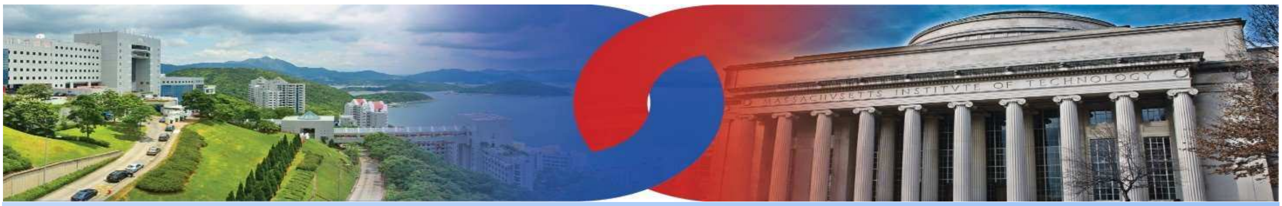

HKUST-MIT Research Alliance Consortium

Information Package

(Last updated as of 8 Feb 2018)

Lead Universities:

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

Massachusetts Institute of Technology

Participating Universities:

香港中文大學 The Chinese University of Hong Kong

香港城市大學 City University of Hong Kong

The Hong Kong Polytechnic University 香港理工大學

The University of Hong Kong

Table of Contents

Projects under IoT Founder's Round

Sponsors: Intel Corporation
Texas Instruments Incorporated

Project Name	PI	Project Start Date	Abstract
Integrated Thermal Energy Harvesting and Storage for Autonomous Wireless Sensor Network	Prof. Yi Chun Lu (CUHK) & Prof Yang Shao-Horn (MIT)	Phase I: 16 March 2015 Phase II:16 March 2017	Converting low-grade heat that naturally exists in the coupled human-environment system (e.g., body heat, indoor-outdoor temperature difference, solar heating, pipe lines, generators etc.) to electricity provides an attractive approach to create autonomous power sources for wireless sensor networks (WSNs) and wearable electronic applications. Such power supply will greatly improve energy efficiency and reduce the labor and cost associated with replacing hundreds or thousands of batteries needed in the WSNs. In this project, integration of thermal energy harvesting and storage will be developed by 1) integrating flexible thermoelectric devices and flexible rechargeable batteries using intelligent power management and 2) by charge-free thermo-battery devices. Key technologies to be developed include flexible

			electroplating-based thermoelectric device prototypes, flexible rechargeable battery prototypes, smart power management circuits, and charge-free thermo-battery prototypes. The prototype designs, physical/mathematical models and system integration designs to be developed in this project will be core technologies and necessary knowledge for creating a sustainable thermal power supply system for autonomous WSNs and wearable electronics applications.
Sensor Interfaces and Wireless Platforms for Smart Green Buildings	Prof. C.Y. Tsui (HKUST) & Prof Anantha Chandrakasan (MIT)	Phase I: 15 Jan 2015 Phase II: 15 Jan 2017	The aim of this project is to continue enhancing the design of the building blocks of an integrated multi-sensing platform for smart green buildings developed in Phase I of this project, and more importantly integrate the sensing, processing, energy harvesting and communication modules into a single working prototype for field test in a real-world setting. The sensing node will feature air quality, temperature, humidity, vision, water quality and thermal insulation sensing together with a power generation module that harvests energy from solar and RF sources, and a low power data transmitter and receiver. Large-scale

			deployment of the developed sensor node is made possible by its low cost and self-sustainability. Based on the research results of Phase I of the project and the comments of the industry sponsors, new features are identified and new enabling technologies will be developed in this phase of the project to enhance the practical use of the sensing node and enable integration for the final field deployment. The detailed project objectives include: (i) address the packaging issues and the final PCB-level integration; (ii) investigate the use of microfluidics and micro-LEDs in the water sensing platform for enhanced integration; (iii) design the methodology for robust gas mixture sensing based on new materials and machine learning algorithms and integrate the technology into an electronic nose microsystem; (iv) develop an efficient face recognition algorithm and integrate it into the developed image sensor; (v) improve the reliability of the pressure sensor and its yield; (vi) investigate the use of thermocouples to harvest energy in addition to the developed solar and RF energy harvester; vii) integrate the developed building block into a working prototype ready for

			field test in real application. In a nutshell, this project will extend the research of Phase I of the project and move the developed sensing node technology closer to actual field applications and commercialization.
A Sparse Recovery Approach for High-Throughput Energy-Efficient Wireless Networks	Prof. Sidharth Jaggi (CUHK) & Prof Dina Katabi (MIT)	Phase I: 31 Jan 2015 Phase II: 28 Feb 2017	The Internet-of-things (IoT) creates unprecedented demands for wireless throughput and energy-efficient communication, which cannot be satisfied by existing network designs. Our project re-examines the network stack from the physical layer all the way to the application layer, to develop new techniques that deliver higher data rates while meeting the energy constraints of the various IoT devices. The project develops software-hardware architectures and targets both low-end sensors for smart environments and high-rate IoT devices such as cameras and virtual reality systems. Our protocols exploit a common thread that enable us to optimize performance in a mathematically sound way. Specifically, it is common in network settings to have complex systems with many variables. However, often enough these variables are correlated

			and depend on a handful of parameters or degrees of freedom. Such problems are referred to as sparse problems and can be addressed with tools and techniques from sparse recovery theory. For example, in mmWave communications, a device may have hundreds of antennas leading to hundreds of channel variables. However, since a mmWave signal propagates along a couple of physical paths, all of these channel variables are correlated and depend on a few path variables. We leverage such sparsity wherever it exists to reduce complexity and optimize performance.

Projects under DS/E-learning Cluster

Sponsors: NTT Com Asia Limited
Trumptech (Hong Kong) Limited

Project Name	**PI**	**Project Start Date (Phase I)**	**Abstract**
An Open Learning Design, Data Analytics and Visualization Framework for E-Learning	Prof. Huamin Qu (HKUST) & Dr Una-May O'REILLY (MIT)	1 July, 2016	The aim of this project is to serve MOOC instructors, instructional designers, institutional curriculum leaders and learning scientists by developing an open framework that integrates three major e-learning technology components: 1) Learning and assessment design models and tools that guide and support e-learning course design and the advance planning of specific learning analytics and evaluation requirements; 2) analytical methods, including learning behavior analysis and predictive analytics, for facilitating personalization of online learning and improving the retention rate of MOOC courses; 3) visualization interfaces for understanding the huge amount of data collected by MOOC platforms and the analytical results. An open source instantiation of the framework will be developed and pilot studies with multiple real

			MOOCs and blended courses will be conducted at Hong Kong University of Science and Technology, MIT, and the University of Hong Kong. The outcomes of this project include a novel approach and suite of tools for e-learning design, tested models of pedagogical and assessment designs for e-learning, new analytics and data visualization methods for learning behavior analysis and prediction, a comprehensive open source system for MOOC course design and data analytics, and new findings on e-learning from the multi-university pilot studies.
PEP:A Personalized E-Learning Platform	Prof. Dit Yan Yeung (HKUST) & Prof Boris Katz (MIT)	1 July, 2016	The long-term goal of our R&D mission is to significantly improve the learning effectiveness of learners on e-learning platforms through personalization, as opposed to the traditional one-size-fits-all approach. To achieve this goal, our project will consist of three major components. First, the profile of each learner will be continuously modeled and updated throughout an online course to give a longitudinal engagement trajectory of the learner. The learner profile will be created from mining both structured and unstructured data. Second, based on the features

			extracted for modeling learner profiles and the knowledge graph constructed from the course content, the performance of each learner will be assessed and predicted with the goal of identifying the areas of and reasons for underperformance. Third, based on the individual assessment and the knowledge graph, personalized remedial learning activities will be recommended to the underperforming learners. We will apply advanced artificial intelligence and data mining technologies to develop these components of the PEP platform. Personalization plays a key role in the pursuit of this research direction because paying attention to the special needs of each individual learner in a personalized, just-in-time manner will likely improve the motivation and effectiveness of learning and result in increased retention rates.
Evidence Based Education based on Data Analytics- Moving Towards a 360 View of the Student	Prof. Lei Chen (HKUST) & Prof John R. William (MIT)	1 December,2016	Our goal in this project is to develop the foundations and tools necessary to move academia towards "Evidence-Based Education" by using data analytics targeted not only at post-course analysis but also at predictive analysis of student performance. For example, based on

			data collected from the first few weeks of a course we believe we can predict many of difficulties the student will face downstream or we can design a tool like Google Navigator, a learning assistant that gets to “know” the student and can give advice and reminders to the student. We plan to incorporate IoT devices to measure not only academic performance but also stress and other social issues the student may be facing. This project team has expertise in data analytics and will propose mixture multivariant models as quality measures during the teaching/learning process for online courses. Without effective techniques to detect outliers or perform transfer learning on quality statistics, teachers may not be able to accurately identify course materials with low quality, give quick assistance to students who have difficulties in their learning, or apply effective teaching methodologies that can successfully help students learn new knowledge. Most importantly, with feedback from teachers and students about the mixture multivariant quality measures, this project will give teachers a 360 degree view of the student and help improve teaching/learning course materials or methodologies, and adaptive achieve high-quality

			education for both individual students and groups of students. Members of the team have already developed an HTML5 course platform on portable devices for gathering stream clicks, keyboard events etc. A Fortune 500 company is currently deploying this course platform in several developing countries.

Projects under IoT Cluster

Sponsors: Lenovo Group (China) Limited
Schneider Electric Buildings LLC

Project Name	PI	Project Start Date (Phase I)	Anstract
IoT/Smart City: Communications Networks and Data Analytics for Intelligent Transportation Systems	Prof. Soung-Chang Liew (CUHK) & Prof Vincent Chan (MIT)	1 May 2017	The research will address an IoT communication and network architecture that is more responsive with much better performance than current networks. It will use data analytics and cognitive techniques to sense and rapidly adapt to data traffic changes to maintainh high performance and support time-critical service: aspects that are very important to safeguard vehicle safety in ITS (Intelligent Transport Systems). Our research will focus on the following: 1. Overall network architecture for highly mobile networks with cognitive and fast network congestion-surge adaptations: wireless (infrastructure-based and MANET) and fiber access networks.

			2. Cognitive sensing and networking to recognize rapid state changes for quick response and optimization 3. Data analytics for improved transportation systems 4. An IoT application on EV charging in ITS using IoT sensors and network 5. Network architecture that supports critical messaging with time deadlines for ITS particularly for platforms with high mobility and fluid connectivity – enhancing vehicular safety using IoT sensing, data analytics, and quick reaction algorithms. As verification of algorithms and applications, we will implement/simulate some of the concepts in a test-bed to be located in CUHK with contributions from all participants.
Smart Adaptive Control/monitoring System for Energy-Efficient Buildings with Low-carbon Footprint and CMOS MEMS sensors and smart actuators	Prof. Yi-Kuen Lee (HKUST) & Prof Nicholas Xuanlai Fang (MIT)	1 June 2017	This joint research consortium between Hong Kong and MIT will focus on the research and development of integrated smart control and management system technology to create sustainable energy efficient buildings (EeBs), including energy-efficient, low-carbon footprint indoor environments. A series of inter-connected technologies, including artificial intelligence-

			based data analytics for EeBs with multiple low-cost CMOS MEMS sensors, metamaterial-based smart windows, personalized ventilation system, smart adaptive energy-efficient control systems for HVAC (Heating, Ventilation and Air Conditioning), advanced computational modelling techniques for design of EeBs will be developed. A combination of advanced experiments and numerical modelling will be employed to develop advanced EeBs to meet the grand challenge of a sustainable built environment. We propose in this series of technology developments to bridge the gaps between basic research and practical engineering, then move to developing novel, yet technically feasible and cost-effective products and technologies that can be applied by the industry. Our multi-disciplinary research team from four different departments and includes senior and junior researchers in electronic and mechanical engineering, computer science and engineering, building technology and architecture engineering. All the team members are leaders or renowned experts in their own fields and with solid track records in leading major research efforts. We

			hope that this research can serve as a platform for further developing science and technology in this important area and support the long-term development of Hong Kong government's 2015~2025+ Energy Saving Plan, and the other part of the world as a leader in implementing a sustainable EeB.
Integrated Network Control for Massively Many IoT Devices	Prof. Wing-Shing Wong (CUHK) & Prof Moe Z. Win (MIT)	1 January 2018	By enabling a growing number of devices to connect and coordinate with each other, the Internet-of-Things (IoT) is becoming the infrastructure of the information society. The massively many connected devices can serve people in multiple dimensions with unprecedented efficiency and effectiveness. The PIs envision that three components are necessary for the effective operation of the IoT, which are situational awareness, efficient networking, and integrated networked control. Following this vision, the proposed research focuses on three primary areas: A new framework and algorithms that exploit the environment for efficient localization; new technologies for multiple access, networking, and data fusion to enable efficient information flows among many IoT devices; and integrated control and resource optimization algorithms that account for communication

			options and constraints of heterogeneous IoT devices. The resulting technology has the potential for immediate economic and societal impact. For example, it will enable new energy-efficient assisted-living facilities, enhance user experience in malls and transportation hubs, and provide a platform for remote interactive control over the Internet. Our research is grounded on a cross-pollination of ideas and methodologies from signal processing, optimization theory, control theory, communication theory, and information theory.

Projects under Adv Mfg Cluster

Sponsors: Delta Electronics, Inc

Lenovo Group (China) Limited

Project Name	PI	Project Start Date (Phase I)	Abstract
Prehensile Dexterity for Autonomous Robotic Manipulation	Prof. Michael Wang (HKUST) & Prof. Alberto Rodriguez Garcia (MIT)	1 January 2018	The aim of the proposed project is to develop a suite of practical tools for realizing robotic dexterity for part handling and manipulation, with a direct application to assembly automation for small consumer electronics products. Robotic dexterity has been considered as key to assembly automation. Traditional approaches to attaining robotic dexterity include using multi-fingered, multi-jointed robot hands that can provide a large number of controllable degrees of freedom, and crafting a sequence of simple tasks each of which can be addressed by a special-purpose end-effector. However, the current state of the art is not advanced enough to effectively automate electronics assembly, which is almost entirely done by human labor. Building on our technical expertise in the theory and practice of robotic

			manipulation, mechanism design, and system integration, we propose devising (1) practical robot planning/control software for grasping, regrasping, reorienting, and inserting a wide range of parts, and (2) actively-controlled, variably-stiffening robotic grippers and fixtures. The proposed techniques can be implemented with minimal actuation and sensing, which promise speed, robustness, scalability and adaptability in a wide range of scenarios.
2 projects to be confirmed			

Projects under Biomedical Systems Cluster

Sponsors: Aptorum Therapeutics Limited
BGI HONGKONG CO., LIMITED
Philips North America LLC

Current Status
5 projects to be confirmed