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Research Assessment Exercise 2020
Impact Overview Statement

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University: The Hong Kong University of Science and Technology
Unit of Assessment (UoA): 12 - Electrical & Electronic Engineering
Total number of eligible staff of the university in the UoA: 39

(1)   Context

This UoA comprises the Department of Electronic and Computer Engineering, within the School of Engineering. As an engineering department, we focus on translating our understanding of science into practical applications that improve quality of life for individuals and foster economic growth, resulting in significant societal and economic impacts. Being an academic institution we also achieve impact on public policy and understanding by sharing our knowledge with the government, industry leaders, and the lay public through advice, open lectures, and workshops. The immediate non-academic users of our research are: i) established companies; ii) startup companies; iii) policymakers and government organizations, globally and in the Greater Bay Area of Greater China. In addition, new products and processes resulting from our research benefit numerous groups, e.g. consumers and hobbiests (e.g. easier to control drones) to factory workers and owners (e.g. better robot control) to logistics centers and the hospitality industry (e.g. better communication systems).

(2)   Approach to impact

During the assessment period, the Unit prioritized impact in line with our mission "to address global challenges and regional opportunities". We have established a culture that encourages impact, reflected in staff annual reviews and reporting on knowledge transfer work and impact evidence. The Unit fully supports faculty in achieving impact through a number of mechanisms:

Interaction with industry: Unit members are encouraged to engage with established engineering companies to address practical problems and opportunities identified by industry. This is facilitated through *joint research projects*, typically sponsored by the Hong Kong government's Innovation and Technology Fund (ITF). Among the activities arranged to help faculty secure these funds, ECE organized a workshop on strategies for maximizing success in ITF applications, with slides from the session subsequently made available on the departmental intranet. We have also arranged mock review sessions ahead of panel presentations. The success of this approach is evident in the increasing amount of ITF funding (average +22% year on year) during the period.

Industry interaction is also promoted through the establishment of *research centers and institutes,* which serve to i) consolidate and showcase research in a particular area, with access provided through a single point of contact; ii) attract a critical mass of researchers with expertise to be pooled in collaborative projects; and iii) act as a contact point for companies to recruit interns and graduates with relevant expertise (see Z. Li case on "Improvements in Motion Control Design of Industrial Robots"). The Integrated Circuit Design Center (ICDC), established in 2018, is one example, consolidating the expertise of 10 Unit members in integrated circuit technology, circuit design, and system design. The ICDC annual symposium in 2019 featured academic speakers from Hong Kong, Macau, mainland China, Japan, and the US, and industry speakers from the AI Institute at Sinovation Ventures, a leading Chinese venture technology firm; Moffet AI, which is building a next-generation AI computation platform; and Mentor Graphics, a leader in electronic design automation. Other examples of new research centers with significant industry interaction include the HKUST Robotics Institute; Intelligent Autonomous Driving Center; and Center for Artificial Intelligence Research.

Facilitating technology transfer: The Unit encourages faculty to patent their inventions, with support from the University's Technology Transfer Center. HKUST provides attractive terms for IP licensing income, which encourages faculty inventors to transfer their technology. After commercialization expenses are recovered, 50% of the first HK$2M in revenue goes directly to the creators. Thereafter, they receive 35%. Such support and incentives have been effective as can be seen in the large number of patents filed and granted during the review period: 292 and 165

respectively. Transfer of patents is then a concrete way in which new knowledge can impact industry users. This strategy's success is shown by the **_12 new licensing agreements signed_** over the review period. These agreements have also generated significant income (HK$7M) for the University.

      Industry standards: The UoA achieves further impact through contributions to industry standards, e.g. those established by the Institute of Electrical and Electronics Engineers (IEEE) Standards Organization (see case).

      Startup companies: The Unit encourages entrepreneurship among students and faculty. This takes many forms. One example is participation in entrepreneurship competitions. Successes include a team of ECE students, supervised by Z. Fan, with the team winning the highly competitive HKUST One Million Dollar Entrepreneurship Competition in 2016. These efforts often lead to faculty and/or students launching start-up companies. As of 30 June 2019, 17 active startups had been established by ECE members, 12 during this review period.

      Policymakers and governmental organizations: As an education institution, we prioritize making knowledge embedded within ECE and created through our research accessible to policymakers and the general public, where it can influence decisions as well as public awareness. One example is through faculty participation in the World Economic Forum, such as the HKUST IdeasLab at Davos. During the assessment period, faculty addressing global leaders at Davos included Z. Li, K.M. Lau, K. Ben Letaief, P. Fung and M. McKay. The Unit also works closely with governmental organizations, e.g. the Applied Science and Technology Research Institute (ASTRI), set up by the HKSAR Government in 2000 to enhance Hong Kong's competitiveness in technology-based industries through applied research. Two faculty members (R. Murch and V. Lau) are advisors.

(3)   Strategy and plans

In the forthcoming review period, we will:

i) Leverage our strength as a multidisciplinary innovator and solution provider, from devices all the way to circuits, systems and applications.

ii) Continue to implement the above approach, extending impact through new platforms, notably the HKUST Guangzhou campus being established, where research will be even more applied and transdisciplinary, and the campus will act as a gateway to industry interaction in the Greater Bay Area.

iii) In Hong Kong, we will also enter a new phase of industry engagement through the Unit's involvement in two of the three InnoHK clusters granted to HKUST: 1) Construction Robotics, directed by Z. Li, and 2) AI Chips, directed by T. Cheng. These clusters involve collaboration with top international institutions (e.g. UC Berkeley, Stanford and UIUC) and focus on technological adoption and commercialization.

iv) The UoA will further seek to expand industrial engagement through targeted establishment of research centers, and by encouraging and supporting faculty in expanding their industry-sponsored research and patent portfolios.

(4)   Relationship to case studies

The Unit's three case studies are based on our research excellence in wireless communications and networking, and control and robotic systems, which form two of ECE's six research pillars. R. Murch and V. Lau's case, *"Commercialization of wireless technology through a startup company, IEEE standard and patents,"* illustrates how our strategy of engaging with a government organization (ASTRI) led to a successful startup, now a medium-sized company with 300 employees and a market leader for long-range WiFi products. It also describes the successful transfer of patents developed at ECE and participation in IEEE standards. Z. Li's case, *"Improvements in the motion control design of industrial robots",* describes how a startup company hired HKUST students to integrate technology developed at HKUST to improve its motion control hardware, leading to increased sales. S. Shen's case, *"Integrating advanced technologies into autonomous drones",* illustrates how the HKUST Robotics Institute and HKUST-DJI Joint Laboratory led to research on visual-inertial simultaneous localization and mapping (SLAM) being adopted into commercial drones, vastly improving their ease of use, which in turn has led to increased sales and economic impact.