS-PM

(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

This report is divided into two sections. The first section reviews the Maxwell Demon, the generalized second law of thermodynamics and the concept of mutual information. The second section discusses the analogy of Parrondo’s game under information measurement, under the condition of no time delay and that of discrete time delay. The demonstration was based on a computer simulation and a Markov Chain matrix calculation. A discussion of the information measurement efficiency will follow in future research.

*Keywords—Maxwell Demon; the Second Law of Thermodynamics; Parrondo Game.*



**Advisor:** SZETO Kwok Yip/PHYS

**Student:** MA Ho Fai/PHYS-PM

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

This report is divided into three parts. The first part reviews the hidden Markov model, which was used to estimate the winning probability of a Parrondo's game. The second part reviews the concepts of mutual information and information. The third part describes the calculation of the expected values of the Parrondo's game with decision making, which were calculated by the Markov chain.

*Keywords—Parrondo's game; hidden Markov model; Markov Chain.*

## Topology and Network Reliability

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** BU Qi/PHYS-PM

**(UROP Course: UROP1000, Summer 2014)**

Average communicability tests whether a network's nodes are well correlated. We modified a network to increase its average communicability. For real-world networks, it usually costs money or resources to rewire the edges, and therefore the tendency is to minimize the change while maximizing the increase in its average communicability. In this research, we concentrated on rewiring one edge to maximize the average communicability. During our research, we also discovered a relationship between a network's average communicability and that between the centrality of its nodes.

**Advisor:** SZETO Kwok Yip/PHYS

**Student:** LUK Patrick Wan-hin/PHYS

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Networks such as small world and random networks have their own attributes, and cascading failure is an important network aspect, as lowering its probability prevents frequent fatal breakdowns. Regarding the average degree of the first shell nearest neighbor, if all of the nodes in the  $(n-1)^{\text{th}}$  shell are being considered as a large node, the graph of the total degree of the nearest neighbors of the large node versus its degree exhibits a y-intercept close to or far from zero depending on the network type. The y-intercept also gets larger when the shell gets larger.

*Keywords—average degree; cascading failure; nearest neighbor; shell.*

**Advisor:** SZETO Kwok Yip/PHYS  
**Student:** SORN Sopheak/PHYS-PM (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

The communicability of a Voronoi dual was investigated with respect to the minimum separation of the Voronoi, the reliability and the mean first passage time of a Levy random walk. With the exponential definition of communicability, it was found that the communicability declined with higher values of minimum separation, and as a result the reliability grew in the reverse way of communicability due to its positive correlation with the minimum separation. The performance of a Levy random walk was also found to be positively correlated with communicability. The report concludes with the optimization of the communicability of a network designed to simulate a highway network in a region with a given population density. However, the simulation's achievement was limited by the performance of the simulated annealing, which yielded a poor result, contrary to our expectation.

### Negative Refractive Index Meta-materials

**Advisor:** TAM Wing Yim/PHYS  
**Student:** FANG Yawen/PHYS (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014;  
UROP1300, Summer 2014)

The phase change of light after reflection off a material can be measured with Fourier transform infrared spectroscopy (FTIR). The measurement of phase change is of great importance in studying high-precision optical systems to obtain a wide range of physical parameters. However, the accuracy of the measurement has not been determined. To better evaluate the reliability of this method, glass samples of different thicknesses were studied using FTIR. Theoretically, the phase change was expected to be about  $-\pi$ . After comparison, the calculated phase change agreed with the theory to some extent.

**Advisor:** TAM Wing Yim/PHYS  
**Student:** WU Tsz Chun/PHYS-PM (UROP Course: UROP1100, Summer 2014)

This research tested whether the phase shift of light during reflection can be determined by Fourier transform infrared spectroscopy with the help of a simple Fabry-Perot model of interference. The reflectance of four types of glass was measured and used to determine the wavenumbers corresponding to constructive interferences. The thicknesses of the glass and phase shift during reflection were then calculated by curve fitting using the Fabry-Perot model with different equations of dispersion. The measurements the thicknesses of the glass were also done by mechanical means using a Teclock dial indicator and a microscope. The results were used to fix the thickness of the glass during curve fitting. The phase shift during reflection found by Sellmeier's equation matched our expectation.

## Experimental Study of Colloidal Diffusion in an Energy Landscape

**Advisor:** TONG Penger/PHYS  
**Student:** XIAO Jinfeng/PHYS-PM (UROP Course: UROP1300, Spring 2014)

Our group has been working on introducing the transition probability matrix, a method well applied to molecular conformational transitions, into the study of colloidal diffusion. My previous projects have confirmed that the diffusion in a two-dimensional hexagonal periodic energy landscape can be estimated with a Markov model and analyzed with a  $2 \times 2$  transition probability matrix, provided that the metastable states can be manually defined based on the physical nature of the energy landscape. In this project, I applied a systematic methodology featuring microstate clustering followed by macrostate lumping, to discover the metastable states. I found that such a methodology can correctly define metastable states in the periodic diffusion landscape studied, as long as the input experimental data satisfy some requirements.

## Plasmonic Enhanced Second Harmonic Generation in Metallic Nanostructures

**Advisor:** WONG Kam Sing/PHYS  
**Student:** SIN Pak To Larry/PHYS-PP (UROP Course: UROP1100, Fall 2013)

Using a femtosecond Ti:Sapphire laser, second harmonic generation was demonstrated for a thin gold film and gold nanostructures. By simulating various gold nanostructures and nanostructure-arrays, particularly the bowtie structure, the optimal configuration for maximizing the near-field enhancement was found. The validity of the simulation results was verified experimentally.

## Neural Dynamics

**Advisor:** WONG Michael K Y/PHYS  
**Student:** CHIU Chun Pang/PHYS-PM (UROP Course: UROP1100, Fall 2013)

Cross modality integration, also known as multisensory integration, is a common phenomenon in brain information processing, and different modalities mutually strengthen or depress each other. A model was developed to simulate the cross modalities of integrating auditory visual localization. Two layers of artificial neural networks including one visual CANN layer and an auditory layer, based on Hebb's learning, were used.

**Advisor:** WONG Michael K Y/ PHYS

**Student:** LAU Sze Cheung/PHYS

**(UROP Course: UROP1000, Summer 2014)**

Beginning with biological neuron function, this research systematically investigated how a real network is simplified, as described by a mathematical model. Then, the model was used to encode input coherence into the network as a way of determining the effect of coherence. The decrease in input coherence resulted in the elongation of the network processing time required to reach a stationary state, and a further distance from the new activity center to the original input center. This result may be helpful in explaining the experimental results involving input coherence.

**Advisor:** WONG Michael K Y/PHYS

**Student:** YEUNG King Yip/PHYS-PP

**(UROP Course: UROP1100, Fall 2013)**

The retina is the light-sensitive layer of the eyeball that is responsible for the production of vision. It comprises various types of neurons, which are categorized by their features and functions in the process of vision production. They form layer structures and participate in both photoreception and signal transmission through specific types of mechanisms and synapses. Apart from providing vision, the retina is also related to some visual effects such as visual adaptations. Dark and light adaptation are two major types of self-adjustments made by the retina in changing sensitivity toward light received. In this research, the causes of these adaptations were found to correspond with the concentrations of rhodopsin and cGMP, proteins and chemical interactions and the synaptic interactions between neurons.

### Service Provision in an Arena: Wireless Sensor Networks

**Advisor:** WONG Michael K Y/PHYS

**Student:** SHI Kun/PHYS

**(UROP Course: UROP1100, Fall 2013)**

This project focused on finding ways to create several types of networks and achieve specific network characteristics. Networks are useful in many areas such as transportation, trading and power grids. Therefore, multiple networks were simulated to determine their features in the computer before use.

## Stability and Robustness in Power Grids

**Advisor:** WONG Michael K Y/PHYS

**Student:** SHI Kun/PHYS-PP

**(UROP Course: UROP1200, Summer 2014)**

In this study, I explored the differences between scale-free networks and networks with regular connectivity in the presence of a cascade. Cascades can cause network-wide collapse, resulting in significant losses. However, levels of cascade defense may differ between these two network types. Therefore, I simulated a scale-free network and one with regular connectivity and compared them with a cascade.

## Elastic Wave Metamaterials

**Advisor:** YANG Zhi Yu/PHYS

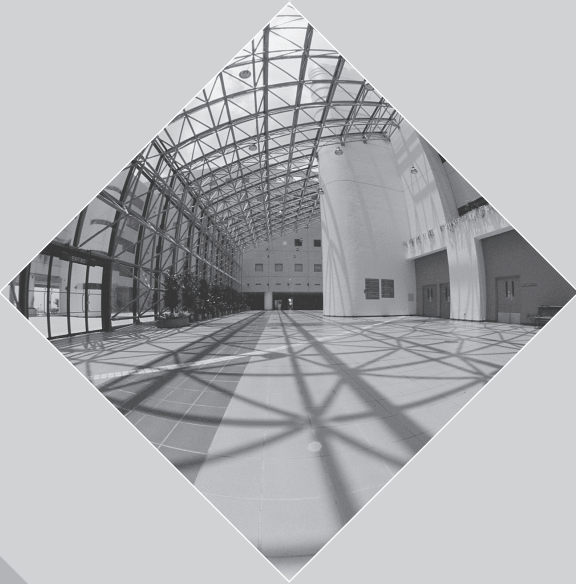
**Student:** TANG Suet To/PHYS-PM

**(UROP Course: UROP1200, Fall 2013)**

Absorption of low frequency sound is a famous topic in device development and architecture because the sound waves in ventilation systems generate vibrations that reduce the height limits of building and damage devices. In general, thick plastic and cement are used to absorb these sound waves, but because they are heavy and large in size, the consequent production costs and design limitations can be high. To tackle this problem, new types of material that exhibit novel sound wave absorption principles are needed. Professor Yang's research team designed a metamaterial to solve this problem, and the focus of this project was to test the efficiencies of new shapes applied to this material in relation to the absorption of sound waves on a metal plate.

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## Department of Chemical and Biomolecular Engineering

### Investigation of Mechanism of Ultrasound-mediated Transscleral Drug Delivery

**Advisor:** CHAU Ying/CBME  
**Co-advisor:** SUEN Wai Leung Langston/CBME  
**Student:** ZHOU Zixu/CBPE (UROP Course: UROP1100, Summer 2014)

The increasing popularity of electronic devices has resulted in eye strain becoming a growing phenomenon, which could result in a higher morbidity of eye diseases. This has created a demand for a more safe and convenient way to deliver medication to the eyes. In our research, ultrasound was investigated as a method for facilitating transscleral drug delivery. The mechanism of such enhancement, the relationship between enhancement effects, the Mechanical Index (MI) and ultrasound frequency were all explored. The MATLAB simulation model we built fit the experimental results quite well, and we observed a vague tendency for the enhancement effect to first increase and then decrease when the highest value appears at the point  $MI = 0.136$ .

### Lithium Ion Battery Assembly and Performance Testing

**Advisor:** CHEN Guohua/CBME  
**Student:** OH Seunghwan/SENG (UROP Course: UROP1000, Summer 2014)

This project focused on preparing materials for the assembly of lithium ion batteries and testing their performance. It strictly followed the procedures provided by a post-graduate research student for preparing target materials and testing. The experimental parameters were varied for each set of battery samples to investigate their correlation with the performance. In addition to the performance data, this report also states the safety precautions for undergoing the project, provided a detailed description of the preparation steps and equipment, the methods, the input materials and types and the battery testing methods.

**Advisor:** CHEN Guohua/CBME  
**Student:** ZHANG Jiabei/CBPE (UROP Course: UROP1100, Fall 2013)

Despite the widespread use of lithium ion batteries in electric vehicles (EVs) and hybrid electric vehicles (HEVs), they still have great potential for improvement. In this project, Zn-doped Li-rich materials containing 1%, 3% and 5% Zn were synthesized by  $Zn(CH_3COO)_2 \cdot H_2O$ , transition metal carbonate and  $LiOH \cdot H_2O$ . Charge-discharge cycle methods were used to test the Zn-doped Li-rich compound powders. The electronic conductivity and electrochemical performance of these materials were detected. The capacity increased from 239 to 255  $mAh\ g^{-1}$  when 1% of Zn was initially introduced. However, when the Zn content was further increased, the capacity dropped significantly. The conclusion was that 0.01 Zn can improve the electrochemical properties of Li-rich material.

## Fabrication and Characterization of Metal-based Core-shell Materials

**Advisor:** LAM Leung Yuk Frank/CBME

**Student:** GARCIA HENRIQUEZ Carolina Lissette/CBME

(UROP Course: UROP1000, Summer 2014)

Silica-core-based nanoparticles with different shell layers of uniform size distribution, tunable shell thickness and layer number have been successfully synthesized through a simple and facile approach, in which silica cores synthesized in a Stöber solution can then be transformed into multilayered core-shell materials. The formation of these structures does not require any sacrificial templates, emulsion droplets, or surface-protective agents. The mesoporous silica spheres obtained possessed controllable diameters, tunable shell thickness and high specific surface area. The aim of this project was to make silica-core-based nanoparticles with different shell layers using this method. The final materials could then be used as a carrier for metal nanoparticles. Finally, their morphology and composition were characterized by transmission electron microscopy.

*Keywords—core-shell; silica; nanoparticles.*

## Fabrication of Metallic Nanowires Using the Templating Approach

**Advisor:** LAM Leung Yuk Frank/CBME

**Student:** NAGARI Kenro/CENG

(UROP Course: UROP1100, Fall 2013)

The fabrication of metallic nanowire has been studied extensively due to its future prospects in the field of material science. Nanowires may replace carbon nanotubes in some applications. Some experiments have shown how the nanowires can be used to build the next generation of computing devices. The synthesis of some metallic nanowires has been reported in the literature, but there have been few studies on the synthesis of metallic nanowires encapsulated in porous structures. In general, the preparation of nanowires can be attained using a templating approach through chemical reduction and electrochemical deposition. Nonetheless, this approach requires a high amount of energy and generates low product yield. A one-step method for the preparation of nanowires introduced by Liu et al., called vacuum vapor deposition (VVD), requires high temperatures (above 1073 K).

A new technique called chemical vapor deposition (CVD) was recently studied to synthesize an ordered metallic nanowire encapsulated in the pore channels of mesoporous SBA-15. The temperature required for CVD is low, making the metal deposition a simple process. To enhance the quality of nanowire with SBA-15, ammonia (carrier gas) was introduced during the precursor deposition.



## Mechanochemically-fabricated Catalysts for the Epoxidation of Stilbene in Ambient Conditions

**Advisor:** LAM Leung Yuk Frank/CBME

**Student:** LAU Pui Yan/CBPE

(UROP Course: UROP1000, Summer 2014)

The purpose of this research project was to fabricate various metal-supported catalysts based on a mechanochemical method, and then carry out the catalytic epoxidation of cis-stilbene to generate stilbene oxides. The fabricated catalysts were characterized by a series of analytical techniques such as transmission electron microscopy and x-ray photoelectron spectroscopy, whereas the reaction products were analyzed by high-performance liquid chromatography to evaluate the yields and conversion. Due to time limitations, this project is still in progress. The first stage is complete and several catalysts are ready for characterization and subsequent reaction. The remaining stages of the project will continue in the coming semester under UROP1100.

## Metal Supported Catalysts for Room-temperature Amidation Process

**Advisor:** LAM Leung Yuk Frank/CBME

**Student:** LING Tin Chung/CBME

(UROP Course: UROP1000, Summer 2014)

The amidation of chemicals is important in the chemical and pharmacological industry, producing molecules such as peptides and polymers. These days, "green" chemistry has become a significant consideration in the design and manufacturing of products. Many scientists and engineers are striving for a greener amidation process to reduce any harmful waste and effects that may be produced during the current reaction. This project developed and designed different metal-based catalysts for the amide formation of benzaldehyde and benzyl alcohol. Different compositions of the catalysts involving various metals and bases were evaluated to obtain an optimal effect on the amidation.

## Ordered Silicon Nanostructures for Energy Technology

**Advisor:** LAM Leung Yuk Frank/CBME

**Student:** CHAU Sin Lok Rock/CEEV

(UROP Course: UROP1100, Fall 2013)

LI Chak Leung Michael/CENG

(UROP Course: UROP1100, Fall 2013)

This project is still in progress after three months' work. This progress report describes the ongoing work, including the use of multi-channel potentiostats/galvanostats and reactor design. Due to time limitations, this work will be continued in UROP 1200, the details of which were discussed in this report.

## Production of Furfural from Xylose by Niobium-based Catalysts

**Advisor:** LAM Leung Yuk Frank/CBME  
**Co-advisor:** LUQUE Rafael/CBME  
**Student:** CHAN Wai Leong Mickey/CEEV (UROP Course: UROP1100, Spring 2014)

Furfural is a versatile chemical that can be used in many different areas. It can act as a selective solvent, such as for removing aromatic compounds from lubricating oils, and as a starting material for other chemical compounds, including furfuryl alcohol and its derivatives. The reaction temperature of furfural production from xylose is around 100°C, but it is also thermodynamically possible for it to occur at room temperature. The niobium-based catalysts acted as the acid catalyst, which contained Lewis and Brønsted acidic sites to catalyze the furfural reaction. The aim of this project was to achieve the production of furfural from xylose at room temperature using niobium-based catalysts. The niobium-based catalyst, synthesized using the ball-mill method, was characterized by Brunauer, Emmett and Teller (BET), x-ray diffraction (XRD), inductively coupled plasma (ICP) and transmission electron microscopy (TEM) analyses. The BET analysis characterized the catalyst's pore size distribution, pore shape and surface area. The XRD analysis identified the composition and status of the impregnated metal on support. The ICP analysis determined the amount of metal (Cu, Ti) loading in the catalyst. The TEM analysis provided a direct morphology of the catalyst's surface and element distribution. The reaction product was also analyzed by high-performance liquid chromatography and gas chromatography.

## Production of Biodiesel from Waste Lipids and Evaluation of the Fuel Properties

**Advisor:** LIN Sze Ki Carol/CBME  
**Student:** LEE Jisoo/CBGBM (UROP Course: UROP1000, Summer 2014)

Biodiesel was produced from lipids by transesterification in the presence of methanol while varying the reaction temperature, molar ratio of lipids to methanol and catalyst. The optimal reaction temperature was 40°C with a 1:5 molar ratio of lipids to methanol when using lipase as a catalyst. A maximum conversion of 98.6% was achieved using a 1:10 molar ratio of lipids to methanol at 60°C using KOH as catalyst. An economic analysis of the biodiesel production process provided an estimated cost of \$1,214.87 per ton of biodiesel. The cash flow diagram of the process shows the economic viability of the biodiesel production process.

**Advisor:** LIN Sze Ki Carol/CBME

**Student:** LINARDI Darwin/SENG

**(UROP Course: UROP1000, Summer 2014)**

Biodiesel has been a topic of immense interest in recent years. However, the production of biodiesel using edible oils has not proven to be economically feasible. Therefore, there is a need for a low-cost feedstock for the production of biodiesel. The waste lipids obtained from food waste are a potential zero-cost source that would reduce municipal solid waste, which is a major problem in small cities such as Hong Kong. In this work, waste lipids were used as a feedstock for transesterification. The maximum conversion obtained using KOH as a base catalyst was 100%. The maximum conversion using lipase *Candida antartica* lipase-B (Novozym-435) at 40°C, a 1:5 lipids-to-alcohol molar ratio and a 12-hour reaction time was 72.5%.

**Advisor:** LIN Sze Ki Carol/CBME

**Student:** PATRIA Raffel Dharma/CBME

**(UROP Course: UROP1000, Summer 2014)**

In recent years, the fossil fuel shortage has become one of the world's major problems. Research has been undertaken to investigate potential renewable energy sources, one of which is the production of biodiesel from waste cooking oil by transesterification reaction. This research focused on the optimization of the reaction condition and reaction method for the lipase-catalyzed transesterification. An experimental optimization between different reaction conditions (temperature, molar ratio of oil to methanol, reaction time) and reaction methods (batch process, stepwise methanol addition, silica gel addition) was performed. The most effective method was stepwise methanol addition and the optimum reaction condition with a biodiesel conversion of 74.2% at a temperature of 50°C, a molar ratio (oil:methanol) of 1:4 and a reaction time of 6 hours.

## Recovery of PHB from Bakery Hydrolysate

**Advisor:** LIN Sze Ki Carol/CBME

**Student:** LAM Man Yee/CHEM

**(UROP Course: UROP1100, Fall 2013)**

Hydrolyzed bakery waste contains high glucose content, which can serve as a cheap carbon source for the production of biodegradable plastic polyhydroxybutyrate (PHB). This experiment aimed to optimize the extraction yield of intracellular PHB. Chemical pretreatment and enzymatic digestion were conducted to disrupt the cells before extraction. The PHB extraction was performed using chloroform and heating. Among the chemicals used in the cell disruption, the alkalis showed the highest degree of cell disruption to the PHB-containing biomass. With the aid of heat treatment, the extraction yield could be enhanced. The highest percentage extraction (72% w/w) was obtained when hydrochloric acid was used.

## Production Large Area Uniform Single-Crystal Graphene Films

**Advisor:** LUO Zhengtang/CBME

**Student:** YU Chun Hang/CEEV

**(UROP Course: UROP1100, Summer 2014)**

Phase change material (PCM) is used to correct the gaps between energy supplies, and is often encapsulated during applications. The material can be organic or inorganic, as long as the concerned heat can be stored and transferred effectively and desirably. We first conducted a literature review and analysis covering present-day PCM technology. Then, we selected one PCM product on the market and investigated its heat transfer phenomenon and thermodynamic properties. In addition, one inorganic chemical  $\text{MgSO}_4$  at a specific concentration involving eutectic interactions with water was examined to determine and simulate a new PCM product with designated and enhanced properties.

## Selective Adsorption of Heavy Metals

**Advisor:** MCKAY Gordon/CBME

**Student:** YIU Tak Shing/MEGBM

**(UROP Course: UROP1100, Fall 2013)**

This project compared the adsorption capacity of NH<sub>2</sub>-MCM-41, mesoporous silica functionalized with NH<sub>2</sub> on the surface, for copper ions and cadmium ions. It was conducted with nine solution sets, each with eight concentrations. Anionic organic compounds of EDTA and Urea were added into the Copper (II) nitrate and Cadmium (II) nitrate to investigate the effect of organic anions on the adsorption capacity. It was discovered that adsorption capacity decreased slightly when Urea was added, and decreased severely when EDTA was added for both Cadmium (II) and Copper (II) nitrate solutions, or a mix of both solutions.

## Productization of Disinfection Technologies

**Advisor:** YEUNG King Lun/CBME

**Co-advisor:** KWAN Siu Ming/CBME

**Student:** HUNG Samantha Ting/SSCI

**(UROP Course: UROP1000, Summer 2014)**

The demand for antimicrobial coating products and concerns about the safety of existing products have encouraged the development of a naturally derived antimicrobial coating product, such as one based on the thyme oil antimicrobial coating formulation being developed. After establishing that the basic requirements of safety and efficacy had been fulfilled through an examination of the relevant databases and regulations, and an interpretation of the results from bactericidal tests, general directions were proposed for product conceptualization in relation to the formulation's strengths, weaknesses, opportunities and threats. After exploring the possible product forms, the concept selected was foaming hand sanitizer. Preliminary assessments of the formulation's suitability for the concept were made, with provisions and ideas for further testing and implementation.

## Pulsed-Electric Field Device for Point-of-Use Water Disinfection

**Advisor:** YEUNG King Lun/CBME  
**Co-advisor:** HUNG Karen/CBME  
**Student:** CHOW Ka Yau/CBGBM (UROP Course: UROP1000, Summer 2014)

This study investigated the conditions and effectiveness of applying a pulsed-electric field electrode prototype (both origami and interdigitated designs) in field test settings. To assess the electrode's functionality for domestic and small-scale use, water quality tests were conducted to justify a suitable site for experiments where an appropriate amount of bacteria could be found in the water source. Then, water was collected before and after applying the pulsed electric field (PEF) provided by the electrode. The water quality was compared using the parameters given by the World Health Organisation through various experiments. The application of a PEF electrode is expected to remove a large proportion of the bacteria in the water under specific conditions, providing users with clean, safe water.

## Site Tests of Smart Antimicrobial Coatings

**Advisor:** YEUNG King Lun/CBME  
**Co-advisor:** LEUNG Hong Hang/CBME  
**Student:** VICTORIA ./SENG (UROP Course: UROP1000, Summer 2014)

An antimicrobial coating formulation using chlorine dioxide has been developed and is currently being tested at Queen Elizabeth Hospital. The purpose of this investigation was to enhance the current formulation to reach up to 90% bactericidal activity with a stable chlorine dioxide release profile for use in filters. The factors altered included the amount of chlorine dioxide, the use of tetraethylorthosilicate (TEOS), hydrochloric acid and citric acid concentration. To measure the effectiveness, bactericidal tests against *Staphylococcus aureus* were conducted and the chlorine dioxide release profile was monitored by iodometric titration each week. The results showed a somewhat positive relationship between chlorine dioxide and citric acid concentrations and bactericidal activity, with TEOS being better than distilled TEOS, and an unstable effect for hydrochloric acid.

## Department of Civil and Environmental Engineering

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

**Advisor:** CHANG Chih-chen/CIVL

**Student:** LEE Wing Hang/CIGBM

(UROP Course: UROP1100, Spring 2014;  
UROP1200, Summer 2014)

The extraction of acceleration data is important in analyzing structural behavior. In this project, an in-built accelerometer, improved by adding a plug-in, was used to extract acceleration data from an iPhone to a Mac computer through the programming of an iOS application by Xcode. This report provides details of the application development process and the knowledge gained.

### Low Cost – High Impact Pedestrian Bridges

**Advisor:** DIMITRAKOPOULOS Ilias/CIVL

**Student:** SETIASABDA Ezra Yoanes/CIVL

(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

The motivation for this research is the need to build pedestrian bridges in remote areas without available funding, industrialized materials, specialized contractors or workers. Nevertheless, despite their low cost, such bridges have a potentially high (positive) impact on the local communities in mainland China and elsewhere. Hence, this project focused on designing easily constructible pedestrian truss bridges at almost zero cost. A general understanding of both the physical and mechanical properties of bamboo, the choice of design methods and the structural types to be used was gathered, with special attention to determining the appropriate wind load used on bamboo.

### Rocking Isolation of Bridges: Analytical and Numerical Approaches

**Advisor:** DIMITRAKOPOULOS Ilias/CIVL

**Student:** KWOK Wing Yu/CIVL

LUK Ka Yui/CIGBM

(UROP Course: UROP1000, Summer 2014)

(UROP Course: UROP1000, Summer 2014)

This project aimed to predict rocking block motion using numerical calculations. To ensure the validity of the Matlab scripts, a simpler motion (a bouncing ball) was first introduced using Matlab scripts. Two methods were used to find the time when the ball reached zero; namely the “*false position method*” and the time-stepping scheme. When those scripts were confirmed to predict the motion of the bouncing ball correctly, the scripts were changed to predict the motion of the rocking block under two conditions: free rocking and rocking under earthquake. This report presents all of the equations used in this project and exhibits all of the related graphs and comparisons.

**Advisor:** DIMITRAKOPOULOS Ilias/CIVL

**Student:** TSE Kwan Shu/PHYS-PP

**(UROP Course: UROP1000, Summer 2014)**

This project examined five analytical methods for solving nonlinear differential equations describing nonlinear oscillators. The accuracy of the approximate solutions was investigated by comparing the approximate closed-form solutions of the same problem with the numerical solution obtained by MATLAB. It was found that perturbation theory and the parameter expansion were unable to provide accurate approximations due to the existence of secular terms and inaccurate assumptions, respectively. Harmonic balance and rational harmonic balance were limited to non-transitory solutions, although they provided solutions that were close to the numerical solution for the discussed problem. The averaging method overcame this limitation, and fit the numerical solution well. Therefore, the averaging method could be applied to practical problems, such as the rocking block problem.

**Advisor:** DIMITRAKOPOULOS Ilias/CIVL

**Student:** WANG Jingwen/CIVL

**(UROP Course: UROP1100, Spring 2014)**

The rocking response of structures subjected to strong motion earthquakes has been an intriguing topic of study, due to its non-linear behavior. In this research, we used strong earthquake parameters such as peak ground acceleration (PGA) and peak ground velocity (PGV) to analyze the response of the rocking block excited by real earthquake records. The main analysis tool was Matlab software, and by implementing dimensional analysis, rocking spectra and coefficient of variation graphs were generated. The results were then compared with the theoretical results of a block subjected to a sine pulse. Moreover, the coefficient of variance was calculated to determine how well the rocking spectra worked.

## Investigating Interaction of Multiple Jets Using Light Attenuation Technique

**Advisor:** KIKKERT Gustaaf Adriaan/CIVL

**Student:** ZHENG Yang/CIVL

**(UROP Course: UROP1000, Summer 2014)**

Despite previous investigations of single negatively buoyant jets, the behavior of multiple negatively buoyant jets has not been studied comprehensively using the LA technique. The purpose of this research was to study the behavior of multiple jets and compare it with that of single jets to reveal similarities and differences. The focus was on a case in which jets discharged upward at a 30° angle with the horizontal and two different density differences: 1.5% and 3%.

## Climate Change Impact Analysis for Hong Kong and Nearby Regions

**Advisor:** LAU Alexis K H/CIVL  
**Student:** CHATURVEDI Isha/EVMT (UROP Course: UROP1100, Fall 2013)

Hong Kong's emission inventory is estimated based on the percentage of the mass of the pollutants emitted from various sources. This does not, however, provide a clear picture of the actual harm caused by those pollutants, as their reactivity varies. In this report, the mass of VOC's emitted from various sources was considered and converted on a reactivity scale using maximum incremental reactivity (MIR) values from the Carter's report (Development of the SAPRC-07 Chemical Mechanism and Updated Ozone Reactivity Scales, January 27, 2010). The MIR values used in this report were gathered from USEPA Speciate Database 4.3, and the emission source inventory is referenced and compared with Hong Kong's source emissions.

**Advisor:** LAU Alexis K H/CIVL  
**Student:** NAM Junghyun/EVMT (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

Climate change is known to increase the spread of infectious diseases. In Hong Kong, there is rising concern over the increasing risk of dengue fever as a result of increasing average temperature. In this research, a simulation model for a dengue outbreak was built using temperature as a major parameter to study the risk of dengue becoming an epidemic in relation to varying temperature. The result confirmed that as years with higher temperatures become more frequent, Hong Kong is likely to face a greater risk of dengue outbreak within 48 years.

## Application of FBG Sensing Technique to Shrinkage Strain Measurement for Cement-based Composites

**Advisor:** LI Zongjin/CIVL  
**Student:** HU Litao/SENG (UROP Course: UROP1000, Summer 2014)

In this research, we used fiber Bragg gratings (FBGs), a type of fiber-optic sensors, to measure the shrinkage strain measurements and temperature changes for cement-based composites. Although we used mortar in our experiments, which differs from cement in the sample-making process and some properties, the basic principles were the same. The shrinkage strain measurements of our specimens in the first 12 hours after mixing were quite hard, as only after reaching a minimum strength can the strain be attached. As a result, most of the shrinkage strain measurements began when the molds were cast, with the specimens and technical norms for determining such quantities based on a certain age for starting the shrinkage measurement. The work presented here revealed more about the early age shrinkage of mortar using the FBGs.

*Keywords—fiber Bragg grating; magnesium phosphate cement; early age shrinkage.*



## Cement-based Piezoelectric Sensor and its Application

**Advisor:** LI Zongjin/CIVL

**Student:** HE Zhou/SENG

**(UROP Course: UROP1100, Summer 2014)**

Cement-based piezoelectric composites can be extremely useful in modern civil engineering projects (Li, Zhang and Wu, 2002). In this experiment, the relationship between the ceramic-cement mass ratio and the  $d_{33}$  value of the sample disk was examined.

## Green Slope Engineering for Hong Kong

**Advisor:** NG Charles W W/CIVL

**Student:** YAU Ching Wan/CIVL

**(UROP Course: UROP1100, Fall 2013)**

Landslides are a significant threat to the people of Hong Kong. They are typically caused by rainfall infiltration, and one prevention method is to reduce soil permeability to reduce infiltration. Planting affects soil suction, which is the main focus of green slope landscaping, and it may also affect soil permeability. Therefore, the aim of this test was to identify the relationship between roots and permeability. To investigate the effects of the physical preferential flow caused by plant roots, a constant head soil permeability test was conducted. During the test nails were used to imitate the physical properties of roots. The results showed that the permeability increased with the number of nails. The relationship with suction will require further investigation.

## The Statistics of Major Earthquakes around Taipei since 1900 and a FOSM Seismic Hazard Analysis

**Advisor:** WANG Jui Pin/CIVL

**Student:** TANG Ho Yuen/CIGBM

**(UROP Course: UROP1100, Fall 2013)**

This report began by introducing the basic principle of First Order Second Moment (FOSM) and its application in seismic hazard analysis. The statistics of major earthquakes around a study site (Kuosheng nuclear power plant) in New Taipei City were then presented. With pre-determined sets of distance and magnitude thresholds, the expected peak ground motion (PGA) of the site was evaluated using the FOSM method. The results from different threshold conditions were combined using logic-tree analysis. The result showed that the best-estimate annual exceedance rate of  $PGA \geq 0.11g$  was 0.2% per year at the site in New Taipei City.

*Keywords—first order second moment method; seismic hazard analysis; probabilistic analysis.*

## Using AFOSM to Estimate Major Earthquake Probabilities

**Advisor:** WANG Jui Pin/CIVL

**Student:** WANG Xueying/CIVL

**(UROP Course: UROP1000, Summer 2014)**

A seismic hazard distribution model based on the advanced first-order second-moment (AFOSM) method was developed. Three computing approaches were used and compared: Excel Solver, Excel VBA and MATLAB. Using the empirical regression equation and the data for the fault, the probability of earthquake magnitude was returned by the model. The Meishan fault case study showed that although the slip rate was relatively high, the probability of exceeding an  $M_w$  7.0 earthquake was 4%. This AFOSM model provided a more conservative and reliable result than other probability distribution models offered, and can be used as a reference in engineering practices and to ensure the seismic safety of the local community.

## An Exploratory Study of the Applications of Transparent Soils

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** CHOW Jun Kang/CIVL

**(UROP Course: UROP1200, Fall 2013;  
UROP1300, Spring 2014)**

The objective of this research was to develop a transparent soil that is environmentally friendly, economical, easy to replicate and feasible in geotechnical engineering modeling. Fused quartz was selected as the study material, and combined with a sugar solution to create a realistic physical modeling soil matrix. A benchmark for the quantification of transparency was established to serve as a systematic approach to grading the transparencies of the various materials available in the market. The hue-saturation-brightness (HSV) format was selected for the presentation of the color component to measure how transparent soil alters and scatters the light that passes through. To examine the feasibility and usefulness of transparent soil, compaction grouting was studied. Several important findings are presented: a) the grouting quality was intimately related to the rate at which it was inserted into and pulled out of the grout tube; b) a segregation of the grout mixture tends to occur due to the components' different viscosities; c) the preferential flow of grout material along the shaft of the grout tube was observed; and d) various stages of grout growth were observed throughout the experiment. Applying the transparent soil allowed the researchers to visualize each stage of grouting to investigate the seemingly unimportant steps that might lead to the unintended failure of the original foundation work. Future work will address other important geotechnical engineering processes, including jet grouting and pile penetration processes.

## Applications of Transparent Soils in Geotechnical Engineering

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** GAO Jiayi/CIVL

**(UROP Course: UROP1000, Summer 2014)**

This work reflects my decision to study the ways in which geotechnical engineering contributes to daily life. I assisted a PhD student with his analysis of soil mechanics and learned a great deal in addition to gaining valuable experience in areas such as 3D printing, particle image velocimetry, the biaxial device, particle tracing, photo adjustment and useful tools such as Tracker and MATLAB.

## The Application of Time-lapse Resistivity Mapping to Landfill Cover

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** KIM Jungsun/CIVL

**(UROP Course: UROP1100, Spring 2014)**

The OhmMapper is a capacity-coupled (CC) resistivity measuring device designed for subsurface surveying. Unlike other conventional equipment, its convenience and efficiency are remarkable. It requires neither soil samples nor drilling, and can finish a survey in a short time. However, using it for ground surveying is not yet popular due to several factors, including the method's innate limitations and relatively low accessibility. The goal of this research was to familiarize myself with the concept and functions of OhmMapper, and to further research and interpret the scientific principles behind the system.

## The Applications of Time-lapse Resistivity Mapping to Green Slopes

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** CHEUNG Chi Yin/CIVL

**(UROP Course: UROP1100, Fall 2013)**

Capacitive-coupled resistivity has been used in geometrical surveys for some time, and this review provided a rough comprehension of its applications. The capacitive-coupled resistivity system studied was OhmMapper, and this report explains what it is, and how and why it is used.

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** KIM Jungsun/CIEV

**(UROP Course: UROP1100, Fall 2013)**

The OhmMapper is a capacity-coupled (CC) resistivity measuring device designed for subsurface surveying. Unlike other conventional equipment, its convenience and efficiency are remarkable. It requires neither soil samples nor drilling, and can finish a survey in a short time. However, using it for ground surveying is not yet popular due to several factors, including the method's innate limitations and relatively low accessibility. The goal of this research was to familiarize myself with the concept and functions of OhmMapper, and to further research and interpret the scientific principles behind the system.

## The Development of a New Type of Sensor, Smart Soil Particle, for Slope Stability

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** LOONG Cheng Ning/CIVL

**(UROP Course: UROP1200, Fall 2013;  
UROP1300, Spring 2014)**

A landslide is the movement of a mass of rock, debris or earth down a slope. Such events have substantial effects on the human lives involved. Understanding the mechanisms of landslides is important for engineers and researchers to develop better preventive countermeasures. In this project, smart and miniature sensors including accelerometers and pore pressure transducers were implemented in a flume test to understand the responses of a groundwater-flow-induced landslide. Six experiments were conducted and the results showed that the failure mode was rotational for homogeneous soil, and the range of frequency for the acceleration was generally less than 100 Hz.

*Keywords—MEMS Sensors; Slope Monitoring System; Flume test.*

**Advisor:** WANG Yu-Hsing/CIVL

**Student:** LUI Hoi Lun/ELEC

**(UROP Course: UROP1100, Fall 2013)**

Three sensor systems have been installed in a remote hill in Lushan, Taiwan, in an ongoing project to study the mechanisms behind the initiation of landslides and landslide prediction. However, the connections through 3G and the Internet by which the systems transmit slope motion data to the server are often lost, especially after adverse rainstorms on the site. This wastes the expensive installation fee spent on the systems. While the cause behind the problem is being investigated, in this work, a fail-safe hardware reset module based on the MSP430-FRAM series was developed to operate with extremely low power consumption to monitor the sensor systems and the OS, providing a necessary and quick solution to the problem.

*Keywords—Landslide Prediction; Landslide Initiation; MEMS sensor; Raspberry Pi; MSP430; Fail-safe system; Finite-state Machine; Open-source; Electronics; 3G; Server.*

## Mapping the Angle of Repose of Earthquake-induced Soil Deposits on Natural Terrains

**Advisor:** ZHANG Li Min/CIVL

**Student:** HE Danqi/CIVL

**(UROP Course: UROP1100, Fall 2013)**

The angle of repose of a landslide deposit is defined as the angle between the horizontal plane and the heap of granular materials deposited during their run-out. This project mapped the angle of repose of landslide debris deposits induced by the 2008 Sichuan Earthquake in China. The angles of repose of 80 landslide debris deposits near Yingxiu in Sichuan Province, China, were measured using the elevation, latitude and longitude data provided by Google Earth. The angles of repose of 30 typical landslide debris deposits were measured along the Yuzixi River, and the angles of 15 additional deposits in remote places such as Pubugou and Xiaojiagou, where field sampling and testing were unlikely, were mapped. The range of the measured angles was from 27.3° to 43.2°, with a statistical mean value of 34.7°. The average value of the angles of repose obtained at the roadside was larger than that at the riverside.

## Department of Computer Science and Engineering

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

**Advisor:** CHAN Gary S H/CSE

**Student:** HAN Haiyang/CPEG

JOO Minhyung/SSCI

ZHANG Juran/EEIC

(UROP Course: UROP1100, Summer 2014)

(UROP Course: UROP1000, Summer 2014)

(UROP Course: UROP1000, Summer 2014)

Captive portals have become popular in public areas recently, and most apply a remote authentication dial-in user service (RADIUS) server as a means of authentication. Users gain Wi-Fi access using a PIN number that they receive on their phone/receipt or by creating an account with a username and password. Our aim was to build a captive portal with a different mechanism in which users gain Wi-Fi access by liking a social network webpage. We used Facebook as the social network platform, as it is by far the most accessible and popular social network with the richest API. For the captive portal, we used pfSense, which comes with a user-friendly GUI and diverse services. A RADIUS server was not used, as Facebook's server provides all of the elements necessary for the authentication process.

### Indoor Localization

**Advisor:** CHAN Gary S H/CSE

**Student:** BATRA Dhruv/COMP

(UROP Course: UROP1100, Fall 2013)

Indoor localization is a technique used to effectively locate indoor users. This technique can be used to offer location-based services (LBS) to users. This project created a website for site owners who offer LBS. To facilitate LBS, location details regarding a particular site (airports, shopping malls, MTR stations) must be stored in a database that includes information on various facilities (e.g. ATMs, libraries, restrooms, lecture theatres) in a site such as the location of these facilities. This research involved building a website that would allow site owners to add the location details for their facilities. This report also provided details on the technologies used to create the website: Hypertext Markup Language (HTML), ASP.NET, jQuery, JavaScript, Cascading Style Sheets (CSS), Visual Basic and Database Management System (DBMS).

*Keywords—Indoor Localization; Location Based Services; Digital Maps; HTML; ASP.NET; DBMS.*

**Advisor:** CHAN Gary S H/CSE  
**Student:** SZETO Sai Kit/COMP (UROP Course: UROP1100, Fall 2013)  
YIP Hong Ip/COMP (UROP Course: UROP1100, Fall 2013)

Location tracking systems have become important tools, but to determine a current location, an inertial navigation system (INS) is needed. The service also requires GPS data and the map covering the location concerned. GPS data can be obtained from mobile devices, but processing the map is more difficult. A map typically has numerous possibilities pointing in different directions; therefore, a map rotation function is required to fix the orientation. The map rotation function maps GPS points to the floor plan flawlessly. Subsequently, users are informed of their current locations. The result of our function was quite satisfactory. The average error was small enough to precisely report the position.

## Indoor Localization and Mobile Computing

**Advisor:** CHAN Gary S H/CSE  
**Student:** CHAN Chi Yee/CPEG (UROP Course: UROP1100, Spring 2014)

These days, localization usually refers to outdoor localization. Thanks to Google Maps, we can easily get outside locations, yet indoor locations are gaining importance. For example, people visiting a shopping mall want to know where they are, without having to find and read one of the maps provided by the mall. In this project, we tested a new method of obtaining locations, namely iBeacon, recently published by Apple and available in the Android library and through open source.

**Advisor:** CHAN Gary S H/CSE  
**Student:** LEE Chun On/COMP (UROP Course: UROP1100, Spring 2014)

Location-based services (LBS) are growing increasingly popular, as their ability to predict someone's location creates numerous business opportunities. Locations can be updated by mobile device using GPS, Wi-Fi signals or Bluetooth signals. In this project, I researched the prediction of step counts and the calculation of step length using the step count sensor in the M7 co-processor of Nexus 5. The aim was to see if the embedded step count sensor was suitable for detecting steps; that is, to see if it can detect a "true" step. I also helped to develop an iOS application on a jail-broken iPad that can collect Wi-Fi RSSI values for predicting location.

**Advisor:** CHAN Gary S H/CSE

**Student:** WANG Ding/CSIE

**(UROP Course: UROP1100, Spring 2014)**

Indoor localization is growing more popular these days with the increasing number of smart phones, the uncountable skyscrapers, the convenience delivered by GPS, etc. Indoor localization, although closely related to the GPS method, varies considerably. Given that the GPS signal can be blocked by buildings, indoor localization requires other technologies including Wi-Fi, sensor data, etc. Professor Sheung-Han Gary Chan and his team implemented newly designed indoor location-based software available from Google Play called “Wherami”. It integrates Wi-Fi and Bluetooth technologies to locate the position of a mobile device in HKUST buildings. I focused on sensor-based Android programming, in which various types of sensor data from Android phones are captured and used to reduce the magnetic-field noise and generate users’ initial orientation.

*Keywords—Sensor-based Mobile Programming; Magnetic-field Noise reducing.*

## Large-scale Multimedia Streaming Technologies in the Mobile Internet

**Advisor:** CHAN Gary S H/CSE

**Student:** KURNIASARI Andrea Juliati/COMP

**(UROP Course: UROP1000, Summer 2014)**

Streamphony HTTP Live Streaming has not been implemented for Windows Phone 8.1 devices, as the Windows Phone environment is a relatively new platform in the Mobile OS industry. This research pursued this implementation using the guides and methods available in the internal documentation and from the Windows Phone Development Center. The unique features of each section stressed the primary purposes and functionalities of the corresponding topic, all illustrated with figures and code blocks to facilitate conceptual or technical understanding. This work could serve as a good stepping-stone for Streamphony Live developers who would like to build client apps to support Streamphony services on Windows Phone devices.

*Keywords—Streamphony; HTTP Live Streaming; Windows Phone; Development.*

**Advisor:** CHAN Gary S H/CSE

**Student:** LEVIERO ./COMP

**(UROP Course: UROP1100, Spring 2014)**

**SUCIPTO Kathleen/COMP**

**(UROP Course: UROP1100, Spring 2014)**

Streamphony is an application that achieves both video on demand and live streaming using HTTP Live Streaming (HLS), a promising protocol that transfers video from the server to devices in high-quality and low bandwidth. Despite the increase in its popularity, it only supports iOS and Android platforms. The aim of this project was to design a simple Windows Phone application using the Streamphony server, focusing exclusively on video on demand. Then, a software development kit was created to provide developers with access to the Streamphony server. To play the video, a media player that supports HLS is needed. Hence, we used an open source named Windows Phone Streaming Media and implemented it in our application.



**Advisor:** CHAN Gary S H/CSE

**Student:** YANG Jiajie/CPEG

**(UROP Course: UROP1100, Summer 2014)**

Video applications are coming closer to the public in the Web 2.0 era, in which everyone can share information with the masses. Although multimedia streaming technology is relatively mature on the PC side, the video applications on the mobile side do not always satisfy public need when compared with the popularity of mobile technology. Long delays and large bandwidth occupation worsen users' experiences with multimedia applications on the mobile Internet. This project focused on developing a live-streaming video on demand system for PCs, and especially mobile devices, based on new streaming technology research. Once the system is deployed, people using PCs and mobile devices, including Android, iPhone and Windows Phone, will experience much faster and smoother live and interactive multimedia for a relatively low cost.

*Keywords—streaming; mobile internet; VoD.*

## Overlay and Peer-to-peer Multimedia Streaming

**Advisor:** CHAN Gary S H/CSE

**Student:** GAO Lisheng/COMP

**(UROP Course: UROP1100, Fall 2013)**

The Streamphony project involves peer-to-peer TV live broadcasting on portable electronic devices and computers, providing technical support for the first mobile TV service in Hong Kong, called UTV, and it is now trying to add new features and expand its influence. I joined the Streamphony team and spent about 8 to 10 hours a week on the work, during which I learned about the project's structure and basic technology. Once familiar with the product, I participated in stress testing Streamphony and then helped to draft the test report. I also took charge of the internal test bed to find the product's potential problems.

**Advisor:** CHAN Gary S H/CSE

**Student:** HUANG Tianwei/COMP

**(UROP Course: UROP1100, Fall 2013)**

A central delivery network (CDN) is a large distribution system used to provide content to clients across the Internet. The two most desirable characteristics of CDN are its efficient request handling and high availability or fault tolerance. In addition to its inner design, we also needed a tool to monitor the system use. The monitor not only helped network service providers get information about their own servers, it also enabled us to do load balancing between different servers in a CDN system, which significantly improves CDN performance. For the sake of confidentiality, in this report I only describe the system's overall structure and avoid detailed descriptions.

## Wireless Mesh and Networking

**Advisor:** CHAN Gary S H/CSE

**Student:** LEVIERO ./COMP

**(UROP Course: UROP1100, Fall 2013)**

The motivation behind the concept of wireless mesh networking is to enhance the performance of current Wi-Fi networks and to provide a robust network that can operate in harsh environments, such as airports, container terminals, etc. Basically, wireless mesh networking consists of mesh routers and mesh clients, with the former providing the network's infrastructure. Lavinet, an embedded software suite that operates under the wireless mesh networking concept, is a project supported by the Innovation and Technology Commission (ITC) and carried out by HKUST, with strong industry support. With its innovative channel assignment and routing, Lavinet enables an adaptive and high-performance multi-hop Wi-Fi network with the use of deployment-friendly wireless routers. This means that its performance depends greatly on the connection between each of the wireless routers. To ensure high performance, Lavinet must maintain the connectivity of each router. The main purpose of this research was to find a way to analyze the connectivity performance by concluding whether ping fluctuation occurred by analyzing the ping data extracted from each of the wireless routers. This paper provides a detailed description of how to analyze the ping fluctuation by observing the ping with the Discrete Fourier Transform concept. It also summarizes the course and reviews the learning outcomes.

**Advisor:** CHAN Gary S H/CSE

**Student:** ZHAO Liyao/ELEC-HR

**(UROP Course: UROP1100, Fall 2013)**

I worked with the Lavinet team to invent a navigation product for wharfs. I reported to Ms. Zheng on a weekly basis and was supervised by Prof. CHAN. My work was divided into two perspectives: finding a driver for a GPS module, and researching the GPS principle. For me, the goal of this experience was to learn as much as possible. Before my participation, I had no knowledge of the Global Positioning System or the OpenWrt (a Linux system). Now, I am familiar with them, especially GPS.

## Development of Location-Aware Android Apps

**Advisor:** CHEUNG Shing Chi/CSE

**Student:** SHANG Hang/SENG

**(UROP Course: UROP1100, Summer 2014)**

For this project, I detected the performance issues of Android applications, using lint tools embedded in the Android studio to characterize different performance bugs and identify bug patterns. An application's performance significantly influences the users' experience, shaping its popularity. However, many application developers are not able to examine the projects carefully to avoid such performance bugs. I summarized some of the bug patterns during the research process based on previous empirical studies.

**Advisor:** CHEUNG Shing Chi/CSE

**Student:** ZHANG Jiaxin/CPEG

**(UROP Course: UROP1100, Fall 2013)**

Smart phones are becoming increasingly significant in our daily lives. However, the performance of smart phone applications can be less than satisfactory. My project was to explore the T.J. Watson Libraries for Analysis (WALA), which provided the capabilities of static analysis on the Java bytecode. The goal was to produce a framework for analyzing any given Android application and implement the functionality of detecting an anti-pattern. The program was designed to provide warning and related information for the given bytecode of the Android application, according to the detection result, to help the user improve the application's performance by modifying the code where it includes anti-patterns.

## Tool Building for Source Code Repository Collection and Analysis

**Advisor:** CHEUNG Shing Chi/CSE

**Student:** CHAN Shing Kit/COMP

CHEUNG Wai Yip/COMP

**(UROP Course: UROP1000, Summer 2014)**

**(UROP Course: UROP1000, Summer 2014)**

Android is a new dedicated platform for smartphones and embedded systems. However, many Android applications suffer from significant performance issues that degrade users' experiences. Because Android has its own framework and features, some of these performance issues are not targeted by the current static optimization tools, leaving people without effective techniques to tackle such performance bugs. Moreover, mobile applications should also consider power consumption and network usage as performance indicators. To help Android developers find their performance bugs efficiently, we designed a new Eclipse plugin to find specific performance bugs in Android applications by identifying common patterns through static code analysis.

## Distributed Algorithms for Cloud Computing Platforms

**Advisor:** GU Lin/CSE

**Student:** FUNG Ho Long/COSC

**(UROP Course: UROP1100, Spring 2014)**

Many commonly used applications have emerged from the fast-growing advancement of cloud computing technology in the past decade, including search engines, cloud storage and path-finding services—all of which have become an indispensable part of everyday lives around the world. All of these utilities directly benefit from cloud computing through the use of distributed algorithms. Such algorithms, if they are found to solve a certain problem, can be implemented in parallel programming and applied to any cloud computing platform to perform and significantly speed-up computation, compared with the trivial serial algorithms. Maximum cardinality matching for a bipartite graph is one such parallelizable problem that results in a notable decrease in the time needed for computation.

## System Software for Cloud Computing

**Advisor:** GU Lin/CSE

**Student:** SHIN Wai Ching Martin/SENG

**(UROP Course: UROP1000, Summer 2014)**

Traditional operating systems work for a single PC, minicomputer or mainframe. With the emerging paradigm of cloud computing, many Internet-based applications run on a much larger platform, but the system software for this new large distributed platform is still in the development stage. Under the supervision of Prof. Lin Gu, I had the opportunity to survey the state-of-the-art in this area with a focus on system software and elastic computing technology. It was a very intensive learning experience in which I implemented and tested system software components on the cloud computing servers. I reviewed research papers and compared different cloud computing technologies, and this progress report reflects on the two major discoveries made: Layer Zero architecture and logistic regression.

## Theorem Discovery in Game Theory

**Advisor:** LIN Fangzhen/CSE

**Student:** HU Anbang/MATH-AM

**(UROP Course: UROP1200, Fall 2013)**

*Generalized ordinal potential games* and *best-response potential games* are two well-known classes of games with pure Nash equilibrium (PNE). However, neither potential class characterizes all games with PNE. This report explored new conditions that characterize games with PNE that do not fall into the aforementioned categories. Some interesting phenomena were revealed via observation of the generalized ordinal potential and best-response potential games in a 2-by-3 case (two-person game with one player holding two strategies, whereas the other holds three strategies). Specifically, two new conditions were found to lead to PNE: the presence of a weak best-response cycle and the existence of an intersection of best responses. Despite the comprehensibility of the two newly discovered conditions, their formulation and generalization were complex in a strictly mathematical sense. A different angle for investigating the existence of PNE in a game was finally proposed.

## Parallel Computing on Multicore CPUs and GPUs

**Advisor:** LUO Qiong/CSE

**Student:** HU Hengyuan/COSC

**(UROP Course: UROP1100, Spring 2014)**

In this project, I focused on the most popular parallel computing languages and their applications in modern database programs. The first part of this report provides a brief introduction to the development of parallel computing, followed by a software review in which I compare the two most popular parallel computing languages, OpenCL and CUDA, to determine their advantages and disadvantages. I then present the primitives I implemented using OpenCL; that is, the most common and basic parts in almost every database application. The efficiency of these primitives is critical in that they significantly influence the overall application. After the software section, I introduce a breakthrough in the hardware; namely, AMD's hUMA technology, and review its effect on the future development of parallel computing.

## Path Finding in Graphs

**Advisor:** LUO Qiong/CSE

**Student:** CHAN Hiu Ting/COMP

**(UROP Course: UROP1100, Spring 2014)**

This project involved a problem with two inputs: a graph and a maximum cost. The graph was undirected, and there were two weights: cost and award. The problem was to find the path with the maximum award, but the travelling cost had to be smaller than the maximum cost. My solution had three versions: the first was recursive, followed by an improvement with dynamic programming and ending with a modified breath first search to provide the solution. The final version was the fastest of the three methods, and I used C++ to implement my solution.

## Mining Crowdsourced Knowledge on Social Media

**Advisor:** NG Wilfred Siu Hung/CSE

**Student:** CHEN Weikeng/COMP

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Community-based Question Answering (CQA) systems are becoming increasingly popular, as they provide a new way of asking and answering questions about specific topics. It is very important to be able to effectively and accurately rank the answers to questions posted in the system. In this project, we developed a new algorithm from the existing algorithms based on social influence network theory, which we applied to improve the recommendation results. We used the information from the users' network and tested our algorithm on Quora data, and it performed well.

**Advisor:** NG Wilfred Siu Hung/CSE

**Student:** WANG Xinyu/CPEG

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Tag recommendation is an important problem in community-based question answering (CQA) that arises in many real applications such as expert finding and answer retrieval. The tag recommendation for a question is very challenging for the short-text nature of the questions. Fortunately, with the prevalence of online social networks, we have found that the askers in CQA engage in other activities, such as user-to-user connection. Therefore, we aimed to transfer the knowledge of online social networks to improve the performance of tag recommendation.

In this paper, we propose a semi-supervised tag recommendation schema that labels propagation dynamically to learn the correlation between labels based on the social network in a dynamic way. Our algorithm provides abundant information about the relationships among both instances and labels using local similarity and an improved fusion-diffusion strategy. Then, we apply the knowledge to effectively build the network among questions (instances) and tags (labels). The empirical experiments on a real-world Q&A community, Quora and datasets over four state-of-the-art recommendation algorithms demonstrate the quality and improvement of our algorithm.

## Mining Uncertain and Large Scale Data

**Advisor:** NG Wilfred Siu Hung/CSE

**Student:** LI Tao/COMP

**(UROP Course: UROP1200, Fall 2013)**

Stream data clustering is an increasingly important task in the development of the Internet and Big Data. Stream data are unlimited and time-sensitive by nature, so there are two critical requirements for algorithms that deal with them. First, they must use a reasonable amount of memory, as the amount of data is unlimited. Second, the result should be updated in time as new data arrive. In this project, we conducted an in-depth comparison study among the most widely used data stream clustering algorithms. Then, we applied the stream clustering algorithm to the Storm platform, which is a popular distributed stream data processing framework. The deployment of algorithms onto the Storm framework makes it possible to deal with large volumes of data, providing significant proof of the feasibility of those algorithms.

## Probabilistic Database Normalization

**Advisor:** NG Wilfred Siu Hung/CSE

**Student:** WANG Yu/MAEC

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Database systems have proven valuable in a wide range of real-time applications (e.g., banking systems, stock markets and social networks). However, real environments are far from ideal, and it is common for data relations to be uncertain occurrences. The ubiquitous occurrence of uncertainty in real-world data makes the classical deterministic database non-feasible. Consequently, research in the probabilistic database field has contributed significantly to real-time applications. In our last report, we provided a useful model for determining the functional dependency in a probabilistic database model; namely, the Top-k Method. The model runs in exponential time, followed by our updated algorithm, for which the running time is polynomial. However, this approach exhibits a defect when more constraints and rules are added to the database. Thus, we introduced the construction of World-Set Trees to deal with the constraint problem.

## Visual Analysis of Big Data

**Advisor:** QU Huamin/CSE

**Student:** BI Minwen/SENG

**(UROP Course: UROP1000, Summer 2014)**

Data visualization is a burgeoning field in which researchers are devoted to coming up with innovative ideas to analyze data and provide a better visual experience. Over the past decade, many well-established systems have been developed to analyze various types of data. However, these systems usually require some programming background, which prevents them from being widely accepted by ordinary users who need to generate their own figures. In this report, a simple process of exploring the “story” behind a large CIC dataset is introduced with the aid of MS Excel, Google Maps and IBM Manyeyes. Because the method requires no programming, we hope it will encourage more people with no science background to create their own data visualization results that can be used to facilitate analysis.

**Advisor:** QU Huamin/CSE

**Student:** LIU Yixing/SENG

**(UROP Course: UROP1100, Summer 2014)**

Massive open online courses (MOOCs) are provided by educational institutions and designed for broad masses of people from every corner of the world to be taken via the Internet. This relatively new form of teaching and learning has gained increasing attention for empowering millions of people to enrich themselves. This has led to the necessity of studying user behavior to provide better online education service. For educators and researchers, MOOCs also function as an education lab and data source. They can have easy access to online users' information and work on visually analyzing the big data. In this research, I took advantage of numerous samples and built a model for each of the subjects.

*Keywords—MOOC; visual analysis; learning behavior; user classification.*

**Advisor:** QU Huamin/CSE

**Student:** WONG Cheuk Fun/RMBI

**(UROP Course: UROP1000, Summer 2014)**

Data are everywhere. They are like a gold mine that, if mined properly, provides significant value. The construction industry was the focus of this research. We investigated ways to visualize the data from construction workers' records, using force-directed graphs and scatter plots to visualize the relationship between workers and the number of construction sites in which they worked. Some non-trivial findings resulted from the visualization, including the discovery of worker grouping and the correlation between the number of sites and the number of colleagues a worker had, which were not proportional. This report demonstrates the importance of data visualization.

**Advisor:** QU Huamin/CSE

**Student:** XU Lanxiao/COMP

**(UROP Course: UROP1000, Summer 2014)**

Currently, millions of people are exchanging opinions online through blogs, tweets, forums and so on. Summarizing the overall sentiments can be a challenging task. Due to the complexity of the emotions involved and the tremendousness reach of the data, there is growing interest in presenting the results of sentiment analysis in various visualized forms. Massive open online courses (MOOCs) have gained significant popularity, and their forum data are highly worthy of sentiment analysis to extract people's insights into various courses. Because many current visualizations cannot be seamlessly adapted into the presentation of sentiments revealed through MOOC websites, we developed a form of visualization exclusively for MOOC sentiment analysis that depicts both the overall and piecewise sentiments extracted from forum data, and presents them in an interactive way.



## Visualization Techniques for 3D Urban Environments

**Advisor:** QU Huamin/CSE

**Student:** BORAR Sheetal/SENG

**(UROP Course: UROP1000, Summer 2014)**

There is a large amount of data available in the world today, which can be impossible to comprehend in its raw form. Hence, we use data visualizations that allow us to understand and discover interesting patterns in our data. This project researched information diffusion in the reference paper citations network using the citations of the reference papers on information diffusion in social media as the database. I formatted and visualized the data using IBM Many Eyes, as explained in detail in the implementation, and discovered several interesting findings shared in the Observations section.

**Advisor:** QU Huamin/CSE

**Student:** CHAN Tong Yan/CPEG

**(UROP Course: UROP1000, Summer 2014)**

The presence of thousands of black kites, a medium-sized bird of prey, in a prosperous city is an infrequent global phenomenon that happens to occur in Hong Kong, yet little research has been conducted on them. This project provides a visual analysis of the weather and the number of kites in Hong Kong through a Web application implemented through Google Earth API in JavaScript. It generates three-dimensional urban environment visual effects for an easy understanding of the relationships involved. The results revealed a low negative correlation between the temperature and the general number of black kites.

*Keywords—three-dimensional visualization; Black Kite; weather; temperature.*

**Advisor:** QU Huamin/CSE

**Student:** CHATURVEDI Isha/EVMT

**(UROP Course: UROP1000, Summer 2014)**

This research implemented data visualization techniques using the IBM Many Eyes tool to analyze Hong Kong Air Pollution Index data from the 1999-2013 period. The line graphs drawn were then used to analyze the air pollution conditions in Hong Kong over the years in different important areas. The results showed that Hong Kong's pollution levels were mostly in the high zone, making the city's inhabitants prone to various diseases. Places such as Central had the highest amount of air pollution in Hong Kong.

**Advisor:** QU Huamin/CSE  
**Student:** GUPTA Akanksha/SENG (UROP Course: UROP1000, Summer 2014)

This project explored the visualization of data (interactive java and flash applets) with word trees using IBM Many Eyes, and that of tag clouds using Wordle. Two databases were used: a collection of personal notes and online timelines, and two HUMA 2589 course books. The aim of the project was to organize data for easier management and make it easier for students and interested historians to learn the history of the two world wars revolving around Hitler, Stalin and Mussolini. This report discusses what visualization software was used, the working and basic algorithms and an analysis of the visualized data. For details, please go to: <https://mypresentation4uop.wordpress.com/>.

**Advisor:** QU Huamin/CSE  
**Student:** WU Tongshuang/CPEG (UROP Course: UROP1100, Spring 2014;  
UROP1200, Summer 2014)

Recently, the classification and analysis of students taking massive open online courses (MOOCs) has emerged as a new research interest. While several studies have covered user classification, almost all of them have used only small data sets for learning behavior analysis, regardless of MOOCs' ability to generate a great amount of log data tracking each student's detailed activities. As a result, many aspects of students' learning patterns remain untouched. This study provides a more comprehensive analysis of classified subgroups' learning behavior. With the use of two existing MOOCs user-classification concepts, it dug deeper into classified user behavior analysis on three levels: individual category analysis, forum social network construction and the comparison of different classification methods' similarities.

*Keywords—MOOCs; user classification; learning behavior; visualization.*

## Efficient Algorithms for Mining Biological Datasets on Modern Graphics Processing Units (GPUs)

**Advisor:** SANDER Pedro V/CSE  
**Co-advisor:** HUANG Xuhui/CHEM  
**Student:** LAW Hei/COMP (UROP Course: UROP1100, Fall 2013)

We worked to design an algorithm that would reorder the triangles in a mesh, enabling the graphic processing unit to process the vertices and pixels more efficiently. The idea was based on the article "Triangle Order Optimization for Graphics Hardware Computation Culling" by D. Nehab, J. Barczak and P. Sander. We strove to modify the algorithm described in the article so that it would allow us to make use of the tremendous computing power of the graphic processing unit to quickly reorder the triangles in a mesh.

*Keywords—Algorithm; Cache optimization.*

## Efficient Algorithms on Knowledge Datasets for Education

**Advisor:** WONG Raymond Chi-Wing/CSE  
**Co-advisor:** HU Jishan/MATH  
**Student:** PUSPITO Edbert Eddie/COMP (UROP Course: UROP1000, Summer 2014)

In this project, we investigated several approaches to creating a search engine for an educational website. We proposed a basic topic modeling-based design that used the Latent Dirichlet allocation (LDA) method, and built a simple version using PHP in a Linux, Apache, MySQL and PHP (LAMP) software model. Then, we tested the software with multiple results gained from a Google search for comparison. We found that our software was accurate enough to predict the topics. We considered the advantages and drawbacks of the model and created a search engine that uses LDA and basic word frequency as the side-by-side weights for the educational website.

**Advisor:** WONG Raymond Chi-Wing/CSE  
**Co-advisor:** HU Jishan/MATH  
**Student:** QI Haozhi/SSCI (UROP Course: UROP1000, Summer 2014)  
SUN Yushi/SSCI (UROP Course: UROP1000, Summer 2014)  
WANG Yiquan/SENG (UROP Course: UROP1000, Summer 2014)

The Internet plays an important role in modern education. Several online learning systems, while showing potential, have not provided a perfect path to self-sustained online knowledge datasets. Identifying the problems behind those pre-existing cases, the STeP team set out to create a better system to help students think by themselves and train their problem-solving abilities. We based our website on CodeIgniter for server-side and database connections, and on Bootstrap and jQuery for client-side user interface and logic. The team members conducted tentative research into the implementations of forum, data security and server- and client-side code optimization.

## Efficient Queries over Databases

**Advisor:** WONG Raymond Chi-Wing/CSE  
**Student:** WONG Ming Kit/COGBM (UROP Course: UROP1000, Summer 2014)

These days, we find many good uses of terrain datasets in our daily lives. For example, Google Maps is a web application that provides map views and additional functions such as route planning. Many tools have been developed to visualize and manipulate terrain data. Terrain-Toolkit is a multi-functional tool for handling terrain data that accepts terrain datasets in a wide range of formats, and supports several terrain operations such as finding the shortest gentle path and terrain simplification. This research studied efficient ways of computing the terrain simplifications proposed in [1], demonstrating the implementation of terrain simplification in Terrain-Toolkit.

**Advisor:** WONG Raymond Chi-Wing/CSE

**Student:** XIE Min/COMP

**(UROP Course: UROP1200, Fall 2013)**

The wide use of location-tracking sensors has given rise to an abundance of data in the form of trajectories. One of the core problems in trajectory analytical tasks is finding a mechanism to compute the spatio-temporal similarities between two trajectories. We studied a variety of distance functions used to measure the similarities of two trajectories, e.g. edit distance with projection (EDwP), edit distance with real penalty (ERP), edit distance on real sequence (EDR), dynamic time warping (DTW), longest common subsequences (LCSS) and structural dissimilarity (DISSIM). Specifically, the latest distance function is *EDwP*, which uses the idea of spatio-temporal segments rather than spatio-temporal points to measure the similarities between trajectories. A novel idea called *Projection* has been introduced to insert a segment appropriately. However, the distance function of EDwP fails to measure the true difference between trajectories, and the idea of projection is so vulnerable that it does not always locate at the correct position. We carefully studied the drawbacks of EDwP and then proposed possible improvements.

## Knowledge Discovery over Databases

**Advisor:** WONG Raymond Chi-Wing/CSE

**Student:** CHEN Anhua/ECOF

**(UROP Course: UROP1100, Fall 2013)**

With the booming popularity of social networks (e.g. Facebook, Weibo, etc.), the models simulating the diffusion of influence and learning behavior among individuals over social networks has been intensively studied for decades. The DeGroot model is a widely known dynamic describing a naïve non-Bayesian learning process. In this research, we studied an extension of the DeGroot model that we called the Memory DeGroot model. In this model a memory feature is captured into the DeGroot model, which addresses not only the latest influence updating matrix but also a forgetful sequence of historical updating matrices. We then studied both the single-player and competitive influence maximization problems under our Memory DeGroot model, asking how we might maximize the number of influenced nodes by seeding a limited number of nodes with constraint budgets before diffusion. Due to the convergent feature of our Memory DeGroot model, it was possible to find an optimal solution to both the single-player and competitive influence maximization problems.

**Advisor:** WONG Raymond Chi-Wing/CSE

**Student:** CHEUNG Tsz Him/SENG

**(UROP Course: UROP1000, Summer 2014)**

Statistical music composition is a popular issue these days. There are a handful of algorithms and software programs that automatically compose melodies and accompaniments. According to some studies and music theories, there are certain patterns between the successive chords within a song. In addition, chords are correlated with the notes in the main melody. In this project, we examined these patterns and correlations and generated corresponding accompaniment in different rhythmic patterns for a melody.

**Advisor:** WONG Raymond Chi-Wing/CSE  
**Student:** MA Quanbin/COSC (UROP Course: UROP1100, Summer 2014)

Amazon Mechanical Turk (AMT) is an online marketplace introduced by Amazon Web Service designed to take advantage of human intelligence. “Workers” can sign up for various human intelligence tasks (HITs) involving image recognition, audio recordings transcription and data deduplication, in which humans are much more efficient than computers. These workers receive “rewards” from “requesters,” who may enjoy their service and achieve the same goal at a much lower cost.

In this project, we explored the existing HITs listed on AMT to draw some pattern and attempted to devise a policy that would help requesters determine the appropriate price, or rewards, for the HITs they wish to post. To obtain a reliable result, the first stage of the project collected a large amount of posted HITs and their relative information over a long period.

**Advisor:** WONG Raymond Chi-Wing/CSE  
**Student:** TANG Suet Chung/SENG (UROP Course: UROP1000, Summer 2014)

The aim of this research project was to build a mobile application for a newly developed melody composer, “T-Music”. T-Music generates music by studying the temporal and lyric-note correlation of the inputted lyrics and uses a frequent pattern mining approach. The program is embedded and acts as the principal part of the mobile application. Other features, such as logging in, levels, credit points calculation and friends’ ratings were added to enhance its popularity. A Web version was first constructed, followed by the Android and iOS applications with a WebView embedded browser for the specific website. Apache Tomcat and MySQL were used as the server and database, respectively.

## Large-Scale Machine Learning on Parallel and Distributed Computing Platforms

**Advisor:** YEUNG Dit Yan/CSE  
**Student:** PENG Rui/COSC (UROP Course: UROP1100, Spring 2014)

The most recently developed and best performing models for image classification are convolutional neural networks (CNNs). A common practice when training such large networks is to use the power of parallel and distributed GPUs to drastically shorten the training phase. With the intention of gaining some insights into common academic practices, we conducted some experimental studies using CNNs as models and a cluster of 11 GPU servers for training. Our results included some findings on the key details of CNNs, such as tuning the learning rate, setting the dropout rate, choosing the layer definition and setting the solver.

## MOCC Data Analytics

**Advisor:** YEUNG Dit Yan/CSE

**Student:** HAN Shuo/COMP

**(UROP Course: UROP1100, Summer 2014)**

Massive open online courses (MOOCs) have become increasingly popular among people who want to pursue knowledge related to their interests. However, it is not uncommon that many students fail to complete the courses. To study this phenomenon, we attempted to use several support vector machine (SVM) classifiers to predict the dropout rate of a particular course in Coursera, one of the most popular MOOC websites, over the duration of the course. The prediction achieved high levels of accuracy and recall, meaning that we successfully predicted which students would drop the course in the early stages, allowing preventative action to be taken.

## Topic-Based Browsing of Online Reviews of Businesses and Products

**Advisor:** ZHANG Nevin L/CSE

**Student:** ZHANG Zhijun/COSC

**(UROP Course: UROP1100, Fall 2013)**

In this research, I studied the fundamentals of probabilistic topic modeling. I first read introduction reports on topic modeling to develop a brief but broad understanding of the field. I then explored the more technical papers to obtain deeper insights into and more comprehensive expertise in topic modeling. With sufficient prior knowledge, I used third-party programs to study topic modeling. I managed to extract topics from several datasets, including a sample Associated Press dataset and the Yelp dataset. This experience provided me with profound exposure to topic modeling, and I am very interested in pursuing deeper and more comprehensive research in this field in the future.

## Office of the Dean of Engineering

### Creative Legoscope for Biological Imaging

**Advisor:** LING Carrie Hang-yin/DENG

**Student:** SO Kam Pang/SENG

(UROP Course: UROP1100, Summer 2014)

Microscopes have been a fundamental tool used in different scientific experiments since their invention. Most students can only use microscopes in a laboratory, which can constrict their absorption of the basic principles of microscopy and optics. Moreover, traditional microscopes have a relatively high price due to the cost of expensive materials and industrial processes. In this project, a “legoscope” was built using Lego blocks, 3D-printing adaptors and the same eyepiece and objective used in traditional microscopes. This project explored the use of cheap materials to build a microscope and integrate 3D-printing technology into microscopy. The legoscope differs from a traditional microscope in that its structure is not fixed, which allows students to design the tool to fit their needs. The objectives of this project were to enhance students’ acquired knowledge of microscopes by designing their own legoscopes, and to introduce this portable product to developing countries for routine clinical diagnosis in the future.

## Department of Electronic and Computer Engineering

### 3DTV

**Advisor:** AU Oscar C L/ECE

**Student:** FAN Xinzhi/ELEC

**(UROP Course: UROP1100, Fall 2013)**

Three-dimensional television (3DTV) is being developed as the future of television, and thus it is regarded as a promising area of research. In this project, we studied the key aspects of 3DTV as an important digital image processing field. One such aspect was image stitching, which provided us with an opportunity to research an in-depth 3DTV topic. We studied some of the achievements in the area of image stitching and analyzed their merits and faults.

*Keywords—image stitching; segmented panorama; motion models; feature-based alignment algorithms; blending algorithms for seamless mosaics.*

**Advisor:** AU Oscar C L/ECE

**Student:** MEHOUACHI Mohamed Wassim/SENG **(UROP Course: UROP1000, Summer 2014)**

Three-dimensional (3D) display is a notion that began to attract the attention of general audiences about five years ago, when filmmakers started producing 3D films designed to immerse the spectator in the experience. The concept of 3D has spread into other media forms, mainly television (TV). Successful research pursues broader knowledge, particularly if the fruit of the work done will later be sold in the market. Thus, research on a technological gadget ultimately intended for sale should also be comprehensive, not only focusing on the technological aspects of the product but also operating from an understanding of the market's status and needs. In this research, we reviewed the history of 3D display, including where and when it was first broadcasted for general audiences and when 3DTV first appeared on the market. Then, we demonstrated the great market demand for and expectations of 3DTV sets both before and after their introduction. Finally, we showed that this product has room for significant improvement, which might make it an essential element of the media broadcasting market (films, TV series, sports coverage) in the near future. Our purpose was to show the importance of increased and enhanced research on how to improve the technologies involved in 3DTV, as they are likely to provide huge revenue. This technology may prove to be a game-changer, and we encourage every corporation or research institute that works on lifestyle enhancement to improve the quality, authenticity and beauty of the image provided by 3DTV.



**Advisor:** AU Oscar C L/ECE  
**Student:** TSENG Tai-chuan/ELEC (UROP Course: UROP1000, Summer 2014)

Image matting is an important problem in both computer science and electronic engineering. The major purpose of image matting is to identify the opacity of the foreground against the background in a certain input image. Image matting is a severely under-constrained problem that requires a variety of algorithms to solve it. We examined the closed-form solution, introduced by Anat Levin, which is a relatively intuitive and elementary method compared with other algorithms. It requires some basic user input, such as trimap or a few scribbles to help obtain the foreground opacity (alpha matte). With the right input and some additional assumptions, we were able to approximately extract the foreground from the original image.

**Advisor:** AU Oscar C L/ECE  
**Student:** ZENG Cancheng/ELEC (UROP Course: UROP1100, Fall 2013)

Stereo matching, as one of the most extensively researched topics in computer vision, has recently entered a new era in response to publicly available performance testing, such as the Middlebury benchmark. In this research, the stereo matching problem was formulated as three coupled Markov random fields that modeled depth, discontinuity and occlusion. Robust statistics were introduced to eliminate the processes representing discontinuity and occlusion. The belief propagation algorithm was then applied to produce a MAP-MRF solution. Such global methods outperform many other stereo algorithms. Currently, this type of stereo matching algorithm is being studied based on belief propagation, and the possibilities for improvement are being investigated.

**Advisor:** AU Oscar C L/ECE  
**Student:** ZHANG Yuan/CPEG (UROP Course: UROP1100, Fall 2013)

Three-dimensional television (3DTV), which provides viewers with stereo perception, is currently in development and has been regarded as one of the most popular choices for future entertainment viewing. However, due to the lack of professional knowledge in this area, the technology has not been comprehensively explored. In this project, we gathered basic knowledge about 3DTV images, such as the general concepts of how to represent an image on our computers and how to manipulate the images digitally to transform them.

## Next Generation Video Coding

**Advisor:** AU Oscar C L/ECE

**Student:** DUAN Yuqing/ELEC

**(UROP Course: UROP1100, Spring 2014)**

High efficiency video coding (HEVC) is currently being developed as the newest video coding standard of both the ITU-T Video Coding Experts Group and the ISO/IEC Moving Picture Experts Group. It is intended to enable significant improvement in compression performance—in the range of a 50% bit-rate reduction for equal perceptual video quality. In this project, we focused on three aspects: accessing basic knowledge about multimedia signal processing and video coding, learning about inheritance and significant HEVC improvements compared with former standards and using relevant software HM to accomplish simple tasks.

**Advisor:** AU Oscar C L/ECE

**Student:** MA Jiangfan/CPEG

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

This report explains how the sample adaptive offset (SAO) filter, one of the most important features introduced in the high efficiency video coding (HEVC) standard, is implemented in (HM) software. First, an overview of the SAO filter is provided to show why it is needed in the HEVC standard. Then, based on the source code of HM software, an explanation of the program is provided to illustrate how the SAO filter works in real software. Following a brief analysis of the SAO filter's performance, the research is summarized and concluded.

**Advisor:** AU Oscar C L/ECE

**Student:** TAN Qiao/ELEC-HR

**(UROP Course: UROP1100, Spring 2014)**

Video coding standards have evolved over past decades, aiming at maximizing compression capability and improving characteristics such as data loss robustness under limited computational resources in industrial settings. Several standards, such as H.262/MPEG-2 Video and H.264/MPEG-4, have been produced and are now widely used in various products that are increasingly common in people's daily lives. However, due to the growing popularity of HD video and the challenges that today's networks face in relation to transmission needs for heavy video-on-demand services, stronger coding efficiency—better than that of H.264/MPEG-4—is required. The high efficiency video coding (HEVC) standard has been developed by the Video Coding Experts Group (VCEG) and the Moving Picture Experts Group (MPEG) to improve compression performance relative to existing standards, and will soon be launched onto the market. This project, under the supervision of Professor Oscar Au, was designed to help students learn the features of the HEVC standard and investigate its efficiency.

**Advisor:** AU Oscar C L/ECE

**Student:** WU Tianhe/ELEC

ZHANG Mai/ELEC

(UROP Course: UROP1100, Summer 2014)

(UROP Course: UROP1000, Summer 2014)

Image matting is an important problem in both computer science and electronic engineering. The major purpose of image matting is to identify the opacity of the foreground against the background in a certain input image. Image matting is a severely under-constrained problem, resulting in a variety of algorithms to solve it. We examined the closed-form solution, introduced by Anat Levin, which is a relatively intuitive and elementary method compared with other algorithms. The algorithm requires some basic user input, such as trimap or a few scribbles to help obtain the foreground opacity (alpha matte). With the input and some additional assumptions, we can approximately extract the foreground from the original image.

## Nanomaterial-based Novel Solar Cells

**Advisor:** FAN Zhiyong/ECE

**Student:** TANG Haoning/ELEC

(UROP Course: UROP1200, Fall 2013;

UROP1300, Spring 2014)

Photoelectrochemical (PEC) solar water splitting represents a clean and sustainable approach to hydrogen ( $H_2$ ) production, and substantial research is being performed to improve the conversion efficiency. Hematite is a good material for PEC water splitting due to its chemical stability and band gap. PEC performance is hindered by the short hole diffusion length, which puts a constraint on the active layer thickness and its light absorption capability. In this project, a novel PEC device structure with an ultra-thin hematite film deposited on a three-dimensional nanophotonic structure (including nanocone and nanospire) was designed, fabricated and tested. It was found to improve the light absorption of the ultra-thin active material and provide a large surface area.

## Semiconductor Nanowire-based Sensors and Electronics

**Advisor:** FAN Zhiyong/ECE

**Student:** CHEN Zhuo/EEGBM

(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

The fabrication of three-dimensional nanostructures has been widely used in the application of nanoscale devices. Specifically, structures such as nanowires, nanopillars, nanocones and so forth have considerable light-trapping features that have earned significant attention in terms of serving as templates for thin-film solar cells. In Prof. Fan's Lab, we used porous anodic aluminum membranes (AAMs) fabricated using a self-organized mechanism as a template for photodetectors and solar cells. By controlling anodization and etching time, we fabricated nanostructures with different pitches and aspect ratios (pore depth divided by pore size). We also investigated the possibility of using Polyimide (PI) as a flexible template for solar cell fabrication by either peeling off solidified PI from a nanostructured AAM (PI cone), or by sputtering aluminum on PI and conducting a surface modification. During the process, many challenges were encountered. We applied previous experience and new thoughts to these challenges and made progress.

*Keywords—template; 3D nanostructures; AAM; flexible.*

**Advisor:** FAN Zhiyong/ECE

**Student:** LIU Xue/SENG

(UROP Course: UROP1000, Summer 2014)

Electrochemical capacitors, also called supercapacitors, have the potential to complement or replace batteries for energy storage and harvesting due to their improved energy and power density compared with conventional capacitors. An anodic of aluminum oxide (AAO) is used in the electrochemical synthesis of three-dimensional nanostructures, which offers great advantages such as increased material loading per area and enhanced ion transport. Thus far, the growth of AAO nanotubes has been a time-consuming job that is not easily controlled, as the growth rate is related to the acid concentration and anodization time. This article explores a new method using a programmable virtual instrument to achieve real-time monitoring of AAO growth.

**Advisor:** FAN Zhiyong/ECE

**Student:** SUN Zeyu/ELEC

(UROP Course: UROP1100, Spring 2014;  
UROP1000, Summer 2014)

Graphene is pure carbon that is only one carbon thick. It can conduct electricity with great efficiency. In addition, it has the largest specific surface area among the material currently used for this purpose. Given these advantages, in this project, we used graphene as the base of a catalysis to form a cathode. This report introduced the research process for making graphene film and the electrodeposition of  $\text{MnO}_2$  as the catalysis. The details of the experiment are provided, problems are discussed and future processes are reported.

**Advisor:** FAN Zhiyong/ECE  
**Student:** ZHOU Shengke/MAE (UROP Course: UROP1100, Spring 2014)

In this project, we studied the background of semiconductor nanowires, their fabrication and applications. Then, we learned printed electronic technology and practiced how to operate an inkjet printer to print and fabricate patterns onto solid substrates. We studied and proposed a new micro-printed battery. After reviewing the development of battery technologies, including the fabrication technologies and materials applied, we proposed a micro-printed Li-ion battery. The experiment will be conducted following materials preparation.

## Big Data, Small Words: Speech and Language Data Mining for Business Applications

**Advisor:** FUNG Pascale N/ECE  
**Student:** LIN Ruixi/ELEC-HR (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)

This report presents a method for analyzing Internet-mediated public sentiments/opinions. The proposed method is based on the use of web crawlers to obtain and analyze language data from various websites. A web crawler is a program that can be used to grab data from websites. The advantage of using a web crawler for language data collection is that it can automate searching and downloading huge amounts of requested webpages whose contexts contain language data of interest. The obtained raw data are basically the webpage's html information, which can be stored in a .txt file. After removing redundant information, the extracted information can proceed for analysis. Opinion mining methods involving semantic interpretations can be applied for analysis.

## Music Information Retrieval

**Advisor:** FUNG Pascale N/ECE  
**Student:** WANG Cui/COGBM (UROP Course: UROP1100, Fall 2013)

Music classification gains importance from people's desire for music to be organized and easily accessible. Genres are then introduced as categorical labels created to characterize the music. By definition, a musical genre is a conventional category that identifies pieces of music as belonging to a shared tradition or set of conventions. It can be used to represent some musical features. To conduct a genre classification for the large collections of music on the Internet, the concept of automatic musical genre classification (AMGC) is raised. This method relies on machine learning to filter music based on extracted musical features. This review covers all of these aspects of AMGC and its importance in classical music classification.

## 3D Display

**Advisor:** KWOK Hoi Sing/ECE

**Student:** ANDERSEN Winston/CPEG

**(UROP Course: UROP1100, Fall 2013)**

The purpose of this study was to understand more about the application used for the head-coupled perspective system applied in a web environment. This investigation was conducted as a continuation of a previous project in which a cube was made to move using the viewer's perspective and a library called 'cvv'. This project involved gathering data from the web with the help of a current and very famous WebGL 3d library called "three.js". It was concluded that the head-coupled perspective is applicable and thus merits further development.

## Automatic Balance Control System for Quad-copter

**Advisor:** LI Zexiang/ECE

**Student:** LIU Wenxin/ELEC

**(UROP Course: UROP1100, Fall 2013)**

Extraordinary progress has been made in recent years in the field of unmanned aerial vehicles (UAVs), and HKUST is making significant contributions to this area. The Robot Manipulation Laboratory plays an important role in robotics research at HKUST, and I was honored by the opportunity to work with and learn from the laboratory's core members, led by Prof. Li Zexiang. This semester, I focused on two quad-copter-related tasks: the hardware for the flight control system, and laser radar.

## High-performance Vision-based Motion Estimator for Mobile Robot

**Advisor:** LI Zexiang/ECE

**Student:** HOANG Long/SENG

**(UROP Course: UROP1000, Summer 2014)**

This project proposed a sensor fusion between semi-direct visual odometry (SVO) and an inertial measurement unit (IMU). The position estimation from the IMU was merged with those from the SVO algorithm using an extended Kalman filter framework. Visual odometry is more robust toward incremental errors such as 'drifting', but compared to an IMU, the data refresh rate is very low. Therefore, SVO has 'blind spots' while the algorithm is processing the next frame. Pairing SVO with an IMU provided a more accurate motion estimate, especially for very quick movements. The result was evaluated through a direct comparison with the ground truth captured by a high-speed infrared tracking system.

## Pose Control of a Quadrotor

**Advisor:** LI Zexiang/ECE

**Student:** WIDY Andreas/ELEC-HR

**(UROP Course: UROP1100, Fall 2013)**

With the advances in unmanned aerial vehicle technology, research on quadrotor control is becoming more popular. There are several different methods for controlling a quadrotor, all of which aim to achieve a precise, fast and stable control mechanism for the quadrotor. The variation in control methods might come from hardware configuration choices, such as microcontrollers and sensors, along with software implementations for processing the signal. Different implementation and methods can result in better quadrotor control quality. This project, conducted by Leonardo YU, investigated and analyzed control methods and hardware implementation for quadrotor pose control using Fourier transform.

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

**Advisor:** LI Zexiang/ECE

**Student:** YIU Kin Tat/PHYS-PP

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

We demonstrated pattern shaping for microparticle manipulation using an axicon lens and multimode interference waveguide. The important component was an axicon; that is, rotationally symmetric prisms with one conical surface and one plano surface. The MMI was a 100  $\mu\text{m}$  square-core silicon waveguide with mm length. The waveguide mode fields had a 1550 nm wavelength. The experiment was conducted with a single mode fiber and a lens fiber. The purpose of the primary simulation was to analyze the pattern generated in the experiment.

*Keywords—multimode interference waveguide; axicon; optical tweezers; microparticle manipulation; Bessel beam.*

## Building Better Multi-touch Screens

**Advisor:** SHE James/ECE

**Student:** DENG Bowen/SENG

**(UROP Course: UROP1000, Summer 2014)**

The rapid development of technology and social media has dramatically increased the amount of information available. Although the Internet plays a significant role in the swift provision of information, we inevitably encounter information directly in the physical world. However, the physical directory is always very large due to the mass of listed information, which decreases its when attempting to attain specific details. Thus, a cyber-physical directory was designed to provide users with a customized and dynamic visualization that can provide information much more quickly. The rest of the report introduces a possible solution to improve the existing cyber-physical directory developed by Jean-Loup.

**Advisor:** SHE James/ECE

**Student:** ZHANG Hongming/ELEC

**(UROP Course: UROP1000, Summer 2014)**

This research developed a detailed analysis of the current design for multi-touch screens, in addition to some other developed and developing technologies used in the field. Increasing the number of cameras improved the accuracy of the whole machine, but the AV video cameras chosen were not suited to normal PCs. We hypothesized the need to set a piece of video convertor into the PCI port. Finally, we introduced a new design combining this type of multi-touch screen and the transparent display screen.

*Keywords—multi-touch screen; multiple AV camera; video convertor; two point touch detection; transparent display board.*

## Cloud-based Storage Network for Video and Big Data Delivery

**Advisor:** SHE James/ECE

**Student:** CHEN Lingxuan/ELEC

**(UROP Course: UROP1100, Spring 2014)**

This project aimed to explore the possibility of using a cloud platform to support the massive computational power and storage resources required by mobile and online social networks. A test cloud platform that incorporates mini PCs as physical nodes and a test bench related to social media computation were used to test the idea and to see whether there would be a prospective gain in processing performance compared with a standalone physical machine. Meanwhile, we tried to make the physical hardware supporting the cloud more powerful and portable. This report presents the baseline record for running a test bench on a single physical node, and proposes a cloud platform structure based on the Openstack project.



## Comparing Whatsapp, Wechat and Line: A Survey with Experiments and Developments

**Advisor:** SHE James/ECE  
**Student:** GONG Bo/SENG (UROP Course: UROP1000, Summer 2014)  
GUO Zhihui/SBM (UROP Course: UROP1000, Summer 2014)  
LIU Xinzhu/SENG (UROP Course: UROP1000, Summer 2014)

Because the Internet is widely used around the world, and people increasingly demand the ability to communicate conveniently with each other, a number of instant messaging applications have appeared. This research featured a comprehensive comparison of the three most popular instant messaging applications: LINE, WhatsApp and WeChat. Their similarities and differences were analyzed from several angles such as social factors, technical factors and advanced function. Based on the acquired comparison, the conclusions indicate a diverse path for the future development of each application.

## HTML5-based Mobile Social (News) Games

**Advisor:** SHE James/ECE  
**Student:** ZHANG Tian/CPEG (UROP Course: UROP1100, Fall 2013)

The main purpose of this project was to design a web game with HTML 5 that would deliver a message to the players. HTML, CSS, JavaScript and enchant.js—programming languages that can be learned via online tutorial—were the technologies required for the game. After familiarizing myself with these languages, I brain-stormed details for my own game. Inspired by the course material for ELEC4170, I decided to create a game based on avoidance. Once the objective was clear, I programed and upload it to ihome. By the end of the semester, I had partially constructed two games: a bear that must escape a dropping ball, and a figure that must survive a typhoon. Both games need to be improved and ultimately completed.

## Smart Phone-Enabled Quadrotor Helicopter Control

**Advisor:** SHI Ling/ECE  
**Student:** WU Aoyu/CPEG (UROP Course: UROP1100, Summer 2014)

This report describes the development of an operations platform for smart devices and a quadrotor airship that implemented a remote control with advanced feature functions such as multi-control and 3D display. The hardware team collected information, proposed the primary tentative plan, purchased components, assembled an airship, performed flight tests, obtained feedback and implemented improvement measures. Given that the ready-made available APM was unsatisfactory, it was advised that a new one be built based on electronic components. The short-term plan highlighted the following tasks: studying the principles of the electronic components and their interactions and conducting experiments on the re-combination of components.

## Wireless Localization

**Advisor:** SONG Shenghui/ECE  
**Student:** CHEN Kejia/SENG (UROP Course: UROP1100, Summer 2014)  
GUO Jiapeng/ELEC (UROP Course: UROP1100, Summer 2014)  
WANG Zixuan/ELEC (UROP Course: UROP1100, Summer 2014)

The objective of this project is to build a location-aware device that can provide location information based on the strength of Wi-Fi signals. We built a portable device which is equipped with a Wi-Fi adaptor to scan the signal strength and send it to other smart devices with powerful computational capability. The location information is then determined based on a probability model for the signal strength. Such location aware devices can be utilized in many applications including security service, path advising, and surveillance, etc.

**Advisor:** SONG Shenghui/ECE  
**Student:** HAN Haiyang/CPEG (UROP Course: UROP1100, Fall 2013)

This project aims to measure and calibrate the difference between the signal strengths measured by different WiFi adapter. The final objective of the project is to build an indoor localization application that can track the movement and location of any person at any time instant. The future development of this application promises a more sophisticated localization system that allows a graphical user interface to guide an individual around the HKUST campus. This is applicable to other indoor areas such as malls and movie theatres. This report focuses on building a signal model for the application to use as a reference map. It describes and compares the methods used for calibration, measurement and data processing in different locations.

**Advisor:** SONG Shenghui/ECE  
**Student:** KWOK Hin Kwan/SENG (UROP Course: UROP1100, Summer 2014)  
YU Xinyuan/SENG (UROP Course: UROP1100, Summer 2014)

Wi-Fi is one of the most widely utilized communication technologies in daily life. It is thus essential that a suitable way of visualizing Wi-Fi signals be found to clarify how a Wi-Fi network covers humans' working and living areas. This research project explored a simple way to display Wi-Fi signals in a three-dimensional space. By analyzing Wi-Fi signal strength (represented by RSSI) in several places on the HKUST campus using specific software, the research team successfully produced a set of visualized graphs of Wi-Fi signal strengths. The findings will enable researchers to further study how humans interact with Wi-Fi, such as the effect of humans' exposure to signals on health and the optimization of Wi-Fi access points to maximize coverage.

*Keywords—Wifi; Wireless Localization; Data Visualization.*

**Advisor:** SONG Shenghui/ECE  
**Student:** LI Haonan/CPEG (UROP Course: UROP1100, Fall 2013)

The objective of this project is to achieve indoor localization using Wi-Fi signals on the Android platform. This brief report covers how we used an open-source project to implement the display location information for indoor localization purposes. The report discusses several topics including the coordinate generation of measured points, the use of the TileView class, the creation of RangeView and the solutions to some other problems encountered. A demonstration of the result is represented by a screen shot of the application.

*Keywords—Android; Map; Image; TileView.*

**Advisor:** SONG Shenghui/ECE  
**Student:** LI Mingwei/ELEC-HR (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)  
SETHI Gursimran Singh/ELEC (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)  
ZHOU Yuqian/CPEG (UROP Course: UROP1100, Spring 2014)

This report explains the working of an android application developed using Wi-Fi localization and positioning. This is an ongoing project that covers background on physical layer implementation, which is vital in building up the mobile application. Wi-Fi localization is a technique used to correctly identify the position of a mobile device in an indoor setting. The mobile application controls and displays the user's position. It calculates the position of the device based on the database and the GUI displays it on the screen along with other data, such as the compass. Apart from the physical layer, this report covers the GUI involved in building the application and its major features, including location determination, GUI and Compass. It also provides suggestions for future developments.

**Advisor:** SONG Shenghui/ECE  
**Student:** WONG Sing Ho/CPEG (UROP Course: UROP1100, Summer 2014)

Based on the LocUs application, which was previously developed to obtain indoor location information through Wi-Fi, this project aimed to integrate a pedometer and a magnetometer into LocUs to enhance its accuracy and overcome some Wi-Fi localization problems. Research on the current LocUs project, pedometers and magnetometers has been conducted, and modifications were made to the open-source pedometer and magnetometer project for better integration into LocUs. The successful integration was tested by comparing the location information from LocUs and the actual position in different places in HKUST. The overall accuracy was acceptable, but there is still room for improvement.

## A Learning-based Analytical Model for Network-on-Chips (NoC) Performance Evaluation

**Advisor:** TSUI Chi Ying/ECE

**Co-advisor:** QIAN Zhiliang/ECE

**Student:** LI Xiaoya/ELEC-HR

**(UROP Course: UROP1100, Fall 2013)**

Network on chip (NoC) is deemed a promising approach for managing the future of complicated on-chip communication. To evaluate the performance of NoC designs, analytical approaches have been proposed to replace the commonly used simulation approach, which is undesirable due to the slow speed and inability to show the influence of design parameters on actual network performance. Conventional NoC analytical models are largely based on queuing theory with assumptions such as Poisson's arrival rate, which introduces constraints and the reduction of adaptability to the model. A novel analytical model using machine learning has provided a more appealing approach with higher accuracy and flexibility. In this project, this concept was further explored by implementing the previous model using a different machine learning algorithm and tuning the model to achieve higher accuracy under different conditions.

## Aerial Smart-Phone Acrobat

**Advisor:** WONG Man/ECE

**Co-advisor:** QIU Li/ECE

**Student:** AMBEKAR Chirag Pradip/ELEC

**(UROP Course: UROP1000, Summer 2014)**

LEE Hay Yiu Horace/ELEC

**(UROP Course: UROP1000, Summer 2014)**

The purpose of this project was to design and build an economical quad-copter controlled by smart phones and the various sensors present in them. This left us to design a frame and a chip that could be used to interpret the digital signals from the phone to control the quad-copter, making the whole setup economical. This report mainly focuses on the added functions, such as Bluetooth, which will be used to connect the phones and relay commands to the airborne device to take pictures. The project, although not complete, has great potential and we intend to follow it through to completion.

## Electronic Buoyancy Adjustment for Underwater Vehicle

**Advisor:** WOO Kam Tim/ECE  
**Student:** ARMANI Rayan/SENG (UROP Course: UROP1000, Summer 2014)  
RUSLIM Elvin/ELEC (UROP Course: UROP1000, Summer 2014)

After competing in the Marine Advanced Technology Education Remotely Operated Vehicle (ROV) 2014 competition, we realized that a compact and efficient buoyancy system is a key feature for stability, performance and design elegance. It is also advantageous to be able to control and change the buoyancy of the machine to provide additional lift, roll and pitch. The purpose of this project, targeting small-class low-budget ROVs, was to find constants in the design of a comprehensive buoyancy system, including both static and active buoyancy, and to develop a basic interface to electronically control the system.

## Localization System for Underwater Vehicle

**Advisor:** WOO Kam Tim/ECE  
**Student:** NAKKA Dhesant Jogi/SENG (UROP Course: UROP1000, Summer 2014)

This research aimed to develop a low-cost localization system for underwater vehicles. To achieve this, certain compromises were made, which meant that position estimates could not be obtained, as the sensors that are available are not accurate enough to provide usable position estimates. Instead, the sensors were used to make a heading reference system and a depth reference system, which can be used with control loops to increase the stability of an underwater vehicle. A test platform composed of a pressure sensor and an inertial measurement unit was used to demonstrate the proof of concept. However, using a Doppler velocity log (DVL) when cost-effective could provide accurate velocity information, which could then be used to obtain position estimates.

## Scalable Nanofluidic Electronic Devices for Biomolecular Analysis

**Advisor:** YOBAS Levent/ECE  
**Student:** CHAN Yiu Pan/ELEC (UROP Course: UROP1100, Fall 2013)  
WU Tongshuang/CPEG (UROP Course: UROP1100, Fall 2013)

Nanofluidic diodes are fluidic systems that integrate nanofluidic components and microfluidic channels to perform ionic current rectification, which can be analogous as a conventional solid-state diode. This feature allows an ionic flow to pass through the nanofluidic device only when a forward voltage bias is applied. In this research, we demonstrated a novel nanofluidic diode consisting of asymmetric nanoslits that fine rectified ionic currents. Using the ionic current rectification effect, the device could be further functionalized to perform various biomedical applications such as biosensing (e.g., DNA, protein) and molecule manipulation. We also illustrated the ionic current rectification effect and demonstrated it on the current-voltage characteristics by applying different voltage pulses.

## High-Performance CMOS Transimpedance Amplifier Design for Short Range

**Advisor:** YUE Chik Patrick/ECE

**Student:** LIN Ruixi/ELEC-HR

**(UROP Course: UROP1000, Summer 2014)**

This report describes the design of a transimpedance amplifier (TIA) for a low-noise, low-power, short-range optical communication system. The design exploited the single-ended open loop common-gate TIA configuration in a TSMC 65-nm CMOS process. The circuit consumed only 0.73 mW from a 1-V voltage supply. The Spectre result showed a transimpedance gain of 44 dB $\Omega$ , a -3-dB bandwidth of 10 GHz and an equivalent input referred noise of 6.4 pA/sqrt(Hz).

**Advisor:** YUE Chik Patrick/ECE

**Student:** SOEBRATA Christopher Sebastian/ELEC

**(UROP Course: UROP1000, Summer 2014)**

This project is aimed to examine the basic operation and performance of a transimpedance amplifier IC. The IC is the OPA380, produced by the Texas Instruments. A spice software, which is the Texas Instruments' TINA, is used in order to examine the behavior of the circuit. Simulations would be carried out in order to prove the theories and calculations which are made or published. The experiments would measure the performance of the transimpedance amplifier, such as the gain and bandwidth of the circuit. During the research, it is expected that the researcher would be able to gain a significant knowledge on the varied performance of the transimpedance amplifier.

## Department of Industrial Engineering and Logistic Management

### Empirical Analysis of Electric Vehicle Infrastructure Development, Adoption and Usage Behavior

**Advisor:** MAK Ho Yin/IELM

**Student:** LIU Yifang/IELM

SO Chung Kit/IELM

(UROP Course: UROP1100, Spring 2014)

(UROP Course: UROP1100, Spring 2014)

This project focused on analyzing the electric vehicle usage pattern by modeling the data extracted from the website of the car sharing service company “Car2go” in North America. The main interest was how users choose among all of the cars available for sharing. Several measurable factors that could influence the dependent choice variable were assumed. The modeling and analysis revealed that fuel level was the most significant factor influencing users’ choices, although it was difficult to ignore some of the other influencing factors that combined to form the residue factor.

### Biologically-inspired Simulation of Alarm Perception in the Presence of Loud Background Noise

**Advisor:** SO Richard Hau Yue/IELM

**Student:** MA Jiaxin/IELM

(UROP Course: UROP1100, Spring 2014)

The topic of this research was the “Biologically-inspired simulation of alarm perception in the presence of loud background noise.” Different types of sound files were analyzed using MAP1\_14, a computer program that simulates all stages of the auditory periphery up to the auditory nerve (AN) and into the brainstem. Especially interesting were the differences we found between different sounds, such as classical and rock music.

### Computational Modeling of Hearing

**Advisor:** SO Richard Hau Yue/IELM

**Student:** NATAWIRA Antonius Andrejanto/IEEM

(UROP Course: UROP1100, Summer 2014)

In this project, I examined the firing and spiking patterns of human hearing. I used Matlab Auditory Periphery, MAP1\_14, to analyze the patterns of several recorded sounds. MAP1\_14 can be used to generate the probability and spiking models of auditory nerve behavior for any given stimuli. Furthermore, using the MAP software, the lowest sound level of different frequencies can be measured. The goal of this research was to look for the presence of firing patterns in nerves when sound stimuli are given, and study the responses in the middle and inner ears.

## Prediction of Game Sickness

**Advisor:** SO Richard Hau Yue/IELM

**Student:** WEN Xuanhao/SENG

**(UROP Course: UROP1100, Summer 2014)**

Motion sickness was first defined by Kennedy in 1986 as “a general term for a constellation of symptoms and signs” attributed to an exposure to abrupt, periodic or unnatural accelerations. Regarding the causes of motion sickness, the hypothesis that it is induced by a disagreement between movement perceived by the visual system and that sensed by the vestibular system is widely accepted. As Guo’s thesis (2014) notes, it is possible to stimulate motion sickness under another form of sensory conflict between an expected and an actual motion status. This report presents the process for exploring some algorithms based on the optical flow calculation, which can be used to predict the visually induced motion sickness stimulated by computer game playing (also called ‘game sickness’). The preliminary results showed that the methodology was basically matched with visually induced motion sickness in reality.

## Next Generation Enterprise Planning System

**Advisor:** TSENG Mitchell M/IELM

**Student:** NI Xiaomeng/IELM

**(UROP Course: UROP1100, Fall 2013)**

This project is related to one studying the Next Generation Enterprise Planning System, which requires cooperation with enterprises from various industries. The focus of this project is to help Vogue Laundry develop a more effective evaluation interference for monitoring its drivers, trucks, customers and the laundry flow. Data were collected from the client and, most importantly, information was extracted from the raw material to establish a feasible solution. For this specific project, Excel and Database Management were required to satisfy the client’s demand. In addition to the technical part and unlike the other research project, Professor Tseng’s project on the Next Generation Enterprise Planning System involves close cooperation with the client companies, and thus communication and negotiation skills play an essential role in the final result.



## Statistical Quality Control in Modern Industry

**Advisor:** TSUNG Fugee/IELM

**Student:** ZHANG Yundi/CIVL

**(UROP Course: UROP1100, Fall 2013)**

Three-dimensional (3D) printing, a fast-developing technology, is said to be leading the third industrial revolution. However, the dimensional inaccuracy of 3D printing products is a significant problem that hinders the popularization of the technology in industries that require high quality. Our group research focused on one of the cheapest 3D printing machine, the fused decomposition modeling (FDM) machine. We tried to use statistical quality-control methods in the model to compensate for the dimensional errors and improve the quality of the printed products. I analyzed a simple cylinder printed by the machine, and modeled its dimensional errors.

*Keywords—Statistical quality control; 3D printing; dimensional inaccuracy; fused decomposition modeling machine; FDM; nonlinear optimization.*

## Department of Mechanical and Aerospace Engineering

### Double Perovskite Sensors for the Automotive Industry

**Advisor:** CIUCCI Francesco/MAE

**Student:** JIANG Chunli/SENG

**(UROP Course: UROP1000, Summer 2014)**

This research developed the entire experimental procedure for and a brief analysis of the new oxygen sensor double perovskite material  $\text{PrBa}_{0.95}\text{Co}_{2-x}\text{Nb}_x\text{O}_{5+\sigma}$  ( $x=0.25, 0.50, 0.75, 1.00$ ) (PBCN). As a samarium-doped ceria electrolyte disc, the PBCN symmetric cell and conductivity test bricks were well fabricated before the test. A potentiostatic electrochemical impedance spectroscopy (PEIS) test with a temperature varying from 450-800°C for every 50°C and an oxygen proportion varying from 0-100% was used to investigate the area specific resistance (ASR) of prepared symmetric cells in a range of situations in a gas-controlled heating furnace. Meanwhile, the conductivity of PBCN bricks were tested by 4-probe conductivity measurement. The performance of PBCN with different niobium-doped ratios were observed and analyzed.

*Keywords—double perovskite; fabrication; Area specific resistance; conductivity; performance.*

### Electrochemical Characterization and Evaluation of Thin Film Cathodes for Solid Oxide Fuel Cells

**Advisor:** CIUCCI Francesco/MAE

**Student:** DU Xiaohan/MEGBM

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

The bootstrap method, an intensive statistical tool, has already been applied in many research fields. In this report, we focus on the application of the bootstrap method to electrochemical impedance spectroscopy (EIS) data for a solid oxide fuel cell (SOFC) thin film cathode made of  $\text{SrNb}_{0.1}\text{Co}_{0.9}\text{O}_{3-\delta}$  (SNC), and to that of a commercialized Li-ion battery ( $\text{LiCoO}_2$ ).

## Engineering Design in the Stochastic Distributed Setting

**Advisor:** CIUCCI Francesco/MAE

**Student:** ROTANSON Jason/SENG

**(UROP Course: UROP1000, Summer 2014)**

Engineering systems are typically complex and involve multi-objective optimization, which manages several conflicting variables that need to be optimized by each designer with the ultimate goal of finding the Pareto frontier, which consists of Pareto-optimal points. In recent years, numerous algorithms have been created and developed to find a more efficient method for reaching the Pareto frontier. This report focuses on the stochastic method, in which an algorithm is applied to test problems found in the literature that are commonly used to benchmark algorithmic performance. Furthermore, the results of the algorithm are evaluated to determine its strengths and weaknesses for further improvement.

**Advisor:** CIUCCI Francesco/MAE

**Student:** ZHANG Yizhe/MAE

**(UROP Course: UROP1100, Spring 2014)**

In many engineering systems, multi-objective problems with conflict objectives are considered for optimization. Finding Pareto-optimal solutions is always the goal of multi-objective optimization. In this report, different evolutionary stochastic algorithms were applied to solve multi-objective problems, mainly based on “sum of squares within” methods. Testing examples were used to prove the methods’ performance, and the results were visualized to enable comparisons of the efficient front obtained for two- and three-objective test problems. The strengths and weaknesses of these approaches are also discussed, so that the algorithms can be improved and a well-distributed Pareto set can be accurately found with fewer iterations.

## Modeling Solar Thermal Fuel Generation

**Advisor:** CIUCCI Francesco/MAE

**Student:** ZENG Zezhi/MAE

**(UROP Course: UROP1200, Fall 2013)**

The amount of solar energy being generated is in excess of present energy consumption. The effective conversion of this renewable intermittent resource into chemical fuel offers a sustainable energy future. The efficiency of conversion, however, may be relatively low. In this project, a model of electrocatalysis in a representative reactor was developed, featuring oxygen, hydrogen and water transport in the gas phase, along with diffusion in the solid phase and surface kinetics. Understanding how the gases diffuse in the porous reactor significantly contributes to controlling the reaction and maximizing the efficiency. More specifically, the defect chemistry model was used to analyze the details of the reaction and diffusion processes.

## Photon Up-conversion for Efficient Solar Energy Harvesting

**Advisor:** HUANG Baoling/MAE

**Student:** CHEUNG Yung Shan/MAE

**(UROP Course: UROP1100, Fall 2013)**

Energy is required to excite an electron into moving from the valence band to the conduction band, and only photons of energy larger than the band gap can produce a photoelectron, whereas others are wasted. The up-conversion of the near-infrared photon is a promising method for reducing the spectrum loss in this region. Photon up-conversion is the process of converting a long-wavelength photon into a short-wavelength emission. However, the up-conversion spectrum of commonly used materials is narrow and weak, and thus it does not contribute much to light harvesting. Following the concept of dye-sensitized up-conversion accompanied by a perfect black reflector, this barrier might be overcome. This research aimed to study up-conversion efficiency under the assistance of a set of near-infrared dye antenna binding on the up-converter; that is,  $\beta$ -NaYF<sub>4</sub>:Yb,Er nanoparticles. Due to time limitations, this report only proposes potential testing and provides the theoretical expectations of the study.

**Advisor:** HUANG Baoling/MAE

**Student:** ZHAN Xucong/MAE

**(UROP Course: UROP1100, Spring 2014)**

Up-conversion (UC) is an optical process in which a lower-frequency photon is absorbed and a higher-frequency one is emitted. The basic mechanism is that an ion with more than one energy level absorbs two or more photons, which leads to electron transition across more than one energy level. When the electron comes back to the ground state, a light at a shorter wavelength is emitted; that is, there must be a number of intermediate states to accumulate the energy from low-frequency light to reach a higher energy level. This upconversion of photons therefore provides an approach for enhancing the efficiency of a photovoltaic device. This project is to explore the feasibility to develop a design based on photon upconversion for high-performance photovoltaics.

## Development of Endoluminal Devices

**Advisor:** LAM David C C/MAE

**Student:** CAI Yaxiong/MAE

**(UROP Course: UROP1100, Spring 2014)**

Stroke is the second leading cause of death worldwide, and one of the leading causes of permanent disability. To treat stroke, a local clot dissolution device (LCDD) was developed by HKUST communities in late 2012. It has the merit of delivering medication to locally dissolve a blood clot and minimize the associated side effects. However, the mechanism of dissolution between the fluid drug and the clot remains unknown. In this project, the aforementioned mechanism of dissolution was investigated. To determine the quantitative relationship between the clot weight reduction rates during time revolution under fluid drug dissolution, a series of experiments were designed and optimized. Currently, the optimized experiment design can successfully capture the weight reduction rates using sugar as sample, with weight similar to clot (0.12 g). It was also observed that a boundary layer of dissolved clot would form around the clot, preventing further dissolution of the clot inside the boundary layer. In the next step, the clot will be treated as a sample using the optimized experimental setup. If the clot weight reduction rates can also be obtained with high repeatability, optimized feeding patterns to dissolve the clot with maximum efficiency can then be obtained using various feeding rates.

*Keywords—Stroke; Mechanism of clot dissolution; Local Clot Dissolution Device(LCDD); Experiment design.*

## Design and Fabrication of a Microfluidic CTC Chip for Cancer Diagnostics

**Advisor:** LEE Yi-Kuen/MAE

**Student:** MA Shuo/MAE

**(UROP Course: UROP1100, Summer 2014)**

To study the flow of plasma in the micro channel, a solution of polyvinylpyrrolidone (PVP) in phosphate buffer solution (PBS) is used to stimulate the plasma and measure the viscosity. In this experiment, the Ubbelohde viscometer was used for the viscosity measurement. The measuring and calculation revealed that the density of the solution did not converge, but rather it dropped at some point between 20% PVP in PBS solution. The viscosity of the solution continued to rise with the PVP concentration. Once the PVP-PBS solution was created to stimulate the plasma, the cells were cultured in different types of solutions to test their influence on viscosity. The public software, CellProfiler, was used to obtain the data on cell size and viability from the pictures taken after the experiment. Similar to counting the cell viability, the input modules and the first two modules of the analysis were the same. The measure object size shape modules were used to measure cell size instead of the reassign object number module. In the former, the mean minimum and mean maximum ferret diameters were obtained, and the average of these two properties was used to represent the diameter of the cell.

**Advisor:** LEE Yi-Kuen/MAE

**Student:** TANG Chen/MAE

**(UROP Course: UROP1100, Spring 2014)**

Circulation tumor cells (CTCs) have drawn attention from researchers for their potential value in cancer diagnostics. Copious research has been done to develop different systems capable of isolating the circulation of tumor cells in blood samples so that the enriched CTCs can be further used to diagnose cancer or for other relevant purposes. The microfiltration device is one such system with some attractive advantages. This project attempted to establish a model describing the relationships among the various parameters of microfiltration and its performance to provide a reference for the further development of microfiltration CTC chips. This report focuses on the packaging of the microfiltration device and the inspection of PC membranes.

### **Development of a Microfluidic System with Feedback Control for High-Throughput Screening in Traditional Chinese Medicine**

**Advisor:** LEE Yi-Kuen/MAE

**Co-advisor:** TSIM Karl Wah Keung/LIFS

**Student:** LEE Cheuk Ngai Aaron/SENG

**(UROP Course: UROP1000, Summer 2014)**

Recent research on the use of a feedback system control (FSC) scheme in optimizing flavonoid combination, a type of traditional Chinese medicine (TCM), has reported significant success. Subsequently, this research used engineering methods to run a small number of trials designed to optimize the combination of Qing-E pills, a well-known type of TCM. The result could save a large amount of time and money. With an increasing number of successful experiments in this field, such research also suggests the possibility that most TCM can be optimized using this method.

### **Biomimetic Design of Flexible Flapping Wings for Micro Air Vehicles**

**Advisor:** QIU Huihe/MAE

**Student:** GAUTAM Aishwarya/MAE

**(UROP Course: UROP1100, Fall 2013)**

Two experiments were performed in relation to the fabrication of wings for a micro air vehicle. The first experiment, particle image velocimetry, replicated a peer-reviewed experiment to achieve similar results. To that end, this report briefly describes the original experiment and then provides an analysis of the experimental setup and the results. Then, the second experiment is described; that is, the analysis of a dragonfly's wings through a high-speed camera at 1000 fps. Some of the experiments' shortcomings are identified and suggestions are made for future improvements.

**Advisor:** QIU Huihe/MAE  
**Student:** LEUNG Liang Kim/MAE (UROP Course: UROP1100, Fall 2013)

Pressure sensitive paint (PSP) is a recently developed fast and relatively inexpensive method of measuring aerodynamic pressure on airborne objects. This project aimed to investigate the practicability of using PSP in a flapping wing vehicle aerodynamics experiment. Computational fluid dynamics (CFD) simulations and wind tunnel experiments were conducted to estimate the total gage pressure on the flapping wing, and the results obtained were compared with each other and with the findings of the Clark Y wing CFD simulation. Unfortunately, the PSP technology may not be powerful enough at this stage for a flapping wing vehicle aerodynamics experiment. However, there were errors due to the assumptions and experimental constraints, so further investigation is recommended.

**Advisor:** QIU Huihe/MAE  
**Student:** LV Guanda/MAE (UROP Course: UROP1000, Summer 2014)

This project explored the biomimetic design of flexible flapping wings for micro air vehicles. Before the experiment, different materials were used to fabricate the flapping wing models with different sizes and surfaces (different  $r$  and AR). In the experiment, the effects of fluid dynamics such as leading-edge vortex (LEV) were observed and analyzed. The major experiment applied particle image velocimetry measurement, using an electric motor to drive the rotation of flexible wings in a water tank filled with hollow glass beads of 1-5 micrometers. A laser transmitter and camera were applied to photograph the continuous global flow field and a unique computer program was designed to simulate the flow field using these photos. In the other minor experiment, one more electric power supply was used to electrolyze the water near the flexible wing to generate gas bubbles. The fluid dynamics of the wing could be observed in the fluid field revealed by the vaporific bubbles in motion.

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

**Advisor:** QIU Huihe/MAE

**Student:** KUMAR Mayank/MAE

(UROP Course: UROP1000, Summer 2014)

LIYANTO Henry/MAE

(UROP Course: UROP1000, Summer 2014)

The first part of this research analyzed the flapping wings phase difference angle of the free-flying dragonfly during its take-off. The results showed that the phase difference was not constant during different strokes, and it varied between  $50^\circ$  and  $8^\circ$ . This result was used to perform a particle image velocitometry (PIV) experiment to observe and analyze the flow around a pair of rigid glass wings for the simulation of a dragonfly's different flight modes. In this experiment, we tried to simulate the flight mode in which the dragonfly's forewings change their phase in the mid-flap while the hind wings maintain constant speed. The forewings always lead the hind wings, but they eventually come back in phase at the top, original position. The pair of glass wings were driven by two water-proof servos connected to an Arduino microcontroller, and processed into vector plots and vorticity contours. In this experiment, we found that in upstroke motion, during which the constant speed of the hind wings catches up with the slower forewings, the intensity of vorticity on the trailing edges of the hind wings and the leading edges of the forewings was noticeably higher than that on the edges closer to another wing. As for the down strokes, during which the forewings are twice as fast as the hind wings, shed vortices occurred on the trailing edges of the forewings. A higher intensity of vorticity, compared with the hind wings, was also clearly observed there.

*Keywords—Flapping Flight; Micro Aero Vehicles; Wing-Wake Interaction; Tandem Wing Configuration.*

## Development of Novel Icephobic Surfaces for Anti-frosting and Defrosting

**Advisor:** YAO Shuhuai/MAE

**Student:** ZHOU Peng/SENG

(UROP Course: UROP1000, Summer 2014)

Vast efforts have been made to find passive ways of solving the industrial ice formation problem. Scientists have created surfaces with low energy density and nanoglass texture exhibiting superhydrophobic properties that have been applied to some icing situations. However, whether such superhydrophobic surfaces achieve icephobicity remains unknown. Some research has shown that superhydrophobicity can be weakened in low temperature situations. Other studies have found that the high contact angle hysteresis of coating materials can significantly increase ice shear strength. Thus, we proposed a hybrid surface morphology containing both superhydrophobic nanoglass and hydrophilic pillars. Both the theoretical calculation and experimental results implied better performance than that of surfaces with just superhydrophobic nanoglass. This new surface design could prove especially useful in mechanical structures where a high heat transfer coefficient and icephobicity are required.



## Measurement of Liquid—Liquid Interfacial Tension in a Microfluidic Device

**Advisor:** YAO Shuhuai/MAE

**Student:** YAO Yuan/MAE

**(UROP Course: UROP1100, Fall 2013)**

This report describes a detailed analysis of the droplet synchronization process using two parallel railway-like micro channels to optimize the synchronization period and methods for different droplet sizes. Based on data from “water in oil” synchronization experiments obtained from a stroboscopic camera, we used Matlab image processing programming to analyze the time-varying separation distance between two droplets and the change in speed, respectively. As for droplets of different sizes, the outcome indicated that there exists a critical size difference, below which the two droplets finally meet an equilibrium state. As for two droplets of the same size, passive synchronization can be rather difficult and a special channel trap was needed to speed up the process. These results show the feasibility of the passive synchronization method using ladder-like channels.

*Keywords—droplet synchronization; Matlab image processing; ladder-like channels; time-varying separation distance.*

## Study of Condensation Dynamics in Microchannels with Superhydrophobic Nanostructures

**Advisor:** YAO Shuhuai/MAE

**Student:** YAO Yuan/MAE

**(UROP Course: UROP1100, Spring 2014)**

This report developed a detailed analysis of the condensation enhancement principle of nanostructured surfaces and the experiment setup design to quantify such condensation and heat transfer facilitation. By controlling the purity, temperature, pressure and flow rate of the vapor import based on specific boiler and valve design, the condensation and heat transfer rates were measured under pure water vapor conditions. It was hypothesized that the droplet jumping phenomenon associated with such nanogrased surfaces would enable continuous condensation to produce a bigger heat transfer rate, which would have great potential in industrial cooling applications.

*Keywords—Superhydrophobic; Condensation enhancement; Nanostructure; Jumping surface phenomenon.*

## Study of Dropwise Condensation on Nanoengineered Surfaces for Enhanced Thermal and Water Harvesting

**Advisor:** YAO Shuhuai/MAE

**Student:** GAUTAM Aishwarya/MAE

(UROP Course: UROP1100, Spring 2014)

An experiment was conducted to analyze the homogenous nucleation of water droplets. The project was concerned with fabricating the apparatus needed to obtain temperatures  $\sim -40^{\circ}\text{C}$  to observe supercooling. To that end, the report first provides a brief description of the theory behind homogenous and heterogeneous nucleation, followed by a literature review of a similar study that was conducted in 2009. Finally, the experimental procedure for the Si-Si bonding is described and the future objectives for the project are identified.

**Advisor:** YAO Shuhuai/MAE

**Student:** HAN Zhuofei/MAE

(UROP Course: UROP1200, Fall 2013)

When condensed droplets coalesce on a super-hydrophobic nanostructured surface, the resulting droplets can jump from the surface due to the release of excess surface energy. If designed properly, these superhydrophobic nanostructured surfaces can not only allow for easy droplet removal at micrometric length scales during condensation, but also promise to enhance heat transfer performance. However, much of the preliminary research has indicated a counterintuitive decrease in condensation heat transfer on nanostructured surfaces in vapor chamber condensation experiments. Because the film-wise condensation forms on the nanostructured surface in a high heat flux and saturation pressure environment, the surface energy released from the coalescence of condensate droplets cannot overcome the energy barrier for the Wenzel to Cassie transition due to the strong pinning of the film-wise condensate. Nevertheless, nanostructured superhydrophobic surfaces show significant condensation heat transfer enhancement in a low saturation pressure environment, which provides an approach to increase efficiency for applications such as atmospheric water harvesting and dehumidification. This project aimed to build an experimental setup to evaluate the thermal characteristics of nanoengineered surfaces at a low saturation pressure.

*Keywords—superhydrophobic; nano grass; condensation; water harvesting.*

## Experimental Demonstration of Shape Effect on Knudsen Force

**Advisor:** YE Wenjing/MAE  
**Student:** BHOOSNURMATH Hemant/MAE (UROP Course: UROP1100, Fall 2013)  
TRIPATHI Siddhant/MAE (UROP Course: UROP1100, Fall 2013)

A Knudsen force is a force originating from a phenomenon called thermal transpiration across a porous surface due to a temperature gradient across the surface. If the force is profound enough, it may cause the surface to move or rotate if mounted on a spindle. A Crookes radiometer uses this force to work as a heat engine. The main aim of this research was to analyze the dependence of the direction of this force on the shape of the vanes used in the radiometer. It also analyzed the effect of changing other parameters such as the vanes' material, their initial position and orientation, the position of the light source, etc.

**Advisor:** YE Wenjing/MAE  
**Student:** FENG Chenxi/SENG (UROP Course: UROP1000, Summer 2014)  
LIU Xi/SENG (UROP Course: UROP1000, Summer 2014)

Knudsen force is a mechanical force induced by a non-isothermal temperature field. This project analyzed the dependence of the direction of this force on the shape of the vanes used in the radiometer. A setup similar to a Crookes radiometer was built and vanes of different shapes were designed and manufactured. Upon exposure to sunlight, the vanes were heated, but to different degrees, and hence the Knudsen forces created varied, resulting in different responses. The results of such experimental demonstrations can be used to prove a proposed hypothesis.

## Studies of Fluid Turbulence Using High Performance Computing

**Advisor:** YEUNG Pui-kuen/MAE  
**Student:** LYE Wilson Wei King/MAE (UROP Course: UROP1100, Spring 2014)

Turbulent flows occur in our everyday lives. The word turbulence indicates the randomness and uncertainty of any flow. Due to the randomness of flow, turbulence can enhance transport and fluid mixing, and thus might serve as an important area of research, especially when applied to combustion chamber studies and air quality control. By applying statistical studies and direct numerical simulations, the probability of the flow properties can be estimated, enabling the prediction of weather conditions and even the pathways of tornados. In this UROP, I learned some of the basics about turbulence and applied direct numerical simulation to plot probability and joint probability density function graphs and study the behavior they revealed.

**Advisor:** YEUNG Pui-kuen/MAE

**Student:** TSOI Ka Wai/MAE

**(UROP Course: UROP1100, Spring 2014)**

Turbulent flows refer to flows that are unsteady, irregular, seemingly random and chaotic. The velocity field varies irregularly in both position and time. Research on turbulent flows has proven challenging due to the unpredictability and unrepeatability of experiments. However, turbulent flows significantly influence human life because they exist everywhere, such as in the atmosphere, oceans, rivers and so on. Moreover, many applications and technologies use the special properties of turbulent flows. Therefore, new knowledge of turbulent flows is desired and would assist novel technological advancements.

### Material Development for 3D Printing

**Advisor:** YUEN Matthew Ming Fa/MAE

**Co-advisor:** KWAN Charles Chi-Fong/MAE

**Student:** CHEN Wenhao/MAE

**(UROP Course: UROP1100, Spring 2014)**

The three-dimensional printing of high-speed steel by selective laser melting has wide potential applications. This project aimed to improve the mechanical properties of high-speed steel by applying ultrasound. As part of a project preparing the laser melting experiment, an ANSYS simulation was conducted to discover the heat distribution of the steel under a moving laser heat source. A feeder system to spread the metal powder was designed and manufactured and the feeder control system was setup and tested. Laser melting can start once the whole feeder system is embedded in the working platform.

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## Department of Accounting

### Global Macro Analysis

**Advisor:** LI Xi/ACCT

**Student:** CHEN Shidie/ECOF

**(UROP Course: UROP1000, Summer 2014)**

As numerous studies have proposed, the macroeconomic index (i.e. inflation, real interest rate, real estate market) is correlated with stock returns, and thus is widely used when making investment decisions. Instead of establishing a complex model and using historical macroeconomic data to test its possible effect on stock returns, this research focused on the periods divided by the transition points of several important indices. By comparing the performance of various Hong Kong industries during the 1997–2013 period, the intention was to identify industries that are sensitive to specific economic situations in the hope that the findings may provide suggestions for future investment decisions. Ongoing research may continue to analyze the data of each stock when considered necessary.

**Advisor:** LI Xi/ACCT

**Student:** CHEN Zhiyu/SBM

**(UROP Course: UROP1000, Summer 2014)**

This project focused on inflation in emerging and developed markets ([http://www.msci.com/products/indexes/country\\_and\\_regional/dm/](http://www.msci.com/products/indexes/country_and_regional/dm/)), and its analysis was based on correlation analysis. The data were retrieved from the World Bank and IMF databases on an annual basis, from 1960 to 2013. The tools used in the analysis were Excel and VBA. The report for this project describes the data sources and analysis procedures for the different variables.

**Advisor:** LI Xi/ACCT

**Student:** LAM Chi Kit Edward/ECOF

**(UROP Course: UROP1000, Summer 2014)**

WANG Yuan/SSCI

**(UROP Course: UROP1000, Summer 2014)**

In this research project, we focused on analyzing Japanese news and economic data to identify underlying reasons for the variations in the 10-year Japanese Government Bond (JGB) yield. During this process, we studied different economic data, including population growth rate, inflation rate and consumer price indices, to understand the Japanese economy in the previous decades. We also studied past financial news, mainly *Wall Street Journal Asia* via ABI Info and Microfiche, to identify specific reasons for the sudden reversal in yield curve during the downward trend from over 8% in the early 1990s to below 2% in the late 1990s.

**Advisor:** LI Xi/ACCT  
**Student:** LAM Kai Yan/SBM (UROP Course: UROP1100, Spring 2014)

This report reviewed global macro data collected over the past few months to discuss the trends in the global economy, particularly the Hong Kong market. The aim of this “Global Macro Analysis” was to gain insight from the historical performance of different regions and sectors. Part I introduced the data sources used in this project and the relevant concepts studied. Part II presented investment cases that were analyzed by applying the concepts discussed in Part I. Part III focused on an industry analysis of both Hong Kong and Brazil. Part IV featured an industry-specific analysis of real estate in Hong Kong and Australia.

**Advisor:** LI Xi/ACCT  
**Student:** WU Suo/SBM (UROP Course: UROP1000, Summer 2014)

This project aimed to discover the relationship between government bond yield spread and the financial industry stock markets’ performance in the ‘Fragile 8’: Chile, Indonesia, South Africa, Turkey, India, Brazil, Argentina and Russia. As debt corresponds with high long-term interest rates and credit with low short-term interest rates, we made the assumption that the term structure of the 10Y-1Y government bonds’ interest rate shares the same trend with the price of financial industry stocks, represented by the MSCI indices of banks, diversified financials, insurance and real estate at the country level. By studying the relationship between these two, it will be possible to predict the stock performance of financial companies based on the term structure in the long run.

## The Impact of Investment Bank Ownership in Venture Backed IPOs on Analyst Recommendations

**Advisor:** LI Xi/ACCT  
**Student:** CHANG Xinwen/SBM (UROP Course: UROP1000, Summer 2014)  
CUI Yunpeng/SBM (UROP Course: UROP1000, Summer 2014)  
JIANG Yihong/SBM (UROP Course: UROP1000, Summer 2014)  
KA Chun Hang/SBM (UROP Course: UROP1000, Summer 2014)

This project investigated whether bank ownership in venture capital-backed initial public offerings (IPOs) creates conflicts of interest or certification effects when stock recommendations on the venture capital-backed IPOs are made by banks’ analysts. Due to ownership in venture capital-backed IPOs, banks are more likely to have information that makes it possible for them to exploit outside investors by inflating the stock prices. Moreover, they can share the information with outside investors if they want to purchase at a fair price. To examine this empirical question, we used SDC to download the list of venture capital-backed IPOs from 2001, collected information from the IPO prospectus on bank ownership and matched it with I/B/E/S recommendations. Our final results mainly consisted of equity ownership and loans.

## Financial Information and Equity Valuation

**Advisor:** YOU Haifeng/ACCT

**Student:** CHUI Wing Hong/ QFIN

TIAN Xiaoxiao/ECOF

**(UROP Course: UROP1100, Fall 2013)**

**(UROP Course: UROP1100, Fall 2013)**

In this project, we examined the role of financial information in equity valuation. We examined financial statements from a unique perspective from the traditional methods generally adopted by analysts. By breaking down and reintegrating line items, we managed to generate a set of purified financials that provided more rigorous forecasts of future financials to better serve the valuation purpose. We then used stock simulation to test the effectiveness of the trading strategies based on the aforementioned new financial information, by comparing realized returns both over different investment horizons and across different portfolios. In this research report, we discuss the new financial statement analysis methodology and then share what we discovered about the implications of financial information on trading strategies.



## Department of Economics

### Firms in Globalization: Evidence from China

**Advisor:** LI Yao/ECON

**Student:** CUI Yiye/MAEC

**(UROP Course: UROP1300, Fall 2013)**

In this research, we examined the agglomeration and coagglomeration levels in Chinese industries. We found, first, that the overall agglomeration level in China initially increased, and then slowed down or even dropped slightly. The agglomeration level increased from a 2-digit level to a 3-digit industry level and from the city to the province level. Second, we ran a comparison in the agglomeration index between foreign and local firms in identical industries. Not only were the foreign firms more agglomerated than their local counterparts in the same industries, but also the former experienced faster growth in the sense of agglomeration. Third, the overall coagglomeration level was negative throughout the sample, such that a negative coagglomeration index meant that those two industries were “more” dispersed than with random distribution. Fourth, the most coagglomerated industry pair was quite persistent.

**Advisor:** LI Yao/ECON

**Student:** HAO Yijun/ECOF

**(UROP Course: UROP1100, Summer 2014)**

In this project, we focused on the relationships between the research and development (R&D) of parent companies and the labor intensity of affiliated firms. To test our hypothesis that R&D-intensive companies usually have labor-intensive affiliates, we used some empirical evidence from Taiwanese companies and their investees in mainland China gathered using the data analysis software “State.” First, we updated the whole dataset to 2009 using different criteria, based on previous matching results and newly available data. Second, to better understand some of the key variables related to the trade mode, we reviewed the literature on the differences between ordinary and processing trades. Finally, using the largest dataset on hand, we studied the data with several analysis techniques, tested the hypothesis for companies with different trade modes and compared the behavior of hybrid firms with processing to that of ordinary firms. In conclusion, the hypothesis did not hold, and the hybrid firms acted more like processing. The report for this project introduces the methodology and analyzes the results in detail.

**Advisor:** LI Yao/ECON  
**Student:** HON Wai Kin/FINA (UROP Course: UROP1100, Spring 2014)

Globalization has played an important role in recent economic development worldwide, from the West to the East. In response to Klette and Kortum's article, "Innovating Firms and Aggregate Innovation," we searched for similar patterns and stylized facts in the Western and Eastern economies. Data were collected in China to analyze the similarities and differences in the several factors of development for firm aspects such as distribution, growth and survival rates.

**Advisor:** LI Yao/ECON  
**Student:** KAN Chen/ECOF (UROP Course: UROP1100, Fall 2013;  
UROP1200, Summer 2014)

Under the trend of globalization, agglomeration has become increasingly common around the world, which means that factories in similar industries tend to stay in the same region. This project focused on the agglomeration phenomenon in different Chinese industries. First, we expanded the CIE data we had and conducted some necessary disposal to get the information we needed. Then, we took the agglomeration index of each industry in China and analyzed it for trends. The main tool of analysis was STATA software. The report for this project describes the process of constructing samples and conducting the analysis, and presents the results. The problems encountered are also mentioned.

**Advisor:** LI Yao/ECON  
**Student:** LAW Yue Hin Keith/ECON (UROP Course: UROP1100, Fall 2013)

This progress report aimed to demonstrate what the project participants achieved during the project period. It detailed how the project was structured and how tasks were assigned by the supervisor. The project was divided into two parts: a literature review and a data analysis. Over approximately 14 weeks, the participants achieved several outcomes and created products, documents or files to showcase their progress. The achieved targets and documents produced are also shown in this report, along with the results of the data analysis (e.g. tables and figures). Finally, a summary of what the student learned is provided.

**Advisor:** LI Yao/ECON  
**Student:** LI Chi Ho/ECOF (UROP Course: UROP1100, Summer 2014)

Taiwanese firms have been investing in mainland China and setting up affiliated firms in recent years. To analyze the parent-affiliated firm relationship, past students created a structured dataset regarding Taiwanese parent firms and their affiliated firms from 2000 to 2008. Given the 2009 Chinese industrial enterprise dataset, the current dataset was updated by different matching methods. Then, the relationship between parent firms and affiliated firms with different trade modes was analyzed. This report focuses on the matching process for the 2009 observations, and the analysis approach to the trade modes.

**Advisor:** LI Yao/ECON  
**Student:** WONG Tai Wai/MAEC (UROP Course: UROP1100, Summer 2014)

Taiwanese invested firms in mainland China's electronics industry have shown an increasing trend in trade. In this project, a cross-sectional analysis was used for the dataset. The hypothesis, that parent firms with relatively higher research and development intensity or shares have affiliated firms with relatively lower labor shares, was tested based on the data between 2000 and 2008. The newly merged data from 2009 were excluded due to missing EMP values. The hypothesis was also tested in relation to different import and export types, respectively, to find any similarities between ordinary, processing and hybrid trades. The report also covers the process of merging the 2009 data into the master file.

**Advisor:** LI Yao/ECON  
**Student:** XIA Yicong/ECOF (UROP Course: UROP1200, Fall 2013)

This report summarized the research results from the 2013 fall semester, with a focus on the following actions: investigating the degree of coagglomeration for industries in China using data collected from 1998 to 2008, calculating the geographic agglomeration and matching two datasets to see whether one is a subset of the other.

**Advisor:** LI Yao/ECON  
**Student:** XU Hao/ECOF (UROP Course: UROP1100, Spring 2014)

This report summarizes my proceedings and findings for the UROP1100H project, *Firms in Globalization: Evidence from China* (2014). In this project, data from Chinese manufacturing firms in 1995, 2004 and 2008 were used to verify Facts 7-9, as listed in Appendix A of *Innovating Firms and Aggregate Innovation* by Tor Jakob Klette and Samuel Kortum. The investigation proved that the findings from Chinese manufacturing companies in 1995, 2004 and 2008 were consistent with our facts. This report presents the data construction process and shows the consistency with facts about the entry, exit, growth and size distribution of firms.

**Advisor:** LI Yao/ECON  
**Student:** YAN Mingyang/ECOF (UROP Course: UROP1000, Summer 2014)

Multinational firms play an important part in facilitating international technology diffusion. This research focused on the technological link between Taiwanese parent firms and their affiliates in China's electronics industry. Anteceding the analysis of this technological link, the existing dataset was expanded from 2008 to 2009. This update comprised two parts. The first was to find the updates of the affiliates in the existing dataset. Second, a record of Chinese affiliates in 2009 from Taiwan was used to ensure that new affiliates appearing in 2009 were not missed. T-tests were used to determine whether parent firms with relatively intensive research and development expenditure had affiliates that were more labor intensive.

**Advisor:** LI Yao/ECON  
**Student:** YANG Haoming/FINA (UROP Course: UROP1100, Spring 2014)

This report summarizes the progress and findings of my UROP1100A project entitled “*Firms in Globalization: Evidence from China*” (2014). I used data from China’s manufacturing sector from in 1995, 2004 and 2008 to examine the consistency of the 10 stylized facts listed in “Innovating Firms and Aggregate Innovation” by Tor Jakob Klette and Samuel Kortum, regarding America and China.

*Keywords—stylized facts; Chinese firms.*

**Advisor:** LI Yao/ECON  
**Student:** YUAN Yixuan/SBM (UROP Course: UROP1100, Spring 2014; UROP1000, Summer 2014)

This report summarizes the proceedings and findings of my project, *Firms in Globalization: Evidence from China* (2014). The process focused on matching the data from both mainland and Taiwanese sources and testing the hypothesis regarding the relationship between parent firms and affiliated firms. The matching process aimed to provide an expanded database for further testing tasks. The testing was conducted at the parent firm, child firm and trade mode levels. Several methods were used to expand the TIF data file by matching with key variables representing unique firms and the keyword of each enterprise name. Moreover, a preliminary examination was conducted of the correlation between parent firms’ research and development (R&D) input in Taiwan and affiliated firms’ labor input in mainland China. The findings showed that when parent companies are more R&D intensive, most of their affiliated firms are less labor intensive, with the exception of some outliers. This fact was tested at three different levels.

**Advisor:** LI Yao/ECON  
**Student:** ZHANG Ye/MAEC (UROP Course: UROP1100, Fall 2013)

This progress report reviews the method used to refine raw data using STATA, and summarizes the situation, in which the raw data were provided by our supervisor. Our supervisor provided us with a huge data file containing more than two million pieces of information about roughly 680,000 various Chinese firms. We had two tasks: to refine the huge amount of raw data, including filling in the missing data based on the existing reasonable parts and marking different types of data after the refinement, and to summarize the situation of these raw data in the form of statistical tables, which contained the percentages and amounts of reasonable data to judge whether the file could be used for further research. During the process, STATA was used as the principle tool for processing the data.

**Advisor:** LI Yao/ECON  
**Student:** ZHOU Feng/FINA

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

This project aimed to investigate the locational behavior of a group of mainland Chinese firms. The statistics software STATA was used to analyze the firm data of Chinese industrial enterprises, as provided by the supervisor. Some special STATA commands were involved in this project. Corporate name (CRC), industry type (INDTYPE), firm employment (PERSENG), reporting year (YEAR) and location code (LC) were the variables most frequently used. The concrete focus of this project was the agglomeration behavior; that is, the relative geographic concentration of different industries.

**Advisor:** LI Yao/ECON  
**Student:** ZHU Hanjing/ECOF

**(UROP Course: UROP1100, Fall 2013)**

Foreign investment has always been a non-neglected part of China's economy. This project continued the research conducted last summer on Taiwanese invested electronics firms in mainland China. Our work was divided into two parts. During the first half of the semester, we used the data to analyze the import and export conditions of these firms, such as how much import and export in China contributed to Taiwanese investment firms and whether the type of firm was correlated with large import or export volume, etc. In the second half, we emphasized the research and development (R&D) side. We tested whether certain types of firms were more likely to put money into the R&D sector, and what types of firms were willing to spend more on R&D. We used STATA for the data arrangement and mining process, including regression. This report presents the processes of constructing different samples and summary or different regression analyses, in addition to the conclusions based on the results.

## Research on Emerging Markets

**Advisor:** PARK Albert Francis/ECON  
**Co-advisor:** VRISHALI/ECON  
**Student:** CHIU Kwok Yan/MAEC

**(UROP Course: UROP1100, Spring 2014)**

This research focused on the effect of minimum wage in some emerging economies including Brazil, Russia, India, China, South Africa, Mexico, Indonesia, Nigeria, Turkey and Hong Kong. It started with a policy review of the minimum wage laws in these economies, and then incorporated the changes in the real value of the minimum wage, along with the changes in unemployment rates, into an analysis. The results showed that there was no significant relationship between minimum wage and unemployment. Possible explanations are also discussed.

**Advisor:** PARK Albert Francis/ECON  
**Co-advisor:** VRISHALI/ECON  
**Student:** HUANG Yuxi/MAEC (UROP Course: UROP1100, Spring 2014)

Climate change is becoming an increasingly serious problem. As industrial development advances, global warming exacerbates the increases in carbon dioxide emissions. The climate change problem is especially severe in developing countries, as they rely more heavily on the manufacturing industries. To cope with the problem, developing countries such as Brazil, China and India have taken steps, including legislation, the release of guidance or plans, the formation of dedicated government or non-government organization and international cooperation. The time lines of the actions taken by Brazil, China and India are summarized in this report.

**Advisor:** PARK Albert Francis/ECON  
**Co-advisor:** VRISHALI/ECON  
**Student:** YE Guangzhi/MAEC (UROP Course: UROP1100, Spring 2014)

This report provides a literature review for a recently proposed topic in economics; that is, the middle-income trap. The middle-income trap is an economic development situation in which a country attains a certain income due to given advantages and then gets stuck at that level. The description and definition of middle-income trap are given in this report and the literature on the topic is studied and presented. The data evidence and analysis are included as supporting information to clarify this situation.

## Understanding the Savings Constraints of Migrant Domestic Workers

**Advisor:** VISARIA Sujata/ECON  
**Co-advisor:** LEE Clarence M F/ECON  
**Student:** CHU Hiu Yin/GBUS (UROP Course: UROP1100, Fall 2013;  
 UROP1200, Spring 2014)  
 LI Yuxiao/MAEC (UROP Course: UROP1100, Fall 2013;  
 UROP1200, Spring 2014)  
 NAN Shengyue/ECON (UROP Course: UROP1300, Spring 2014)  
 ZHANG Keyu/MAEC (UROP Course: UROP1100, Fall 2013;  
 UROP1200, Spring 2014)

Many domestic workers in Hong Kong tend not to save enough to cover their consumption and investments. Some of them are willing to take out high-interest loans to finance asset-building projects, such as land purchase and home renovation, even though they could avoid paying the high interest if they saved regularly. The aim of this project was to encourage members of the Asian Migrant Credit Union (AMCU) to save more regularly, and help them increase their savings amount. Through a controlled experiment introducing savings boxes to AMCU members, the box product is expected to help them build better saving habits and improve their financial situations.

**Advisor:** VISARIA Sujata/ECON  
**Co-advisor:** LEE Clarence M F/ECON  
**Student:** SONG Yang/ECOF (UROP Course: UROP1100, Fall 2013)

This report summarizes what was learned this semester about the saving constraints of migrant domestic workers (MDWs). Given that a large population of MDWs work in Hong Kong, and many of them do not make rational financial decisions, this report investigated the background behind and identified the determinants that affect their decision making. Based on the data analysis, this report aims to explain the phenomenon. The research revealed some of the project's defects, and this report provides possible solutions and improvements.

**Advisor:** VISARIA Sujata/ECON  
**Co-advisor:** LEE Clarence M F/ECON  
**Student:** WANG Ting/ECOF (UROP Course: UROP1100, Fall 2013)

This report elaborates on the study of the savings constraints of migrant domestic workers conducted during this semester. While foreign workers contribute much to Hong Kong society, many of them are trapped by financial difficulties. Through reading related materials and conducting controlled experiments, we aimed to understand the background of this scenario and the reasons behind such workers' transaction behavior; that is, the preconditions for helping them. We achieved our goals by conducting individual interviews, collecting cash box savings and modifying the questionnaire. We came to a preliminary conclusion, but further study is required.

**Advisor:** VISARIA Sujata/ECON  
**Co-advisor:** LEE Clarence M F/ECON  
**Student:** ZHANG Keyu/MAEC (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014;  
UROP1300, Summer 2014)

Many domestic workers in Hong Kong choose to cover their consumption or investments by taking out loans, even though they could simply avoid paying the high interest rates by saving regularly. This project aimed to clarify the savings constraints experienced by these workers to help them improve their financial situations. Through a controlled experiment introducing savings boxes to members of Asian Migrant Credit Union (AMCU), the project is expected to help them build better saving habits and accumulate their wealth.

**Advisor:** VISARIA Sujata/ECON  
**Co-advisor:** LEE Clarence M F/ECON  
**Student:** ZHANG Xialing/ECON (UROP Course: UROP1300, Fall 2013)

The research topic for this project was “Understanding the Savings Constraints of Migrant Domestic Workers”. The saving behavior of migrant domestic workers in Hong Kong was studied to provide insight into their bad financial decisions, such as preferring to borrow at a higher interest rate rather than successfully saving their money. The project proceeded for three semesters (including the summer term), and new insights and problems continued to emerge. We also obtained a deeper understanding of the poor through reading and discussions.

### Middle-Income Trap, International Trade and Economic Growth

**Advisor:** WANG Yong/ECON  
**Student:** LIANG Yuanning/ECOF (UROP Course: UROP1200, Fall 2013;  
UROP1300, Spring 2014)  
SHU Shi Yuen/MAEC (UROP Course: UROP1200, Spring 2014)

We used trade and productivity data to test how, as described in a three-country model extended from Krugman (1979), a middle income country’s per capita income gap with respect to the high-income country is affected by the productivity changes in both the high- and low-income countries. Our results showed that, subject to some conditions on productivities, the income gap enlarged with the increase in the productivity of either the high- or the low-income country in a free-trade setup. The results were subject to an enlarging of the sample size and tests in a frictional trade setup for further examination.

**Advisor:** WANG Yong/ECON  
**Student:** WAN Tsz Shing/ECOF (UROP Course: UROP1100, Spring 2014)  
WANG Shiqi/ECOF (UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)  
WU Yu/ECOF (UROP Course: UROP1100, Spring 2014)

This report focuses on the entry barrier of the upstream service sector and its effect on economic growth. The key idea was that a high entry barrier creates inefficiency in production service, which may hinder some middle-income countries from converging to high-income countries, sending them into the middle-income trap. The regression analysis following the previous semester’s study showed that the negative effect of the entry cost of upstream service increased as countries became wealthier. A new classification of the upstream service industry was completed based on the use of an upstreamness score. The initial attempt to test the model did not produce favorable evidence, and some improvements are suggested for further investigation.



**Advisor:** WANG Yong/ECON

**Student:** WANG Shiqi/ECOF  
YE Guangzhi/MAEC

**(UROP Course: UROP1100, Fall 2013;**

**UROP Course: UROP1100, Fall 2013)**

In this research, we studied the entry barrier of the up-stream service sector and its effect on economic growth. The key idea was that a high entry barrier creates inefficiency in the production service, which may hinder some middle-income countries from converging to high-income countries, sending them into the middle-income trap. A regression analysis revealed that the entry barrier of production service has a negative effect on GDP per capita, and the effect increases as countries become wealthier. Case studies of regulatory reform in the telecommunication and electricity sectors in Japan, Korea and Hungary showed that the introduction of competition and liberalization in the market may be followed by an increase in the growth rate of GDP per capita.

**Advisor:** WANG Yong/ECON

**Student:** WU Yu/ECOF

**(UROP Course: UROP1100, Spring 2014;**

**UROP1200, Summer 2014)**

This report focuses on the entry barrier of the upstream service sector and its effect on economic growth. The key idea was that a high entry barrier creates inefficiency in production service, which may hinder some middle-income countries from converging to high-income countries, sending them into the middle-income trap. The regression analysis following the previous semester's study showed that the negative effect of the entry cost of upstream service increased as countries became wealthier. The positive effect of production service share also increased as countries developed. The attempt to test the model produced favorable evidence of proposition 1.

**Advisor:** WANG Yong/ECON

**Student:** XU Minjie/MAEC

**(UROP Course: UROP1200, Spring 2014)**

This research continued a previous theoretical analysis of how income inequality and distribution affects economic growth when an economy is at the middle income level, with the introduction of foreign demand on the manufacturing sector. The results showed that it might be possible to achieve one or more general equilibria within the economy if there is no assumption on market structures. As more constraints are imposed on the competitiveness of markets, the economy might not be able to accommodate a direct foreign demand on its manufacturing sector. This indicates that the economic structure must be modified for further analysis to consider the effects of international trade.

## Structural Change, Real Exchange Rate and Growth

**Advisor:** WANG Yong/ECON  
**Student:** CHENG Cheuk Lai/ECOF (UROP Course: UROP1100, Spring 2014)  
YUAN Xinyu/SBM (UROP Course: UROP1100, Spring 2014)

This research examined the factors affecting real exchange rate, especially that between the United States and China. Whether the Reminbi is undervalued has been a hot debate, with most of the claims based on the Balassa-Samuelson model. We examined what the result would be if the effect of structural change was introduced into the model. Accordingly, the productivity differential was no longer the only variable in the model, as it was joined by the shares of traded and non-traded goods. We gathered data for China, the United States, Japan and South Korea to see if modifying the model fit the present-day situation.

**Advisor:** WANG Yong/ECON  
**Student:** CUI Yiye/MAEC (UROP Course: UROP1100, Summer 2014)  
WU Meng/MAEC (UROP Course: UROP1100, Summer 2014)  
ZHOU Sitong/MAEC (UROP Course: UROP1100, Summer 2014)

This research aimed to prove the existence of the middle-income trap. After reviewing the empirical evidence, we adopted four methods and reported the corresponding results. We obtained the following two findings. First, due to the current methods, there is no sufficient evidence indicating that the mid-income trap is a mainstream problem for all countries. Instead, it is more likely to be a regional phenomenon. Most trapped countries are geographically clustered. Second, middle-income countries are less likely to stay in their original income status; namely, some enter the rich group while others are left behind and become poor countries. We also applied our findings to support the project being conducted by our supervisor.

**Advisor:** WANG Yong/ECON  
**Student:** LI Xuezhu/ECOF (UROP Course: UROP1100, Fall 2013)

Throughout this project, our team mainly focused on analyzing the data of Chinese manufacturing enterprises. Based on the 2004 and 2008 census data we had on all registered Chinese manufacturing enterprises, we considered China's industrial structure changes through the age density distribution. In Part I, we analyzed companies' age density distribution for 9 out of 96 representative groups. In Part II, we analyzed the difference between state-owned enterprises (SOEs) and non-SOEs from 2004 to 2008. In Part III, we explored the possible link between economic environment and the policy effects on industry structure change in China. In Part IV, we tried using the Leontief input-output model to classify different industry groups, and the results were interesting. Further work might be conducted by the future students involved in this project.

## Department of Finance

### ESG Factors in Asia: Development, Trends and Market Usage

**Advisor:** BENZ Entela/FINA  
**Co-advisor:** LIANG Samuel Xin/FINA  
**Student:** MA Wan Ki Karsic/RMBI (UROP Course: UROP1000, Summer 2014)  
TSANG Ki Yip/QFIN (UROP Course: UROP1000, Summer 2014)

This research aimed to address the predictive power of ESG regarding forward-looking financial indicators such as estimated P/E ratio, ROA and earnings. The possible implications of using ESG scores for asset allocation were discussed and a regression analysis was used to understand the relationship between ESG and indicators. The analysis covered 1,124 filtered securities, including both developed and emerging markets. The major forward-looking indicators, including blending forward 12 months' estimated EBIT, EBITDA, sales, net income and EPS showed positive relationships with ESG scores. In conclusion, this research found that the ESG scores were in line with investors' expectations for companies' growth.

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

**Advisor:** BENZ Entela/FINA  
**Student:** WANG Ying/RMBI (UROP Course: UROP1000, Summer 2014)

Sustainable and responsible investment (SRI) has undergone rapid growth over the past decades. Substantial research has investigated the effect of SRI factors on companies' accounting and stock performance. In the long run, companies that are highly ESG-rated tend to generate significantly positive abnormal returns and outperform their counterparts. Despite the substantial research on this topic, there has been no single paper that separately examines the effects of the E, S and G factors on stock prices. This research focused on measuring the effects of each one of the aforementioned factors on stock returns, and their risk premiums.

## Rights Issues around the World

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** CHEN Yi/MAEC (UROP Course: UROP1100, Fall 2013)

Rights issues are a major way to raise external capital in many countries. There are three methods of external financing: rights issuance, debt issuance and seasoned equity offerings (SEOs). Compared with debt and SEOs, rights issuance is advantageous in that it avoids the asymmetric information problem because the additional shares are offered to existing shareholders. It is also tradable and cheaper. However, not all countries use rights issuance commonly, and this phenomenon is known as the “rights issues puzzle.” In this project, we collected data on rights issues, debt and SEOs from different countries to examine this problem.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** DOU Yao/SBM (UROP Course: UROP1100, Summer 2014)

This report provides an overview of the research on rights issues, and my contribution to such research. Rights issuance is a common external financing method, especially in Hong Kong. The motivation for this research is the fact that the popularity of rights issues among countries is quite different. This project analyzed the outcomes of rights issues, and discussed the reasoning behind why rights issues are popular in some markets and unwelcome in others. Every country with exchange was considered, and to understand the differences, a comparison was made with alternative financing methods including debt, seasoned equity offerings and initial public offerings. My contribution to this research was the collection of information from 8 countries in the past 24 years through two databases, Bloomberg and DataStream.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** GUAN Guhan/MAEC (UROP Course: UROP1100, Fall 2013)

Rights issuance is a major way to raise external capital in many countries, including the UK, Hong Kong and China. In a rights offering, issuers give existing shareholders the right to buy new shares at a specified price. Because they allow existing shareholders to avoid dilution, rights offerings are favorably regarded by regulators outside the US and mandatory in many European and Latin American countries. For our project, which was in a start-up period, we collected the historical record first, then used the information we collected to analyze the stock performance after rights issuance. Moreover, we analyzed the financing approach preferred by different companies based on these data.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** LAU Cheong/ECOF (UROP Course: UROP1100, Fall 2013)

Many companies seek different ways to raise funds to support their new business plans or daily operations in the face of steadily increasing competition from their peers around the globe. Listed companies have several methods of external financing, three of which were studied in this project: seasoned equity offerings, debt issuance and rights offerings. The data collected on these three methods provided the information needed to analyze the important reasons and factors influencing companies' decision-making. Therefore, this project provides a better understanding of these three financial instruments and the companies' subsequent behavior. My role in this project was to hand-pick rights issues data for seven countries. In this report, I discuss the process, my findings and observations, difficulties and reflections on my participation.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** LI Zhiqi/QFIN (UROP Course: UROP1100, Spring 2014)

During spring semester 2013-2014, I participated in Professor LIANG Samuel Xin's UROP project entitled "Rights Issues around the World." My aim was to gain hands-on experience in a finance research project and learn how to analyze accounting and market data to achieve the specified objectives. I was responsible for collecting accounting and market data from five developed countries and four developing countries. After several days spent searching the Bloomberg terminal and DataStream database, I successfully collected all of the required data and obtained a better understanding of the finance research process.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** LIN Yiming/SBM (UROP Course: UROP1100, Summer 2014)

This final report provides an overview of the UROP 1100 project entitled "Rights Issues around the World." It describes the work done throughout the process. Rights issues refers to an offer made to a firm's existing shareholders that provides them with the option to buy a specified number of shares at a specified price (also called a subscription price) before the option expires. Rights issues is an important topic because it is an essential method of external financing, along with seasoned equity offerings (SEOs), debt issuance and rights issuance.

However, the deployment of rights issues differs by country to some extent. Therefore, a deeper investigation into this new topic is justified. This project searched countries all over the world and collected data on companies that had issued debts, SEOs or rights. During the project, I converted codes from Bloomberg into proper ISIN codes and then retrieved data from the DataStream terminal and organized it in Excel. The work contained data from 22 variables in 17 countries, including some big countries such as Switzerland and the UK.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** MIAO Kai/QFIN (UROP Course: UROP1100, Spring 2014)

Rights issues is an important external source of financing. By offering new shares at a specified price to existing shareholders it raises capital without diluting control of the business, generates goodwill and maintains the predictability of shareholder governance. However, although favorably regarded by regulators outside the United States and mandatory in many European and Latin American countries, rights issues are still not widely used around the world, which makes them worthy of study. We added firms' financial variables to the previously collected data on rights issuance, debt and second equity issuance in the past 22 years to prepare a database for the performance analysis of different financing sources in the next stage. During the process, several challenges were encountered and addressed.

*Keywords—Rights Issues; Debt; SEO; Bloomberg terminal; Datastream.*

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** WU Yue/QFIN (UROP Course: UROP1100, Spring 2014)

This report provides an overview of the research project entitled "Rights Issues around the World" and summarizes my related work. Rights issues are an external financing method that provides a firm's existing shareholders the option to purchase extra shares at a lower subscription price. Rights issues are preferred over other external financing methods, including debt issuance and seasoned equity offerings (SEOs) because it is valuable, tradable and only available to existing shareholders. However, the deployment of rights issues is fairly different across the globe, making it a new topic worth exploring. This project targeted countries all over the world and collected information from all of the firms that had issued debts, SEOs or debts in the past 20 years. Those companies were then compared in relation to their typical financial variables. My contribution to this project was the conversion and proper reference coding of data from Bloomberg, followed by the retrieval of data from the DataStream terminal. I was responsible for collecting data on 22 variables from 10 countries.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** YAN Mingyang/ECOF (UROP Course: UROP1100, Spring 2014)

This report describes the progress of the project entitled "Rights Issues around the World." I explain the concepts involved, i.e. the meaning of rights issues and seasoned equity offerings and their implications for the financial market and investors. Then, I describe my task of data collection according to the timeline and listed the eight financial variables I was looking for. I provide a primary summary of the data regarding rights issues in Egypt, Finland and France and review the trends for each of the financial variables found in the data.

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** YUAN Xinchun/ECOF (UROP Course: UROP1100, Spring 2014)

Rights issues, as a major source of raising external capital in many countries, are theoretically well-designed and have very few disadvantages. However, some countries, especially developed markets such as the US, are relatively inactive when it comes to rights offerings. In this project's previous stage, we finished collecting data from companies that had issued rights, debts and second equity offerings in the past 22 years. In this stage, we collected the financial multiples of each individual company, including daily and yearly data. The purpose of this stage was to build a database of the values of each company before and after each financing activity to see how different financing channels may have affected a single company, and to identify further research.

*Keywords—Rights Issues; Warrant; Entitlement; Open offer; Debt; SEO; Argentina; Australia; Austria; Belgium; Bermuda; Brazil; Chile; Canada; China; Bloomberg terminal; Datastream; 22 years(1990-2013).*

**Advisor:** LIANG Samuel Xin/FINA  
**Co-advisor:** DASGUPTA Sudipto/FINA  
**Student:** ZOU Ziyuan/ECOF (UROP Course: UROP1100, Fall 2013)

This research focused on rights issues around the world and the rights issues puzzle. We collected data on debt, rights offerings and seasoned equity offerings in nearly 50 countries from 1990-2013. This report, which describes the data collection from the United States, shows the process and results of data collection and provides a basic analysis of rights offerings in the United States. Seasoned equity offerings and debt issuance are also mentioned, along with some thoughts on the financial regulations and rights offerings development around the world, especially in the United States.

*Keywords—Right Offerings; United States.*

## Political Connection, Political Uncertainty and Asset Pricing

**Advisor:** LIU Xiaolei/FINA  
**Student:** LU Yanjie/FINA (UROP Course: UROP1100, Fall 2013)  
YE Yiqi/GBUS (UROP Course: UROP1100, Fall 2013)

This report presents the data collection, data processing and information extraction processes of the research project entitled "Political connection, political uncertainty and asset pricing." The processes mainly involved online database searching and manual matching. Because this project is still in progress, the data analysis and results derivation have not been completed and thus are not discussed in this report. In addition to this topic, the research team also conducted ad hoc tasks at the request of the supervisor, and the relevant work processes are illustrated in this report.

**Advisor:** LIU Xiaolei/FINA

**Student:** YEUNG Fai/ECOF

**(UROP Course: UROP1100, Fall 2013)**

In Feb 2012, Bo Xilai, the former Communist Party chief in Chongqing, was expelled from the Communist Party and parliament was to face prosecution for bribery, corruption and abuse of power. As Bo's scandal was considered an unexpected shock to China, it became a good candidate for a natural experiment to test how political uncertainty and political connection affect asset pricing. After gathering sufficient data and conducting an analysis, a basic conclusion was made and the research entered the second phase, in which the time horizon was extended back to 1990 in China. In the third phase of the research, we expanded the geographical dimensions of our investigation by considering companies outside China.



## Department of Information Systems, Business Statistics and Operations Management

### Searching Digital Music Infringement Behavior Using Search Engines

**Advisor:** KWOK James Sai Ho/ISOM

**Student:** CHU Chun Yiu/MARK

**(UROP Course: UROP1100, Fall 2013)**

This research investigated the effectiveness of delisting measures against the behavior of downloading “illegal” movies from the Internet. Copyright infringement has always been a major problem for digital media, including software, movies, music, electronic games, books, etc. Thus, it is important to understand the performance of such delisting methods. The purpose of this research was to quantify the effectiveness of delisting measures against digital content infringement using search engines such as Google. Specifically, it investigated the searching behavior of movie infringement using Google Trends to identify the optimal time of delisting. The solution to the research problem was to find the peak in the infringing behavior and delist one week before and after that peak point for optimal results.

### Risk Management

**Advisor:** SO Mike K P/ISOM

**Student:** LI Xiaoyue/RMBI

**(UROP Course: UROP1100, Fall 2013)**

Extreme value theory is a branch of statistics dealing with quantifying the stochastic behavior of a process at unusually large—or small—levels. The application of extreme value analysis is emerging rapidly in many disciplines, including both financial and non-financial fields such as portfolio adjustment, risk assessment on financial markets, traffic prediction, earth sciences and structural engineering. The estimation of an event’s probability is often more extreme than an event that has already been observed, and extreme values are highly likely to be poorly sampled. Thus, the main difficulty when dealing with extreme values lies in how to choose an appropriate method of estimation to generate proper assumptions and, more importantly, to build a realistic model that can interpret real-life scenarios and optimize data. Several classical suggestions for solutions were addressed. Various scenarios were considered based on their complexity of assumptions and suggested models were developed and diagnosed by statistical and probabilistic tools.

## Analyzing Financial News with Topic Modeling

**Advisor:** ZHENG Rong/ISOM

**Student:** PENG Rui/COSC

**(UROP Course: UROP1100, Fall 2013)**

The common practice for analysts in financial institutions is to hand-label financial news, yet doing so is inevitably inefficient as it only focuses on the polarity of the content. In the interests of bringing machine insights into the analysis of large financial datasets at the topic level, and speeding up the labeling process, we investigated an advanced Bayesian approach called topic modeling that allowed automatic topic-level information retrieval. Specifically, Latent Dirichlet Allocation, a generative probabilistic graphical model, was used to study the effectiveness of an unsupervised learning algorithm on a financial news dataset consisting of around six million news records. The results, which consist of the discovered topics and soft topic labels for news articles, are highly meaningful for further analysis by accounting professionals.

## Text Mining with Topic Modeling

**Advisor:** ZHENG Rong/ISOM

**Student:** CHEN Ran/ELEC-HR

**(UROP Course: UROP1100, Fall 2013)**

As more information becomes available, it is proving more difficult to gain access to what we are looking for. We need new tools to help us organize, search and understand these vast amounts of information. Topic modeling is an advanced Bayesian approach for extracting useful information from text for various business purposes. This project conducted a general text analysis of the Financial Times Top 40 Journals with topic modeling open-source software packages to automatically summarize the key information and uncover the hidden topical patterns in different academic journals. This information can then be used to analyze the relationships between several business areas.

**Advisor:** ZHENG Rong/ISOM

**Student:** SHI Xilin Cecilia/MATH-ST

**(UROP Course: UROP1000, Summer 2014)**

Text mining—the process of extracting useful information from text—has been applied for a variety of research, government and business purposes. However, as more information becomes available, it becomes increasingly difficult to find what we are looking for. To solve this issue, topic modeling can provide ways to automatically search, organize, understand and summarize a huge amount of information. It can also reveal hidden patterns, annotate the information corresponding to the topics and use the annotations to search, organize, understand and summarize the texts. This project involved the collection of papers from *Marketing Science*, *Strategic Management Journal*, *MIS Quarterly* and *Operations Research* for general text analysis using the Stanford Topic Modeling Toolbox. A detailed report of the methods used and the progress achieved is provided.

*Keywords—text mining; topic modeling; Stanford Topic Modeling Toolbox; Python.*

## Department of Marketing

### Counterfeit Consumption II

**Advisor:** DALTON Amy N/MARK

**Student:** CECUTTI Lorenzo/MARK

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

This research explored how counterfeits can elicit mixed emotional reactions in those who wear them to social occasions, and how these mixed feelings in turn affect the performance of simple tasks such as word generation through ego depletion. This is a relatively new topic, as mixed feelings have seldom been paired with counterfeit products in the previous research, and mixed emotions have not yet been used as predictors for ego depletion. This research also explored the potential moderators of this relationship, to be included in a future study.

*Keywords—Consumer behavior; decision making; counterfeit consumption; mixed emotions; ego depletion.*

### Luxury Marketing in Emerging Markets

**Advisor:** HELSEN Kristiaan/MARK

**Student:** TAM Chun Kit/GBUS

**(UROP Course: UROP1100, Summer 2014)**

Social media marketing is a new branch of online marketing first developed among fast-moving consumer goods' brands. Yet due to China's unique social media landscape and luxury consumer behavior, such marketing has yet to be widely adopted by luxury brands in China (Cheng, 2014). This report provides a brief account of the consumption behavior of Chinese luxury buyers, followed by an analysis of the potentials and limitations of social media marketing in the luxury sector, which traditionally follow a distinctive strategy that goes very much against the traditional marketing rules (Kapferer & Bastien, 2012). Finally, the report suggests that it is sensible for luxury brands to launch this marketing initiative, supplemented with recommendations for enhancing its effectiveness.

School of  
**Humanities &  
Social Science**

Undergraduate Research  
Opportunities Program



## Division of Humanities

### Chiang Kai-shek Diaries Transcription and Collection

**Advisor:** CHANG David Cheng/HUMA

**Student:** LAU Hiu Kwan/GCS

**(UROP Course: UROP1000, Summer 2014)**

Chiang Kai-shek kept diaries as a lifetime practice, and they cover the period from 1915 to 1972. From today's perspective, Chiang's diaries present a valuable source in the study of modern Chinese history, as they may help us to reframe our understanding of Chiang. Chiang's diaries allow us not only to study his political decisions after he came to power, but also the story behind his participation in the revolution and the initiation of his political career. This research examines three aspects of Chiang's early life and childhood experiences: schooling, upbringing and family education, and the humiliating experiences of his childhood and youth. It also analyzes how these experiences shaped his future career and life.

**Advisor:** CHANG David Cheng/HUMA

**Student:** MAN Tingjun/SBM

**(UROP Course: UROP1000, Summer 2014)**

Chiang Kai-shek, as the leader of Nationalist Party and China, played a vital part in Sino-Japanese relations of his era. Since Sino-Japanese relations today remain complicated and unpredictable, the historical origins of the relationship between the two countries may provide a lesson. It is necessary for us to learn and grow from historical experience. This report aims to examine the social environment in both China and Japan before war and explore alternative historical probabilities. It studies Chiang Kai-shek's attitude toward the two countries. Chiang Kai-shek diaries give us a precious opportunity to appreciate history from a leader's point of view.

*Keywords—Sino-Japanese relations; Chiang Kai-shek; social environment; historical origins.*

**Advisor:** CHANG David Cheng/HUMA

**Student:** TSE Ka Wai/GCS

**(UROP Course: UROP1000, Summer 2014)**

This research investigates how Chiang Kai-shek's rise was enabled by his political positioning and networks from 1924 to 1927. In descending order in terms of significance, these factors include his command of the Whampoa Military Academy, his intra-party role as a centrist, his positioning as Sun Yat-sen's faithful follower, and his marriage to Soong Mei-ling. The political connections built through these aspects could have served as the power base for the rising star in the Chinese Nationalist Party, strengthening his political influence and enhancing his charisma. Such contributions also reflect the importance of political connections in one's political career.

## Korean War Prisoners Oral History Interview Transcription

**Advisor:** CHANG David Cheng/HUMA

**Student:** HAN Wenfei/SBM

**(UROP Course: UROP1000, Summer 2014)**

This report provides a brief summary of the project entitled “Korean War Prisoners Oral History Interview Transcription,” which explores the history of the Korean War and the lives of its prisoners by reviewing and transcribing prisoner interviews. After the interview data are recorded and reorganized, certain historical facts and the varied opinions of the interviewees are revealed and analyzed. Further findings in prisoners’ motivations can be discovered by comparing archival documents and the interviewees’ explanations.

**Advisor:** CHANG David Cheng/HUMA

**Student:** YANG Chunpu/SBM

**(UROP Course: UROP1100, Summer 2014)**

2013 marked the 60th anniversary of the Korean War Armistice Agreement, and numerous historical facts and documents have been introduced to the public over time. As the usually forgotten group in every war in human history, prisoners of war (POWs) and their experiences always grant readers the opportunity to explore little-known aspects of every conflict. Based mainly on the interview videos of some former Chinese POWs and American soldiers made by the project supervisor, I transcribed the interviews, extracted some important information concerning the interviewees’ prewar lives and adventures on the battle field. Much of the attention and effort have been paid to the screening and repatriation process, which was quite opaque and controversial during the war. These transcriptions are expected to provide scholars with persuasive evidence of what went on behind the scenes. Moreover, every war can be considered a node connecting the personal destinies of a generation and human history. The life experiences of those who served in the Korean War may trigger the memories and introspection of people from that period.

## Twentieth Century China in Photographs

**Advisor:** CHANG David Cheng/HUMA

**Student:** LIU Huixue/GCS

**(UROP Course: UROP1100, Summer 2014)**

Famine was a continuous theme in China in the 1940s, and thus has left an indelible mark on China’s contemporary history that also serves as a bitter memory for many members of older generations in China. This report presents four major famines during the 1943-1945 period in China: the 1943 famine in Henan province, the 1943 famine in the Canton areas, the 1944 famine in Wanning, Hainan province and the 1945 famine in Hunan province. Both words and pictures are used to bear witness to the barren farmlands, increasing crop prices and populations affected. The photos vividly record the plight of refugees and the report analyzes the causes and consequences of these catastrophic famines.

**Advisor:** CHANG David Cheng/HUMA  
**Student:** MA Yujia/BIOL (UROP Course: UROP1100, Fall 2013)

This report provides some possible explanations for the success Madame Chiang, the First Lady of the Republic of China, achieved during her visit to the United States in 1943. Sources include old photographs, news reels, and scholarly research about Madame Chiang.

**Advisor:** CHANG David Cheng/HUMA  
**Student:** MARK Daniel Valdemar/GCS (UROP Course: UROP1000, Summer 2014)

This project involved creating a database of historical Chinese photographs. The choice was made to create an online database using a content management system (CMS), as it produced the most efficient and user-friendly database. This report elaborates on why using a CMS was the best choice by demonstrating the intuitiveness of the product designed. The main strength of the product is its robust ability to store, search for and filter keywords relating to the photographs, which makes it easy to find specific photos for specific purposes. A discussion on how the project could be improved is conducted at the end of the report.

**Advisor:** CHANG David Cheng/HUMA  
**Student:** ZHENG Shiyin/GCS (UROP Course: UROP1100, Summer 2014)

The Chongqing Negotiations in 1945 was one of the crucial turning points in the relationship between the Chinese Communist Party and the Nationalist Party and in modern Chinese history. The objective of this research is to collect and inspect historical photographs, use relevant historical knowledge to interpret them, closely observe the details hidden in them. Referring to a chronology of historical events, I also examine whether these photos offer reasonable explanations for the aforementioned details. Another objective is to investigate how the photographs illustrate historical moments, how the photographers documented historical events, and whether the photographers' political leanings influenced the perspectives and narratives of the works.

## Division of Social Science

### Single Women in the Hong Kong Media

**Advisor:** GROVES Julian M/SOSC

**Student:** WANG Yuqian/GCS

**(UROP Course: UROP1100, Summer 2014)**

This project was conducted under the supervision of Dr. Julian Groves with two research assistants, myself and Anne Wong. In this research, we investigated how single women in Hong Kong perceive and respond to the television program “Bride Wannabes.” Specifically, we analyzed the data we collected from focus group discussions to understand how the program was received by the participants, and how they connected it to the reality of being a single woman in Hong Kong. We conducted one focus group discussion involving five participants and we are in the process of transcribing the recording of the discussion.

### China/Africa Links Project

**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** AU Ka Yi/GCS

**(UROP Course: UROP1100, Fall 2013)**

This semester’s project focused on gathering news articles relating to China and Africa to analyze the nature of the reports. Canadian newspapers were gathered from four main news agencies: *Globe and Mail*, *National Post*, *Vancouver Sun* and *Montreal Gazette*. A period of 2.5 years was examined, from January 2011 to November 2013. Twenty-four articles were analyzed, of which three were neutral in their reporting tone. The remaining 21 articles were found to be negative in their reporting tones, with the major problems in reporting falling into 12 categories, including invidious comparison, monolith, misleading exaggeration, Chinese imperialism/colonialism, quoting government officials, over-generalization, anachronism, popular resentment, immoral Chinese behavior, illustration method and examples of untrue reports. Elaborations on the examples in each category are also provided.



**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** KWAN Wing Chung/ACCT

**(UROP Course: UROP1100, Fall 2013)**

Since the reform and openness in 1978, there has been rapid growth in the Chinese economy. China has become a political and economic superpower. To support the fast-growing economy and industrialization, raw materials and oversea markets are extremely important to China. Therefore, China is looking to the resources and raw materials in Africa, making cooperation between China and Africa increasingly important.

However, unlike Western countries and companies, China and Chinese companies adopt the Chinese model of doing business in Africa. In fact, most Chinese oil and mining companies are state-owned enterprises overseen by the Chinese government. To exchange oil and mining contracts, the Chinese government and Chinese oil companies provide low-interest loans to African countries in addition to helping them construct infrastructures. Over the last 15 years, this type of mutual benefit sharing has become increasingly important, and the total amount of trade between China and Africa has increased steadily.

Given China's growing power in Africa, Western countries and media have expressed growing concern. In most Western media, Chinese investments are described as imperialism and colonialism exploiting African resources. These elaborations are subjective and usually misleading for the reader. Western media, particularly in America, are trying to build up an idea that the growth of China is threatening the rest of the world by showing that their activities in Africa are legitimate.

In this project, we conducted documentary research through the library's database. We collected and analyzed misleading elaborations of Chinese–African cooperation in Western media.

**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** LI Ka Kit/MATH-ST

**(UROP Course: UROP1100, Spring 2014)**

This project provided a brief overview of the main characteristics and evolution of Chinese state-owned enterprises (SOEs). The reason behind the strength of these formidable SOEs and their relationship with their supervising organ, the State-owned Assets Supervision and Administration Commission (SASAC), was investigated. The SOEs play a major role in China's rapidly increasing foreign direct investment (FDI), but they are also frequently losing money overseas, and there is something beyond profit for which they are aiming. In the evolution of Chinese SOEs, major events such as massive privatization and the establishment of the SASAC have contributed to the current status of the state sector.

## China's Ethnic Policies

**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** CHEN Kangliang/EEGBM

**(UROP Course: UROP1100, Spring 2014)**

Social organizations are playing an increasingly important role in the ethnic community development in China. Given the large number of such organizations, their internal variations should be noted. This research conceptualized the three models that are motivated by different sources through an analysis of the operations and underlying incentives of various parties. It also explained the absenteeism of locally initiated organizations, as shown through the illustration of the government's incentives and concerns, which tend to eventually lead the resulting policies to a lack of local organizations. The limitations revealed in this study also shed light on the direction of future research.

**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** CHEUNG Chun Yat Julian/GCS

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

China is a multi-ethnic nation comprising 56 ethnic groups. As many of the members of these ethnic minorities are disadvantaged, preferential policies are needed to help develop their regions. However, these policies have created inequity between different ethnic groups, raising grievances and triggering conflicts. The situation has aroused controversy between scholars arguing whether the policies should be reconciled or abolished. In this project, the viewpoints from Ma Rong and Hao Shiyuan were compared to analyze the current preferential policies.

## The Hong Kong Anti-Mainlandization Movement

**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** CHEUNG Chun Yat Julian/GCS

**(UROP Course: UROP1000, Summer 2014)**

The opposition expressed by Hong Kong's population against people from the mainland is growing in frequency and intensity. The contradictory mindsets and differences in the moral values and daily living habits of these two groups of people trigger significant friction. Hence, they have become polarized to the extent that their interactions are typically inharmonious. On a daily basis, arguments, conflicts and even fighting between the two groups have been observed. In this report, I provide possible explanations for this phenomenon and analyze how and why the situation is rapidly deteriorating.

**Advisor:** SAUTMAN Barry Victor/SOSC

**Student:** TANG Sitie/ECOF

**(UROP Course: UROP1000, Summer 2014)**

Recent years have witnessed growing tension between mainland China and Hong Kong. From the very first incident involving Chinese media figure, Kong Qing Dong, to the most recent scandal of the toddler allowed to urinate in public in Mong Kok, the relations between mainland Chinese and Hong Kong residents have deteriorated since the implementation of related policies, such as the individual visitor scheme and the restriction of milk powder. While Hong Kong residents' reactions have been well-represented in the media, the mainland Chinese side has not received equal attention. This report reviews the main incidents by timeline to generate the existing opinions of the mainland Chinese toward the anti-mainland movements in Hong Kong. It also discusses the design of a questionnaire intended to determine the public's opinion on these issues.

## **Investigating and Evaluating the State of Innovation and Technology in Hong Kong and the Region**

**Advisor:** SHARIF Naubahar/SOSC

**Student:** LIU Yuhong/SBM

**(UROP Course: UROP1100, Summer 2014)**

In this research, we investigated research and development (R&D) centers in Hong Kong. Our preliminary work involved gaining the basic information about such centers' establishment histories, stated missions and successes and failures in operating status quo. In the analysis stage, with regard to the economic background when R&D centers were established and other relevant statistics of the innovation industry, we achieved a more holistic picture of the R&D centers in Hong Kong. Finally, we compared R&D centers in Hong Kong with those in other countries to draw a tentative conclusion about the formers' structure.

**Advisor:** SHARIF Naubahar/SOSC

**Student:** ZHOU Xinyi/MARK

**(UROP Course: UROP1100, Fall 2013)**

This project investigated the various aspects of innovation and technology development in Hong Kong, and possibly Guangdong province. It included (but was not limited to) an examination of the role played by universities in Hong Kong's innovation system, government policies for the promotion of innovation and technology, firm-level innovation activities in Hong Kong, etc. I conducted relative research on the university and government policy aspects. The project was led by professor Sharif, who has made significant achievements in the development of Hong Kong's innovation system, the emergence of the innovation system's approach in academic policy making circles, the history of technology from a business and economics perspective and the sociology of technology.

## Hong Kong Government and Politics

**Advisor:** SING Ming/SOSC

**Student:** AU-YEUNG Huen Tat/ECOF

**(UROP Course: UROP1000, Summer 2014)**

In this research, we examined the relationship between major families in Hong Kong and the Chinese government. We compared the top 10 leading families in Hong Kong in 1992 and 2014, and found that the successes of the remaining families seemed to be related to better relationships with the Chinese government.

*Keywords—Hong Kong politics; political connections; Chinese government; Hong Kong major families.*

**Advisor:** SING Ming/SOSC

**Student:** KONG-WONG Kody/SBM

**(UROP Course: UROP1100, Summer 2014)**

In 2009, the Hong Kong SAR government introduced a political reform package for the public's consideration. Yet, when it was released, public opinions on it varied to a large degree. This report examined the government document for the political reform package, mainly through the public views documents submitted by various groups and organizations in Appendix III, to discover to what extent the public agreed or disagreed with the proposal. Furthermore, the report examined some of the claims made by the organizations to ascertain their current validity, two years after the reform.

**Advisor:** SING Ming/SOSC

**Student:** LAM Tin Wai Grace/GBUS

**(UROP Course: UROP1000, Summer 2014)**

There have been ongoing discussions regarding the inseparable relationship between the business sector and the government in Hong Kong, dubbed "crony capitalism" by various scholars in recent years. This research investigated whether this relationship exists in Hong Kong society by exploring the relationship between listed firms and the Election Committee, which is responsible for electing the Chief Executive, and the Commission on Strategic Development, a government think-tank that gathers elites from different industries. The results concluded that crony capitalism does exist in Hong Kong, and that it is the government's utmost responsibility to ensure that corruption and collusion do not occur, so as to safeguard Hong Kong's core values.

## Issues of Governance and Politics in Hong Kong

**Advisor:** SING Ming/SOSC

**Student:** TANG Wing Yan/GBUS

**(UROP Course: UROP1100, Fall 2013)**

This research explored the importance of press freedom in an international financial market. Despite the various international honors that Hong Kong has won, the rise of Shanghai and Shenzhen have prompted many to question Hong Kong's long-term competitiveness. Therefore, it is important to understand the precious assets that enable Hong Kong to continue as an international financial center. Chen's (2003) work noted that capital institutions, including freedom of press, are the best assets differentiating Hong Kong from upcoming competitors. He claimed that press freedom is currently an economic institution, especially in an economy that relies on the financial and service industries, given its intangible nature. This research also examined the current situation in Hong Kong on press freedom and identified the government's increasing intervention in the flow of information, such that the press freedom Hong Kong people have been proud of is gradually diminishing. This has raised concerns about the current intervention and prompted calls for greater protection of press freedom.

## The Anti-Mainland Movement in Hong Kong: Origins, Transformation and Implications

**Advisor:** SO Alvin Yiu-cheong/SOSC

**Student:** CHUNG Wai Chu/SBM

**(UROP Course: UROP1000, Summer 2014)**

The purpose of this project was to study how the "individual visit scheme" resulted in the anti-mainland sentiment and movements. Since June 28, 2003, the individual visit scheme has been promoted, allowing some mainland Chinese to travel in Hong Kong. Undoubtedly, the scheme has benefited Hong Kong's economic development, but it has also exhibited some drawbacks that have disturbed local lives, such as rent increases. Meanwhile, the "Hong Kong–Mainland conflict" is getting worse, with an increasing number of anti-mainland activities in Hong Kong, such as the "Anti-locust" campaign in Tsim Sha Tsui on February 9, 2014. Although there are various factors causing the issue, this project focused on the specific effects of the individual visit scheme.

## Internet Finance and Microcredit in China

**Advisor:** TSAI Kellee Sing/SOSC

**Student:** CHEN Kangliang/EEGBM

**(UROP Course: UROP1000, Summer 2014)**

Microcredit firms are booming in China. In this research, I examined the recent trends in regulations and studied those companies or organizations that are typical of their types. Their operations were analyzed mainly through interviews, and instead of drawing a conclusion based on the information found, this report describes the changes that are going on in China. This analysis of microcredit companies' business models reveals a clear trade-off among efficiency, flexibility and the price to pay.

**Advisor:** TSAI Kellee Sing/SOSC

**Student:** DENG Jiejun/FINA

**(UROP Course: UROP1000, Summer 2014)**

I initiated this research by conducting interviews with industry insiders in the active, newly established investing-financing companies in Chengdu. This report presents my partial field notes, which cover interview records about these new-born companies' operation details. These interviews, to a large degree, demonstrate that many of these companies are well aware of the importance of risk control, and have quite impressive measures to retain investors.

**Advisor:** TSAI Kellee Sing/SOSC

**Student:** YUNG Wai Ting Winnie/QFIN

**(UROP Course: UROP1000, Summer 2014)**

The Internet is becoming increasingly important in the everyday lives of Chinese citizens. A growing number of people are investing their money in online financial products such as Alibaba's Yue'bao, or are managing their spending on payment service platforms such as Tencent's Tenpay—both of which are examples of Internet finance. The current scale of Internet finance in China in terms of transaction volume is over 5 trillion yuan, and is likely to increase along with the growth of the population, increased Internet coverage and the wealth of Chinese citizens. Presently, more than 1,000 firms are taking part in online businesses. However, questions of regulation are arising, as these businesses pose many new risks.

The People's Bank of China and the China Securities Regulatory Commission have subsequently voiced their views on this issue, which have been generally positive. Although there have been incidents where parts of some businesses were temporarily suspended, actions of the authorities such as inviting large Internet firms to discuss regulatory matters, have suggested that they are trying to keep an open mind about the emerging industry.

## Psychology of Emotion

**Advisor:** YIK Michelle/SOSC

**Student:** IP Hui Yan Lilian/BICH

**(UROP Course: UROP1100, Fall 2013;  
UROP1200, Spring 2014)**

Language provides a window through which we see how people conceptualize emotions across cultures. Russell (1991) proposed the *script hypothesis* to help us better understand cultural variations in emotional concepts. However, past studies on scripts have all been in the English context (Shaver, Schwartz, Kirson & O'Connor, 1987), with literally no script study conducted in the Chinese context. This research reported some preliminary results on the emotion scripts for the Chinese emotion term “disgust” (N = 16). The *script hypothesis* was found to serve well in examining the culture-specific elements of emotion concepts in the Chinese context. Future studies can focus on comparing the emotion scripts obtained in different languages to examine the interplay between culture and language on people’s understanding of emotion concepts.

## China and the World

**Advisor:** ZWEIG David Stephen/SOSC

**Co-advisor:** KANG Siqin/SOSC

**Student:** LI Yongzheng/GCS

**(UROP Course: UROP1100, Summer 2014)**

After China implemented its reform and opening policy, an increasing number of overseas Chinese decided to return to pursue better opportunities. In terms of scientific research development, the 100-Talent Program is the national funding program designed to boost scientific research by attracting the considerable number of Chinese scholars functioning abroad. Founded in 1994 by the Chinese Academy of Sciences, hundreds of scholars have been drawn back by the appealing opportunities being offered. This research focused on overseas (Chinese) scholar returnees by probing the 2012 100-Talent Program. We examined the successful application forms and attempted to summarize certain characteristics of the program to determine whether it could attract high-quality scholars.

## Returned Scholars and University Reform in China

**Advisor:** ZWEIG David Stephen/SOSC

**Student:** ZHANG Pengfei/GCS

(UROP Course: UROP1100, Spring 2014;  
UROP1200, Summer 2014)

In this research, I used a cost-benefit analysis to understand overseas nationals' decisions about the return option in the domain of science. I focused on the cost of academic excellence, compensation for the aging process and the advantages of domestic networks. I found that an overseas scientist returns if and only if the cost of being senior and the ease of adaption transcend his/her concerns about research output. I conducted a regression analysis on a pooled cross-section of data that merged China's returnees and overseas scholars to empirically delineate the negative effect of academic excellence, the positive effect of age and the positive effect of connection on the probability of return. The findings have great implications for both the brain-drain literature and China's talent policy.



# Interdisciplinary Programs Office

Undergraduate Research  
Opportunities Program



## Air Pollution in China

**Advisor:** CHAN Chak Keung/ENVR

**Student:** HUNG Pui Kwan Isa/SSCI

**(UROP Course: UROP1000, Summer 2014)**

The Pearl River Delta (PRD) region has gradually developed into a global manufacturing center since the onset of China's economic reform in the late 1970s. Due to the rapid industrialization and urbanization of the cities in the PRD region, and the rising number of private vehicles on the road, air pollution has become a serious problem. In this research, we examined the air pollution situation in the PRD region and the causes of its severity. Then, we investigated the effects of cross-border pollution, with Hong Kong and Guangzhou as examples. Finally, we reviewed the air pollution measures being implemented by the Chinese government in PRD region, evaluating past policies and introducing the most recent ones.

## Real-Time Measurements of Particulate Pollutants

**Advisor:** CHAN Chak Keung/ENVR

**Student:** ZHANG Estina Liting/CHEM

**(UROP Course: UROP1000, Summer 2014)**

Amine sulfates may not be stable, as amine re-evaporates in its liquid phase. The literature has reported that certain amines such as dimethyl amine sulfate ( $\text{DMA}_2\text{SO}_4$ ), trimethylamine sulfate ( $\text{TMA}_2\text{SO}_4$ ) and diethyl amine sulfate ( $\text{DEA}_2\text{SO}_4$ ) evaporate in dry conditions when the aminium-to-sulfate molar ratio approaches equilibrium at or below 2:1 (Chan and Chan, 2013). Amine evaporation may have a significant effect on chemical composition, and thus it is worth investigating amine evaporation from aminium sulfates in both dry and wet conditions at room temperature. The evaporation time and amount of six different aminium sulfates—methylamine sulfate ( $\text{MA}_2\text{SO}_4$ ), ethylamine sulfate ( $\text{EA}_2\text{SO}_4$ ), ammonium sulfate ( $(\text{NH}_3)_2\text{SO}_4$ ), dimethyl amine sulfate ( $\text{DMA}_2\text{SO}_4$ ), trimethylamine sulfate ( $\text{TMA}_2\text{SO}_4$ ) and diethyl amine sulfate ( $\text{DEA}_2\text{SO}_4$ )—under dry and wet conditions at room temperature were investigated in this project using a flow cell setup.

Two stock solutions for each aminium sulfate solution were prepared and each was given a target to achieve; namely, a sulfate molar ratio of 2:1, as verified by ion chromatography (IC) measurements. The generated droplets of all of the amine sulfate solutions, in sizes of approximately 1.5 mm, were run in flow cells at <3% RH and 50% RH. A suitable time series was investigated with trimethylamine sulfate and transferred to all of the other amine sulfate experiments. Both the initial stock solutions used in one system and the result solutions from the flow cells were diluted and measured via IC to obtain the corresponding starting point and final ratios for further comparison.

The results showed that methylamine sulfate ( $\text{MA}_2\text{SO}_4$ ), ethylamine sulfate ( $\text{EA}_2\text{SO}_4$ ) and ammonium sulfate ( $(\text{NH}_3)_2\text{SO}_4$ ) exhibited a relatively stable trend and the weak evaporation of amines. Dimethylamine sulfate ( $\text{DMA}_2\text{SO}_4$ ) and trimethylamine sulfate ( $\text{TMA}_2\text{SO}_4$ ) exhibited an unstable trend and moderate amine evaporation. Diethylamine sulfate ( $\text{DEA}_2\text{SO}_4$ ) was considered an exception with several uncertainties, and may thus require further investigation. It was found that particle size significantly influenced the time required for amines to approach the sulfate molar ratio equilibrium, with mm-sized droplets taking up to several days to approach their equilibriums.

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