Knowledge Transfer Annual Report 2012/13

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1. Knowledge Transfer at HKUST

As a leading research university, HKUST is committed to the creation, dissemination, and application of knowledge for the benefit of society. Our knowledge transfer (KT) focus for this triennium is to conduct mission-oriented research that flows through our KT platform with greater industry, government and society engagement; at a quicker pace and with a wider reach. The three strategic goals include:

- To build a campus culture that is conducive to innovation on an efficient and proactive KT platform
- To bring innovations that meet the specific needs of society, government and industry
- To expand the influence of HKUST's innovations beyond Hong Kong

These KT strategic goals will strengthen HKUST's mission through increased relevance of our research to industrial applications and enhanced connections to the industry at different stages along the KT process.

1.1 KT Infrastructure and Enhancements

HKUST has a well-established KT infrastructure. The Office of the Vice-President for Research and Graduate Studies (VPRGO) oversees the KT operations, with the support of the Office of Contract and Grant Administration (OCGA), the Technology Transfer Center (TTC), the Entrepreneurship Center (EC), and the HKUST R and D Corporation Ltd. (RDC). The subunits work seamlessly together in handling all aspects of KT, from identifying collaboration opportunities, research and IP management, to technology transfer and commercialization, as well as entrepreneurship education and incubation.

KT funding enables HKUST to hire and maintain a comprehensive team of KT professionals who are committed to the implementation of the University's KT strategies and activities. OCGA administers research at the University, actively seeks funding opportunities to support the research efforts of our faculty members and effectively disseminates relevant information to faculty members through its e-newsletter, GrantWise. In order to facilitate more effective research management for HKUST's Mainland platforms, a China Desk (Research Administration) was set up in the past year for centralizing all Mainland research grant applications and management operations.

KT funding was utilized by TTC to obtain professional patent analysis service for select inventions to strengthen the patent evaluation process. The service augments the existing well-established technology review process at the University to enable more effective decision-making on strategic IP portfolios in high impact areas, and to provide intelligence on critical industrial trends. HKUST also invites IP practitioners to share best practices and provide IP training to the University community on a regular basis.

The University continues to foster KT culture by encouraging faculty members and students to participate in different KT activities, as well as developing deeper collaborations with industry, government and society. A proactive approach has been adopted in exploring collaborative opportunities through open innovation forums including research and development workshops and networking sessions. The HKUST Science-for-Lunch Talks introduce state-of-the-art R&D to society and business leaders regularly. In addition, professors share their innovative research insights with the general public through interviews and regular columns in local newspapers, such as The Standard (see Appendix B for details). The University's **O**pen **R**esearch, **I**nnovation and C**o**llaboration **N**etwork (ORION) also provides an online open innovation platform for HKUST to engage with the industry and the general public.

Open innovation enables HKUST and the research partners to collaborate at an early stage to develop research that has direct impact on the industry. The University also provides support to researchers in the form of a Proof-of-Concept Fund to encourage them to undertake pre-commercialization development of promising inventions with commercial potentials. RDC acts as the business arm of HKUST for partnering with and transferring knowledge to the industry. To enhance KT enterprise, a new Chief Operating Officer of RDC has been recruited and assumed duty in November 2012. The operating, governance and financial practices and policies of RDC, as well as its operational effectiveness, have been reviewed to facilitate enhanced commercialization of technology inventions.

EC nurtures the entrepreneurial spirit within the University community through entrepreneurship education and training, business outreach and start-up incubation. The annual HKUST One Million Dollar Entrepreneurship Competition continues to draw many aspiring entrepreneurs. EC has recently introduced the E-Academy program to provide systematic entrepreneurial training to students. It has also initiated its Entrepreneur-in-Residence (EIR) program, which provides opportunities for faculty and students to explore the feasibility of setting up start-up companies with seasoned industry veterans.

2. Key General Achievements

2.1 Fostering Research Excellence and Culture

Funding success in collaborative research

HKUST was awarded a total of HK$162.6m in collaborative research[1] funding during the reporting year, a significant increase over the HK$68m awarded in the previous year. Funding for two HKUST-led projects — "Stem Cell Strategy for Nervous System Disorders" and "Cost-effective and Eco-friendly LED System-on-a-chip"—was secured from the Theme-based Research Scheme of the Research Grants Council. In addition, HKUST was awarded over HK$24m for the project "Large-scale Study on Realization and Application of SANI Process in Sewage Treatment in Hong Kong", and over HK$11m for the project "Indoor Localization, Tracking and Navigation" by the Innovation and Technology Commission (ITC) in conjunction with the Hong Kong R&D Centre for Logistics and Supply Chain Management Enabling Technologies (LSCM).

Two Areas of Excellence projects led by HKUST researchers were awarded a total of close to HK$100m on "Novel Wave Functional Materials for Manipulating Light and Sound" and "Mechanistic Basis of Synaptic Development, Signaling and Neuro-disorders". HKUST-led teams were also awarded two National Basic Research Program (973 Program) projects by the Chinese government. Furthermore, HKUST's application to set up a Partner State Key Laboratory on Advanced Displays and Optoelectronic Technologies was approved by the Ministry of Science and Technology (MOST) of China.

The past year also saw HKUST submitting a total of 69 applications to the ITF scheme, representing the most applications in the past five years. In particular the University submitted 12 applications under the University-Industry Collaboration Programme (UICP). This reflects industry's desire to work with HKUST to bring innovations that meet its specific needs.

The funding success demonstrates the level of participation of the HKUST research community in KT activities; it also shows that the University's brain power, expertise and research capability are recognized by both academia and industry.

Promoting theme-based research — Establishment of the Energy Institute and the Institute for Emerging Market Studies

The Energy Institute was established at HKUST in December 2012. It aims to provide a strong visible leadership role in energy research in Hong Kong, and to engage in emerging energy research that will have a long-term, transformative effect on Hong Kong and the nation's energy future. The Institute will plan and coordinate the energy research at HKUST and serve as a multi-disciplinary focal point for energy research in several areas of strength including sustainable energy production, energy storage, energy efficiency and conservation, as well as energy policy.

HKUST has received a generous sponsorship from Ernst & Young for the establishment of the Institute for Emerging Market Studies (IEMS), which seeks to provide thought leadership on issues facing businesses and policy makers in emerging markets. The Institute's objectives are to promote research collaborations,

[1] Collaborative research projects are those involving at least two partners (not including the institution itself), one of which is a government or public body.

communicate research findings, and provide a platform for exchanging ideas about issues facing emerging markets.

Significant breakthrough research with big impacts

HKUST has a clear positioning as a focused elite research and education institution. The University has made many world-class knowledge breakthroughs in the past and will continue to do so in the future. Two of the recent breakthroughs with commercial potentials are highlighted below.

A Technology Platform Based on the Aggregation-Induced Emission Phenomenon

Luminescence is often weakened or quenched at high concentrations, a phenomenon widely known as "concentration quenching". Professor Benzhong Tang (Chemistry) discovered “aggregation-induced emission” (AIE), an uncommon luminogen system in which aggregation worked constructively, rather than destructively as in the conventional system. Professor Tang and his research group is the world leader in the research and development of the AIE platform technology with potential applications in the areas of chemo-sensors, bio-sensors, cell imaging, protein conformation study, highly efficient solid state light emitters, and OLED. The technology platform is protected by 13 granted or pending patents. Meanwhile, the group is also collaborating with other universities such as National University of Singapore and South China University of Technology, as well as industry with the goal of commercialization.

Acoustic Metamaterials with Soundproofing Functions

Professor Ping Sheng, Professor Zhiyu Yang and Professor Che Ting Chan (Physics) developed a novel energy absorption metamaterial to absorb sound energy. The thin and light metamaterial is made out of elastic membranes with specially designed patterns of rigid platelets and can effectively absorb sound in selected frequency ranges. It is particularly effective against sound in low frequencies between 100–1,000 Hz. Absorptive metamaterial panels or walls can be made from this metamaterial. Such panels or walls can potentially be used to lower cabin noise in airplanes and to reduce environmental noise in buildings. The research team was awarded the 2013 Brillouin Medal by the International Phononics Society in recognition of this ground-breaking work. The University is now engaged in ongoing discussions with industrial partners interested in developing commercial applications for the technology together with the research team.

2.2 Open innovation at HKUST — Innovations that meet the specific needs of industry, society and government

Open Innovation enables researchers, institutions and corporations to collaborate at a very early stage, in identifying the technology challenges and developing innovative solutions. Through close interactions, more industry-relevant research with direct impact will be developed. The University encourages researchers to collaborate with corporations that are committed to long-term research and development through activities such as research forums and networking sessions. In particular, HKUST has been directly communicating many innovations to the public through the Science-for-Lunch talk series for the past year, as well as through regular contributions to The Standard, a local Hong Kong newspaper.

In addition, ORION (http://orion.ttc.ust.hk) provides an online platform for effective knowledge management and technology marketing. The platform adopts open innovation practices and allows HKUST researchers to connect with international partners and the public. ORION showcases the growing number of technologies and research resources available at HKUST. It features the latest research news at HKUST, technologies in selected areas, patent portfolio information and available software. It also contains a catalog of specialty compounds, including a series of chemical markers for Traditional Chinese Medicine (TCM). ORION provides a one-stop technology marketing and matching platform for the University and industry. The portal is now cross-linked with other regional IP exchange and marketing hubs including the Hong Kong Trade Development Council (HKTDC) and South International Technology Trading (SITT) Market, with more linkages anticipated in the near future.

Both HKUST's open innovation practice and the ORION platform have received positive feedbacks from research partners from institutions and corporations. The examples below illustrate how leading corporations and the public have benefitted from HKUST's adoption of open innovation practices.

Establishing joint laboratories with industry leaders

HKUST's faculty members have been collaborating with researchers from Huawei Technologies for the past five years through the Huawei-HKUST Innovation Laboratory, the company's largest joint-lab outside of China. The collaboration involves research and talent development in wireless communication, data analytics, and network and semiconductor technologies. In addition, Professor Qiang Yang (Computer Science and Engineering) was appointed the Head of Huawei's Noah's Ark Lab in Hong Kong, with the mission of conducting state-of-the-art research on data mining and artificial intelligence by exploring theories and building intelligent systems.

Deutsche Telekom AG, Laboratories (T-Labs) is supporting the HKUST System and Media Lab (SyMLab), to conduct pilot research in the areas of augmented reality (AR), mobile computing and networking, social networking and media, Internet services, cloud computing, and complex systems. SyMLab has the vision of bringing cutting-edge system and media research to Asia by providing an excellent academic research environment with strong ties to industries.

Delivering research and innovation for the benefit of society

HKUST researchers continue to serve the society through research and innovation. Professor Tim Woo, Professor Albert Wong (Electronic and Computer Engineering) and their research teams collaborated with the Hong Kong Society for the Deaf (through support from the Hong Kong Government's OGCIO) to develop mobile applications for linguistic training.

To broaden our students' international exposure and engage them in making contributions to the community, the School of Engineering has set up the Center for Global and Community Engagement, with programs that create and facilitate educational and leadership opportunities. Students are encouraged to utilize their engineering knowledge and technology knowhow innovatively in projects or competitions to contribute the society. The objective of the Center is to prepare the students with the knowledge and tools to confront shared global and social problems.

HKUST-MIT Research Alliance

HKUST and the Massachusetts Institute of Technology (MIT) initiated a research alliance anchored to a consortium of companies interested in the research and development of intelligent living technology. Forward-looking companies with interests in pre-competitive research are recruited under four major themes that are of importance to Hong Kong's future development and in which Hong Kong's tertiary institutions have strengths. Within each theme, research projects are developed with industry relevance in mind to ensure that companies would be interested in further developing these technologies into products. This innovative program is supported by MIT in conjunction with an ITF fund.

2.3 Proof-of-Concept Fund (PCF)

PCF continues to provide gap funding to faculty members for pre-commercialization development of promising, cutting-edge technologies emerging from their research. Industry experts are invited to sit on the PCF committees to evaluate the funding applications. They offer valuable inputs and perspectives to the faculty members. During the reporting year, 14 PCF applications were received, and the committee elected to support five projects with high commercialization potentials in the areas of power electronics, advance materials, photonic device and biomedical analysis.

Meanwhile, the University continues to look for technology transfer opportunities for completed PCF projects. Streamphony, a technology that enables distribution of video streams on the Internet with much better video

quality, lower bandwidth requirement, and lower hardware cost than most of its competitors, has been deployed by industry leaders China Mobile Hong Kong (CMHK) and Mei Ah Digital Technology for broadcasting live TV channels on the Internet. The University is also completing a licensing arrangement with a start-up company regarding a new contact lens technology for glaucoma diagnosis.

2.4 Fostering Research and Industry Connections with the Mainland

Over the past decade, HKUST has established research platforms at different strategic locations within China, including Shenzhen, Nansha, Foshan and Zhejiang. HKUST intends to play a more important role in the economic and social development of the nation through increased collaborations with the Chinese Government and industry. The HKUST Shenzhen Industry, Education and Research (SZIER) Building for the HKUST Shenzhen Research Institute (SRI) and the HKUST LED-FPD Technology R&D Center in Foshan both completed their first full year of operation last year. Significant progress has been achieved on these mainland platforms.

HKUST Fok Ying Tung Graduate School

HKUST's research platform in Nansha, the Fok Ying Tung Graduate School (FYTGS), has grown from strength to strength over the past six years, deepening its engagement in research and education in the Mainland. The School enables HKUST faculty and students to participate in Mainland research. With the Nansha New Development Zone being earmarked in the nation's 12th Five-year Plan as a commercial service centre, technological innovation centre and educational training base, the School hopes to play a significant role in the region's development and to become a major platform for fostering Hong Kong-Mainland collaborations.

HKUST Shenzhen Research Institute (SRI)

SRI provides space and equipment for scientific research, technology transfer and executive training at the 15,000 m^2 SZIER Building. The building houses HKUST Entrepreneurship Enterprises including Googol Technology (Shenzhen) Limited, Perception Digital Technology (Shenzhen) Limited, DJI Innovations, HiHex (深圳市艾合石科技有限公司), and Velda (深圳市萬達科技有限公司).

SRI also provides a platform on which HKUST's faculty members can apply for research funding from the Chinese Government. In the past year Professor Nancy Ip (Life Science) and Professor Benzhong Tang (Chemistry) were awarded grants of over RMB 30 million from the prestigious National Basic Research Program (973 Program) for research on Alzheimer's disease and aggregation-induced emission respectively. The research funding, together with R&D facilities in the areas of biopharmaceutical, advanced manufacturing, automation, electronic materials and packaging and mechanical engineering, places SRI in an excellent position for transferring knowledge to the Pearl River Delta area.

HKUST LED-FPD Technology R&D Center in Foshan

The HKUST LED-FPD Technology R&D Center in Foshan was opened in March 2012. In its first full year of operation, the HKUST LED-FPD Technology R&D Center has offered technical services, conducted personnel training and developed networking opportunities for the investment communities in the LED area. The Center has completed more than 60 technical projects for enterprises in the South China region. The services offered by the Center have been very well received by the industry. As a result, more companies are seeking technical advice from the Center. For personnel training, the Center has successfully held many workshops and technical forums on LED technology, with over 1000 attendees participating. Speakers at these events came from both academia and industry. The Center has also been assisting the Foshan government in attracting capital investment to the region, by receiving trade mission groups, as well as introducing foreign venture capital groups to the local community.

2.5 Fostering an Entrepreneurship Culture and Promoting Commercialization

HKUST's Entrepreneurship Center (EC) has continued to develop by focusing on three major areas: entrepreneurship education and training, business outreach and start-up incubation. The education and training events organized by EC attracted a large number of participants which included students, alumni, and

staff from the four schools at HKUST and external guests. In particular, "Be Your Own Boss" (BYOB)—one of EC's flagship seminar series—has been very well attended during the 2012/13 academic year with over a thousand participants.

EC has also developed a 3-credit technical elective course for undergraduates entitled "Introduction to Entrepreneurship" and offered it through the School of Engineering in the Fall 2012 and Spring 2013 semesters. This course attracted 30 students from different disciplines in each intake, and will be replicated in the following academic year. EC is continuing to develop entrepreneurship-related courses to enhance entrepreneurship education at HKUST. In particular, the University is currently considering the inclusion of specific BYOB seminars in a postgraduate credit-bearing course.

EC has also initiated the Entrepreneur-in-Residence (EIR) program, which will commence in Fall 2013. This program will provide personal direction for aspiring entrepreneurs by helping them to conceive, launch and manage their own enterprises.

In addition, EC launched a pilot program, called E-Academy, with the sole objective of creating entrepreneurs by a) providing systematic entrepreneurial training to students; and b) fostering an entrepreneur ecosystem within HKUST. This E-Academy differs from earlier efforts in that it will be largely managed by students themselves, and so they will be able to identify with it. The E-Academy ecosystem is envisioned to compose of students, mentors, external enterprises and partners. In this regard, the E-Academy is currently formalizing partnerships with HKUST satellite sites such as the LED-FPD Technology R&D Center in Foshan and the SRI in Shenzhen.

While the EC education and training activities target mainly aspiring entrepreneurs, the HKUST Entrepreneurship Program is executed jointly with RDC and aims to incubate entrepreneurs by guiding them to identify their value proposition and formulate a compelling business model. The program currently has 16 incubatees, and the objective is to deliver at least 25% of them to graduation in three years. This represents a more than double success rate relative to the industry norm of 10%.

The annual HKUST One Million Dollar Entrepreneurship Competition was held with a total of 85 eligible entries. The judging panels consisted of over 50 internationally recognized serial entrepreneurs who selected 12 finalists after several rounds of rigorous competition. Applications were received from local, mainland and international teams who had at least one HKUST faculty or student in their teams and who wanted to start their business in this region. This competition has helped HKUST to become a role model in promoting entrepreneurship in Hong Kong and surrounding region. The winning team of 2012 (Neoid) has achieved good business success and became an event sponsor this year.

Business outreach and networking activities have also been intensified. The Center communicates regularly with the local entrepreneurship network including the Hong Kong Business Angel Network (HKBAN), Science Park, Cyberport, The Entrepreneurs Network (TEN), MBA Entrepreneurship Club and HKUST Alumni. EC has also established international links with the entrepreneurship center of Tel Aviv University (Startau) in Israel, and universities in Turkey.

3. Impact Case Histories

3.1 Wi-Fi Data Access in Harsh Environments

Professor Gary Chan (Computer Science and Engineering) has been working on improving Wi-Fi network access since 2007. Current Wi-Fi networks suffer from limited coverage, high interference and costly setup. In certain harsh environments such as airports, container terminals, central business districts or mining fields where cabling is costly or blinds spots are many, providing pervasive Wi-Fi access is very challenging indeed. To overcome these problems, Professor Chan invented Lavinet, a software solution enabling an adaptive and high-performance multi-hop Wi-Fi network. The software implements innovative channel selection and routing algorithms that effectively eliminate dynamic and complex blind spots, avoid traffic congestion and

reduce signal interference. Lavinet can simply be installed in most Wi-Fi access points and wireless routers without modifying the existing infrastructure. A Wi-Fi client in the network, without having to install any software, can connect to the network to enjoy reliable and fast Wi-Fi data service. Lavinet intelligently searches for and assigns optimal wireless channels and routing paths. This greatly enhances the performance and maximizes the wireless coverage areas. The Lavinet technology is protected intellectually through a patent (pending) and software copyrights.

The research and development work on Lavinet started in 2007 and has since received over HK$10m in funding from ITC, Boeing Company, Hong Kong Aircraft Engineering Company (HAECO), Modern Terminals Limited, OpenPlatform Technology, Ruckus Wireless and Altai Technologies Ltd. The R&D team currently comprises more than 20 postgraduate and undergraduate researchers.

Lavinet has received several awards including HP Labs Innovation Research Awards in 2011, Silver Award of Boeing Research and Technology in 2009, Bronze Award for Best Innovation and Research Award at the HK ICT Awards in 2012, and Merit Award in Asia-Pacific ICT Award in 2012. It is currently deployed in the Tsing Yi terminals of Modern Terminal Limited. Lavinet has also been licensed to OpenPlatform Technology, successfully demonstrating the technology transfer of world-class research results to industry.

3.2 TCM Testing, Quality Control and Certification

Through the support from the Hong Kong Jockey Club since 1990, HKUST has established the Biotechnology Research Institute for research with a focus on TCM-based drug discovery. The multi-faceted state-of-the-art laboratory consists of best-in-class facilities and technology to drive both TCM-based research and drug discovery. HKUST has also established a rich database of TCM herbs with associated empirical data and developed a standardized process for isolating TCM extracts and fractions. The effort helps to enhance the acceptance and commercial profitability of TCM. HKUST has developed a successful knowledge-based drug discovery strategy whereby natural products such as TCM herbs are used as the starting point for identifying potential drug candidates for treating various diseases. Through this unique approach, HKUST has identified novel active candidates that are bioactive and have therapeutic significance in the treatment of diseases, such as Alzheimer's disease, that currently have no effective remedies.

In 2012, the Center for Chinese Medicine R&D was set up at HKUST with a grant of HK$5m from the Hong Kong Jockey Club to provide professional TCM testing, quality control and certification services in Hong Kong. The Center is currently keeping over 3,000 TCM biomarkers, which are made available to the TCM community.

HKUST has been working with different TCM and pharmaceutical companies on various issues, including the quality assessment of TCM raw materials and their commercial products, the determination of active ingredients and the investigation of biological effects. These companies include local and regional companies such as Guangzhou Pharmaceutical Holdings, and international companies such as GlaxoSmithKline and Sanofi-Aventis. Over 100 collaborative projects between HKUST and different industry players have been completed, with contract value over HK$100m. The projects have resulted in 26 TCM-related invention disclosures from HKUST researchers. Nine of the technologies have been transferred to commercial entities with contract value over HK$20m.

3.3 Eco-Friendly Sewage Treatment

Conventional biological wastewater treatment employs microbes to convert pollutants in water into carbon dioxide to treat wastewater. A major drawback of the process is that these microbes grow rapidly and eventually become sludge which also needs to be eliminated. But elimination is difficult and costly. In Hong Kong, for example, landfills taking sewage sludge are close to capacity and sludge incineration is undesirable because of the effects it would have on nearby residents and air quality.

Professor Guanghao Chen's (Civil and Environmental Engineering) research team developed an innovative Sulphate Reduction Autotrophic Denitrification and Nitrification Integrated (SANI) process for wastewater treatment. This energy-efficient and low-carbon sewage treatment technology makes full use of Hong Kong's

pioneering seawater flushing system. In particular, it utilizes the sulphate-reducing bacteria in seawater to oxidize and remove the pollutants. These bacteria are tremendously efficient, yet they have a much slower growth rate than the microbes in the traditional method. As a result, much less sludge is produced during the process.

HKUST worked with the Drainage Services Department on a successful pilot test for the SANI process in Tung Chung between 2007 and 2010. Results of the pilot test showed that this novel technology effectively reduced sewage sludge production by 90%, decreased energy consumption by 35%, and lowered greenhouse gas emissions by 35% when compared to conventional processes.

The research team has also launched a large-scale trial of SANI at the Shatin Sewage Treatment Works in April 2013, with the support of HK$24.6m in funding from the Drainage Services Department, ITC, and other private parties. This represents the largest sponsorship for a single local environmental ITF project to date. Upon successful completion of the trial, the Drainage Services Department would consider applying the revolutionary technology in several sewage treatment works in the territory. Successful demonstration may also lead to the future adoption of the SANI technology in other parts of the world.

The SANI process has also been adopted by the Hong Kong International Airport in conjunction with a low-cost triple water supply system that combines freshwater, seawater for toilet flushing, and water recycling systems for air-conditioning, kitchen and laundry activities. The technology has been globally recognized with the research team garnering three International Water Association awards and a second prize for the International Huber Technology Prize in Germany.

3.4 DJI Innovations – A success story of the Entrepreneurship Program

DJI Innovations is one of the leaders in developing and manufacturing high performance, reliable, and easy-to-use small unmanned aerial systems (UAS) for commercial and recreational use. A HKUST student, Weng Tao, founded the company under the guidance of Professor Li Zexiang (Electronic and Computer Engineering) in 2006. Once an incubatee company of the HKUST's Entrepreneurship Program, DJI has now established its headquarter at HKUST's Shenzhen IER building.

DJI produces unmanned helicopters of various sizes and types as well as creating algorithms that enable these aerial systems to be utilized effectively. Their autopilot technology coupled with their unique stabilization system enables a camera mounted on the remote-controlled helicopter to take and deliver images that are of comparable quality to those shot from manned helicopters but in a safer and more cost-effective manner.

As a pioneer of small UAS, DJI is committed to innovation and hopes to deliver the best flight technology to customers around the globe. The company is continuously investing in R&D with special emphasis on GPS positioning and WIMAX video functions in order to make their aerial systems more reliable and easier to use. They presently have over 500 employees and claim to be one of the largest companies within the UAS market.

4. Looking Forward

HKUST is committed to the KT strategies set forth and firmly believes that the increased relevance of its research to industrial applications and the enhanced connections to the industry along the KT process made possible with the KT funding will help strengthen its mission.

Looking forward, HKUST is excited to be the strategic partner to the Hong Kong Science and Technology Parks Corporation (HKSTPC) for InnoAsia 2013 with the theme of "Towards a Smart Green City Agenda" to be held on 4-7 December. The event will provide an excellent opportunity for HKUST to strengthen its relationship with industry, investors and the public, and to demonstrate Hong Kong's commitment to advancing innovation and facilitating the city's growth as a key technology hub in the region.

The University also looks forward to formally kicking off the HKUST-MIT Alliance Consortium early next year. With the support from MIT in conjunction with an ITF fund, the program will offer unique opportunities for universities in Hong Kong to collaborate with leading multinational corporations in conducting pre-competitive R&D with greater commercial impacts.

The University understands that strengthening its KT culture by engaging the University community in the KT process is critical to its overall success. The University will continue to organize public events such as industry days, public lectures and exhibitions, as well as research forums and networking sessions to facilitate interactions among researchers, industry and the public. An annual KT award, which aims to recognize outstanding KT achievements of faculty members whose innovations have significant impacts on the society, is also being planned for the upcoming year.

With the official launch of the E-Academy and the commencement of the Entrepreneur-in-Residence (EIR) program by the Entrepreneurship Center later this year, faculty and students will be able to receive enhanced training and support for starting their own businesses.

The University is also keen on integrating its KT infrastructure into the Mainland platforms, and then leveraging these platforms to support HKUST's KT initiatives in Greater China. The newly recruited Chief Operating Officer of RDC will further explore the KT potentials of the Mainland platforms. Technology transfer operations will be strengthened on each of these platforms to showcase and market HKUST's technologies, and to engage the local industry in collaborative research and development.

HKUST believes these exciting new initiatives and programs will further enhance its KT capability. The University will build on the momentum gained in the first year of the new triennium and continue to work with all stakeholders to ensure the overall KT strategic goals are achieved.

Appendix A – Key Performance Indicators

Performance Indicator		2011/12		2012/13	
Number of patents filed in the year		136		149 [Note 1]	
Number of patents granted in the year		52		80 [Note 2]	
Number of licenses granted		28		33	
	1. Exclusive license	19		21	
	2. Non-exclusive license	8		11	
	3. Option	1		1	
Income (on cash basis) generated from intellectual property rights		$4.0m		$2.8m	
Expenditure involved in generating income from intellectual property rights [Note 3]		$4.2m		$5.1m	
Number of economically active spin-off companies (with breakdown by type)		34		34 (26 spin-off, 8 start-up)	
	Companies with institutional ownership and using IP from HKUST	8		7	
	Companies with institutional ownership but not using IP from HKUST	26		27	
Number of collaborative researches, and income thereby generated		70	$68m	46	$162.6m
Note 4	With local collaborating organizations	44	$37m	30	$91.9m
	With Mainland collaborating organizations	22	$21.4m	20	$89.5m
	With overseas collaborating organizations	30	$22.6m	25	$79.9m

Note 1 CDCF Table 65: The number of patents filed is 149 and the number of inventions involved is 112 in the 2012/13 period.

Note 2 CDCF Table 66: The number of patents granted is 80 and the number of inventions involved is 49 in the 2012/13 period.

Note 3 The expenditure involved was used to support new patent applications in the reporting year and the expenses for all cumulative active patent applications and patents.

Note 4 These figures do not add up as some projects may involve a combination of local, Mainland, and/or overseas collaborating organizations.

Performance Indicator		2011/12		2012/13	
Number of contract researches (other than those included in "collaborative researches" above), and income thereby generated		117	$48.3m	118	$52.5m
	Local (Hong Kong)	67	$17.4m	62	$17.1m
	China	35	$10.9m	38	$19.1m
	International (excluding China)	15	$20m	18	$16.3m
Number of consultancies, and income thereby generated		87	$23.2m	75	$18.7m
Number of equipment and facilities service agreements, and income thereby generated		451	$4.8m	442	$2.2m
Number of student contact hours in short courses or e-learning programmes specially tailored to meet business or CPD needs		46,216 hours		35,869 hours	
Income received from Continuing Professional Development (CPD) courses		New KPI		$18.3m	
Number of public lectures / symposiums / exhibitions and speeches to a community audience		New KPI		239	
Number of performances and exhibitions of creative works by staff or students		New KPI		9	
Number of staff engaged as members of external advisory bodies including professional, industry, government, statutory or non-statutory bodies		New KPI		94	

Appendix B – Sharing of Innovation Research Insights by Faculty

Our faculty members write columns in newspapers regularly to share their research insights with the general public and promote knowledge transfer. The following clippings talk about the work of Prof Guanghao Chen ("How SANI cleaned up awards") and Prof Gary Chan ("How Lavinet bridges the wireless distance"). More clippings can be found at http://www.seng.ust.hk/web/eng/news_detail.php?id=740.

28 The Standard 英文虎報 Wednesday, March 13, 2013

Technology

How SANI cleaned up awards

Chen Guanghao

IN OUR PREVIOUS column, we discussed how we can make use of seawater to save our precious store of freshwater, minimize energy consumption and recover valuable fertilizer from our urine.

This week, we will discuss how seawater can help us to treat our sewage.

Every day, each of us produces 300 liters of sewage. Overall, we produce two million cubic meters of sewage a day in Hong Kong.

This can fill up Tai Tam Reservoir in less than 24 hours. Sewage treatment is not only expensive, but also produces a large amount of sludge requiring special disposal.

Conventional biological sewage treatment processes make use of microbes to digest and degrade sewage organic pollutants.

Since microbes grow rapidly, only about 40 to 60 percent of the organic materials will be converted into carbon dioxide and released into the atmosphere.

The remaining organic matter will be converted into biomass. The excess biomass will have to be disposed of as sewage sludge. In general, about 0.8 kilograms of sludge will be produced per cubic meter of sewage treated.

To treat all sewage generated in Hong Kong, about 2,000 tonnes of sludge is produced every day. Sludge disposal is costly, odorous and energy intensive. At the moment, it is being dumped in landfills. In future, it will be burned in a sludge incinerator.

Is there any way to avoid sludge production?

Every liter of seawater contains about 2.7 grams of sulfate.

By making use of the sulfate in seawater, we recently invented an environmentally friendly technology – known as the Sulphate reduction, Autotrophic denitrification and Nitrification Integrated process – which can minimize sewage sludge production.

The SANI process makes use of common microbes called sulfate-reducing bacteria to oxidize and eliminate pollutants.

In the conventional process, oxygen is provided by bubbling air to the reactors for the microbes to degrade the organic pollutants. However, in the SANI process, no oxygen is required.

The sulfate-reducing bacteria will use sulfate as the medium to oxidize the organic pollutants into carbon dioxide and sulfide. After that, oxygen will be provided to convert the sulfide back to sulfate, thus completing the treatment process.

Since the sulfate-reducing bacteria grow very slowly, the SANI process minimizes sludge production by 90 percent.

During a pilot plant trial in Tung Chung, no sludge disposal was required over a 225-day operation.

This reaffirmed that the SANI process can practically minimize the need for sludge disposal, and reduce 50 percent of sewage treatment costs, 50 percent of space requirements and 35 percent of carbon dioxide emission.

With full support from the Drainage Services Department and the government's Innovation & Technology Fund, a large-scale demonstration run of the SANI process will be conducted at Sha Tin Sewage Treatment Works later this year.

Our pioneering work earned five international awards last year including the Huber Technology Prize of Germany, Finalist of the World Smart Cities Awards of Spain and three other prestigious awards of the International Water Association.

We were also invited by the Unesco-IHE Institute of Water Education to jointly develop these technologies for developing countries hard hit by water scarcity, such as Cuba.

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How Lavinet bridges the wireless distance

Gary Chan

THE CURRENT MEN'S world record for the long jump is 8,95 meters (7.52m for women), while the triple jump record is 18.29m (15.5m for women). More hops mean a bigger distance can be covered.

The same can be said about our wi-fi connectivity. We can cover a longer distance if our wi-fi network, currently based on a single hop, can be extended to multiple hops.

Nowadays, many mobile devices use wi-fi to connect to the internet using radio waves.

Driven by many popular mobile applications such as Facebook, WhatsApp and Twitter, we often take wi-fi for granted and expect it to be available anytime and anywhere. We expect wi-fi coverage to be ubiquitous and pervasive 24 x 7.

Currently, the most common deployment method is called wi-fi hotspot, which offers internet access by wirelessly connecting the user directly to an access point, or AP.

Similar to a long jump based on a single hop, such hotspots have a limited coverage range. If you are outside the AP coverage, you have no signal and you cannot access the internet.

The situation is similar to wanting to cross from one side of a river to the other. If the river is narrow, you can simply hop over.

However, if the river is too wide, you need rocks in between so that you can cross the river in multiple hops.

This analogy is the same for wi-fi coverage.

If the AP is too far from you, putting some intermediate devices in between to relay the signal can extend its coverage to more users.

At HKUST, we are designing such devices to form a multi-hop wi-fi network called Lavinet. And the device to hop is called a Lavinet node.

Lavinet allows the user to connect to an AP that is a long distance away by relaying signals from one node to another in a multi-hop manner. Wi-fi coverage can then be extended with low cost.

But let's suppose that the river bank is wide and it has many rocks in between.

Given your hop stride, there could be many possible paths to cross the river, with some paths being faster than others. The problem is how to choose the best set of rocks to hop across the river.

Further consider a scenario where there are many users scattered along the edge wanting to cross the river through hopping between rocks. Each has a different hop stride.

If each rock at one time cannot hold more than a certain number of users, the task is then more complicated – which path should each user use so that everyone can cross the river in the shortest possible time?

The innovation of Lavinet is how to design paths so that the data traffic from many mobile devices can be efficiently connected to the AP.

Each of the nodes can intelligently decide which hop to forward its data to so as to achieve the maximum bandwidth experience.

Finally, imagine the most complicated situation in which various rocks are floating across the river.

In this case, designing the path to move all the users from one riverbank to another becomes very challenging, as the environment keeps changing and the decision has to be timely to move users from one rock to another.

Lavinet can be applied in a mobile environment by mounting the node inside a car or moving cart.

The situation is then like the above, with floating rocks.

My research team has been devising ways so that users can have reliable and good connections even in a changing mobile environment by means of multi-hopping.

Our approach takes into account many factors such as radio signal strength, interference and congestion. In this way, a user can stay connected even in a vast area, such as a golf course, with the Lavinet node in the cart.

The Lavinet technology has been successfully deployed in the industry so that users can enjoy uninterrupted and satisfactory wi-fi experience.

The project has received extensive support from the government and industry.

Lavinet is transforming our wi-fi experience to be more pervasive, faster and smarter. It allows us to live more freely than ever, wirelessly.

Next time you wade across a river, think about the multi-hop wi-fi that we at HKUST have developed.

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