

RGC Ref. No.: UGC/IDS13/14 <hr/> (please insert ref. above)
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**RESEARCH GRANTS COUNCIL  
COMPETITIVE RESEARCH FUNDING SCHEMES FOR  
THE LOCAL SELF-FINANCING DEGREE SECTOR**

**INSTITUTIONAL DEVELOPMENT SCHEME (IDS)**

**Completion Report**  
(for completed projects only)

**Submission Deadlines:**

1. Auditor's report with unspent balance, if any: within **six** months of the approved project completion date.
2. Completion report: within **12** months of the approved project completion date.

**Important Note:**

**In completing the report, please use the following format:**

Page limit: Items 1 to 5 and Summary of Completion Report: no page limit  
Items 6 to 9: maximum **20 A4 pages** (excluding any appendices and attachments)

Font: Times New Roman

Font Size: **Not smaller** than Point 12

Margin: Two centimeters margin all around

Spacing: Single-line spacing

**1. Project Title**

Programme for the Enhancement of Research Capacity in Sustainable Systems and Technologies 持續系統及技術之研究能力提昇計劃

**2. Investigator(s) And Academic Department(s) / Unit(s) Involved<sup>#</sup>**

Project Team	Name / Post	Department / Unit	Average Percentage of Work Hours Spent on this Project
Project holder* (i.e. Head of Institution)	Professor LEE Chack Fan, President	Chu Hai College of Higher Education	10%
	Mr CHU Hoi Shan Head of Department	Department of Architecture	30%
	Professor WONG Yuk Lung, Professor	Department of Civil Engineering	20%
	Dr. GAO Yuan, Assistant Professor	Department of Civil Engineering	10%
	Professor LO Wai Lun Head of Department	Department of Computer Science	30%

<sup>#</sup> Please state the **key** staff and department/unit involved in the project. Please add row(s) as necessary. Please

also highlight the approved changes in project team composition and quote the date of the RGC approval for such changes.

\* Refer to "Principal Investigator" for 2014/15 exercise, "Applicant" for 2015/16 exercise and "Project holder" for 2017/18 exercise onwards.

### 3. Project Duration

	Original	Revised	Date of RGC / Institution Approval (must be quoted)
Project Start Date	1 Jan 2015	-	-
Project Completion Date	1 Jan 2018	-	-
Duration (in month)	36 months	-	-
Deadline for Submission of Completion Report	31 Dec 2018	-	-

### 4. Project Objectives

Summary of objectives addressed / achieved:

Objectives*	Percentage Achieved	Remarks**
1. Facilitate research into systems, technologies and practices that will advance sustainable development for the built environment	100%	Established an environmental laboratory equipped with a wind tunnel facility, environmental sensors and monitors etc. These resources have been well adopted in teaching and research at the department of architecture. A faculty level research unit has been established to promote interdepartmental research and pursue collaborations.
2. Establish a high-performance computing platform in an advanced model creation and testing environment that provide effective 3D modelling and simulation tools in architectural and construction designs, so as to enhance the understanding of requirements for sustainability	100%	Architecture department set up ANSYS Fluent Computational Fluid Dynamics platform that was used in researching into urban wind behavior and the impact of urban development and emergence of various building typologies since 1960-2015. A research assistant with Master Degree qualification and adequate air ventilation modeling experience has been employed to work under Dr. Ruffina Thilakaratne and Prof. Paul Chu. 3 papers have been submitted to conferences and award competitions based on the outcomes from these researches.
3. Develop an environmental data collection and management system to support real time	100%	

Objectives*	Percentage Achieved	Remarks**
monitoring processes and procedures, efficiently and gathering and analyzing information of relevant factors that impact environment		
4. Organize activities for promoting a basic framework of information sharing and exchange in the College to enhance dissemination of knowledge on sustainability, via seminars, workshops, forums, etc.	100%	Two conferences have been organized and Chaired by the department of architecture in 2016 and 2017. Dr. Ruffina Thilakaratne and Miss. Yana Xiao has been presenting their research papers at International Conferences in Adelaide and Hong Kong. A paper was also submitted to Royal Institute of Architects Presidents Award for Research. Outcomes of research also submitted to Hong Kong Green Building Council Awards under research and planning category and won a finalist award in 2016.
5. Enable the development of new computer science, civil engineering and architectural design curricula to educate a new generation of scientists, engineers and architects who will incorporate sustainability concepts into design and processes.	100%	Established environmental laboratory equipped with a wind tunnel facility, environmental sensors and monitors etc. has been well integrated into teaching and design studios. Students test their physical models made using fabrication facilities established under the same grant in the wind tunnel to see their impact on the surrounding wind environment.

\* Please refer to the originally approved objectives. If there are changes in objectives, please highlight the changes and quote the date of RGC approval for such changes.

\*\* Please provide reasons for significant slower rate of progress when compared with the approved implementation timetable.

## 6. Research Outputs

### 6.1 What are the accomplishments of the project?

- (i) *Please provide reports on conference, seminar, workshop, exchange programmes or other activities held (if applicable).  
(Please provide details of the activities organized, including the theme / objectives of the activities, targeted participants, attendance, analysis of participants, e.g. country of origin, research background, etc., evaluation forms of the activities and a summary of the participants' evaluation. Photos of the activities are preferred.)*

Sustainable Systems and Technologies is one of the popular research area in the science and engineering. Sustainable system and technologies are also driven by environmental awareness and protection. The major aim of this research project is to enhancement the research capacity of the faculty of science and engineering in sustainable systems and technologies through the cross-disciplinary research in the three departments of architecture, civil engineering and computer science. This project will establish a high-performance computing platform in an advanced model creation and testing environment that provide effective modelling and simulation tools in architectural and construction designs, so as to enhance the understanding of requirements for sustainability. The HPC platform is developed for environmental data collection and management so as to facilitate the analysis on this information of relevant factors that impact the environment. Throughout the project period, a number of scholarly activities have been organized for promoting a basic framework of information sharing and exchange in the College to enhance dissemination of knowledge on sustainability and application of HPC platform. Finally, the project can enable the development of new computer science, civil engineering and architectural design curricula to educate a new generation of scientists, engineers and architects who will incorporate sustainability concepts into design and processes.

1. 3-D Printer Introductory Workshops (organized by Mr Paul Chu)  
Three 3-D Printer Introductory Workshops were organized on 4 and 14 November 2015 at the Architecture Workshop of the College. It introduced students and the general public how 3-D printing and laser-cutting technology interlace with relevant computer software in the design process of contemporary product, architectural and urban design disciplines. It also explained how these pieces of equipment assist sustainability research and teaching. A total of 44 participants attended the workshops.
2. Research Workshop (organized by Mr Paul Chu)  
A workshop in the presence of Professor Kazuo Iwamura (Tokyo City University, Japan) and department staff was organised on 26 Oct to 7 Nov 2015. The 11-day workshop encompassed review of the research proposal, methodology, formulation of literature review and reading list. It included sharing of case studies, site visits, meetings of 'research integration into curriculum and pedagogy', progress reviews, and student workshops. Both students and teaching staff benefited.
3. Conference attended and paper presented
  - (a) Assistant Professor David Booth presented his paper 'Schools in Hong Kong: acoustics case study, with particular reference to schools' auditoria ' at the 9th International Conference on Auditorium Acoustics on 29-31 October 2015 in La Philharmonie, Paris, France. The conference attracted around 400 participants.

- (b) Senior Lecturer Leung, L.M. Gordon, Wong, W.G. (2015) "Effect of Pine Aggregate Composition on Moisture Susceptibility of Hot Mix Asphalt", RILEM Book Series Val 11, 8th International RILEM Symposium on Testing and characterization of sustainable innovative bituminous materials and systems, Ancona, Italy, 735-744. The conference attracted around 200 participants.
4. Climate Change Adaptation: Creating a Resilient Hong Kong Conferences (Conference organizer & Chair Dr. Ruffina Thilakaratne)  
In March 2016 the Department of Architecture hosted a one-day conference on the theme which was attended by around 125 participants.
5. Workshop on Development High Performance Computing (HPC) Cluster System and Matlab software (Organised by The Department of Computer Science)  
It introduced the information about HPC and Matlab, as well as machine learning methods. 25 participants (18 BA students in Chu Hai College, 7 Chu Hai staff) attended.
6. IDS Workshop on Deep Learning and Recursive Neural Networks (Organised by the Department of Computer Science)  
On 21 April 2017, the Department of Computer Science hosted a workshop. The academic staff and research staff participated in the workshop.
7. IDS 2017 Workshop on Applications of Deep Learning Neural Networks (Organised by the Department of Computer Science)  
On 20 Oct 2017, the Department of Computer Science has organized a workshop for the academic and research staff.
8. Resilient & Robust Cities conference (Jointly organized by Departments of Architecture and Civil Engineering) Organized by Dr. Ruffina Thilakaratne (Chair) and Dr. Belinda Gao (Co-Chair). The conference was held on 7 December 2017 and was supported by nine professional institutes and NGOs in Hong Kong. They are Hong Kong Institute of Architects, Hong Kong Institute of Engineers, Hong Kong Green Building Council, Business Environmental Council, Hong Kong Town Planners Institute, Canadian Society for Civil Engineering Hong Kong Branch and Hong Kong Waster Management Association. About 80 participants who represented professionals, academics, students, NGO representatives, representatives from the professional bodies attended the conference. Majority of them are from Hong Kong with one participant from Japan.
9. "Effect of Residential Tower Geometries on Urban Wind Environments" paper was prepared based on the outcome from urban ventilation research led by Dr. Ruffina Thilakaratne Dept. of Architecture. The paper was presented by Dr. Ruffina Thilakaratne at World Sustainable Built Environment Conference in Hong Kong in June 2017. The research team consist of Dr. Ruffina Thilakaratne, Miss. Yana Xiao and Associate Professor Paul Chu.
10. "Optimization of Hong Kong Residential Building Design Guidelines to Improve Urban Air Ventilation" paper was prepared based on the outcome from urban ventilation research led by Dr. Ruffina Thilakaratne Dept. of Architecture. The paper was jointly presented by Dr. Ruffina Thilakaratne and Miss. Yana Xiao at Architectural Science Association Conference held in Adelaide in December 2016. The research team consist of Dr. Ruffina Thilakaratne, Miss. Yana Xiao and Associate Professor Paul Chu.



11. “Impacts of building typologies on pedestrian wind environments in high density urban areas” paper was prepared based on the outcome from urban ventilation research led by Dr. Ruffina Thilakaratne Dept. of Architecture. The paper was submitted for RIBA President Award for Research and the research was selected for publishing on book of abstracts. The research team consist of Dr. Ruffina Thilakaratne, Miss. Yana Xiao and Associate Professor Paul Chu. RIBA published abstracts according to their templates and by extracting from the papers submitted. Acknowledgments were mentioned at the end of the paper.

## SUMMARY

In this project, the Faculty of Science and Engineering of the Chu Hai College of Higher Education has organized a number of workshops and conferences to cover the following area:

1. Testing and characterization of sustainable innovative bituminous materials and systems
2. Climate Change Adaptation: Creating a Resilient Hong Kong
3. Application of High-Performance Computing (HPC) Cluster System
4. Machines Learning, Deep Learning and Recursive Neural Networks
5. Study in Resilient and Robust Cities

The outcomes of this research project led to a number of conferences and journal publications in the following area:

1. Impacts from Building Geometries on Urban Wind Environments.
2. Optimization of Hong Kong Residential Building Design Guidelines to Improve Urban Air Ventilation
3. Impacts of building typologies on pedestrian wind environments in high density urban areas
4. Meteorological Visibility Evaluation on Webcam Weather Image using Deep Learning Features
5. Applications of HPC on machine learning research
  - *Facial Expression Recognition Using Depth Map Estimation of Light Field Camera*
  - *Cuffless Blood Pressure Estimation Based on Photoplethysmography Signal and Its Second Derivative*
  - *A Novel Object Tracker Designed Based on a Complementary Framework*
  - *Light field-based Face Liveness Detection with Convolutional Neural Networks*

This research project also led to research collaboration with other institutions. We have established collaboration with the Asian Disaster Preparedness Centre (ADPC), Bangkok through Dr. Senaka Basnayake, the speaker whom we invited for Climate Change Adaptation Conference in 2016. Now the Master of Architecture programme conducts a project in Thailand annually coordinated by the ADPC to meet government officials and community in Thailand. The research outcomes of this IDS research project led to a recently funded FDS research project and research collaborations with Prof. Henry S.H.Chung (Co-I) in the department of electronic engineering of City University of Hong Kong. The following project is a further research in meteorological visibility estimation by using particle swarm optimization and neural network.

- [1] Meteorological Visibility Estimation by using Particle Swarm Optimization and Neural Network, UGC/FDS13/E02/18, Prof. W.L.LO (Principle Investigator), Dr. HONG FU (Co-Investigator), Jan 2019-Dec 2020, 24 months, HK\$ 580,275

In this IDS research project period, a Sustainable Systems and Technology Research Centre has been setup in our College to provide a platform for continue research in sustainable systems and technologies.

(Details of Activities and Pamphlets – **Appendix 1**

- (ii) Please provide reports on asset purchase such as acquisition of research facilities, communal equipment, software licence, dataset and / or status of infrastructure / physical research structure building such as research centre, research supporting unit (if applicable).  
(Please provide supporting documents and / or photos, and provide the utilization rate.)

Department	Equipment Descriptions	Qty
<b>Architecture</b>	3D scanner	3
	Leica DISTO laser distance meter	2
	DJ UAV (fly camera)	1
	External hard disk	2
	Spectrum LightScout Foot-Candle Meter	2
	Digital environmental sensors (Humidity, Temperature, Wind, Lux levels)	4
	Spectrum IR Crop Temp Meter	2
	Testo 870 thermal camera	1
	Kestrel Rugged Environmental Meter	2
	Desktop logger	1
	Testo data logger	2
<b>Civil Engineering</b>	PRIMA 100 portable LWD system	1
	CRT-UTM-NU testing machine	1
	Air compressor FRIC-4HPx100G	1
	Metal mould	1
	YSF CX-105 Reflectorless Total Station	1
	1586A/IHC/C Super-DAQ Precision Temperature Scanner w/High Capacity Module and Accredited Calibration	1
	Fluke Calibration 5615-6-J Secondary PRT	1
	1620A Precision Thermo-Hygrometer with RS232 cable	1
	IOT VOC, CO2, Temperature, RH sensors and coordinator	1
	RION integrating sound level meter and real-time analyser NA-28BA	1
	YSI Multiparameter Instrument	1
	Son Tek hydrosurveyor	1
	In-Situ (Twist-Lock Backshell/Hanger)	1
<b>Computer Science</b>	<b>Dell™ PowerEdge</b>	
	PowerEdge R730 1) Dell MD3800i 2) Dell N4032 Switch	12
	LCD monitor & Racks with PDU	4
	Matlab, Concurrent Licence	
	PowerEdge C4130 Server	
	CS Rack PDU	4
	Dell Precision Tower 5810 ZCTO Base (x2)	2
	Dell Networking N3024	
	Lytro Illum camera	1
	Sandisk 64 GB	1
	2 TB hard disk	1

DEPARTMENT OF ARCHITECTURE

### **Establishment of environmental & fabrication facilities**

The department of Architecture established an environmental laboratory equipped with a wind tunnel facility, environmental sensors etc. and a digital fabrication laboratory, which have been well integrated into research, teaching and design studios. Students test their physical models made using these fabrication facilities in the wind tunnel to see their impact on the surrounding wind environment.

Following software were purchased for research and educational purposes

Item	Quantity	Usage frequency
3D scanner	3	Often used for topography and object scanning for models Around 10 times per semester
Leica DISTO laser distance meter	2	Used during site visits, around 15 times per semester
DJ UAV (fly camera)	1	For taking arial context photos during site visits; around 15 times per semester
External hard disk	2	Used daily for backing up data

### ***Fabrication facilities***

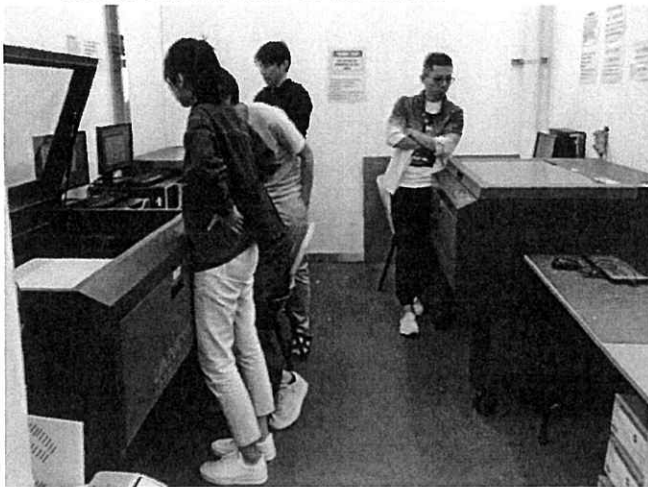
These machines are used extensively when there are project presentations by all 6 programme year students on at least bi-weekly basis. These machines are managed by a full-time technician.

#### **3d Printers**

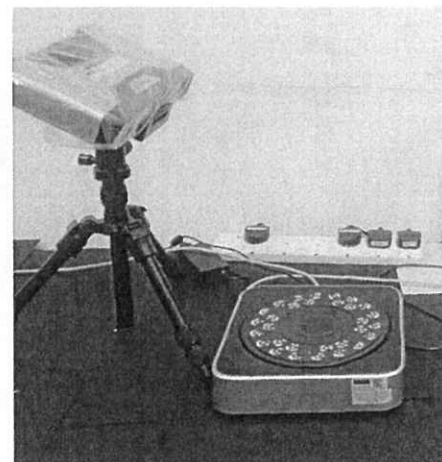
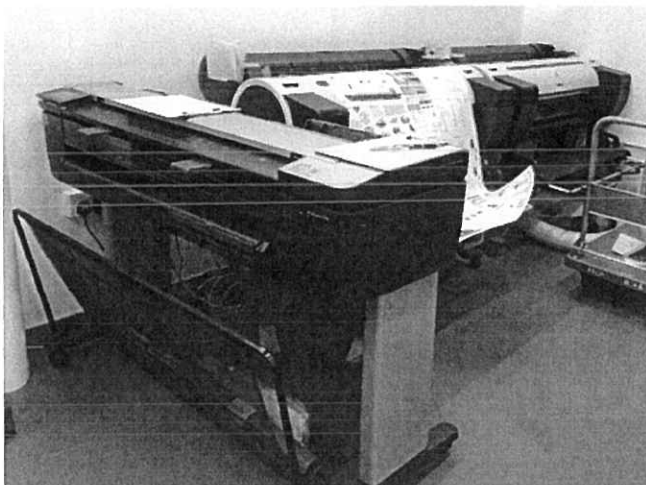




Laser cutters and CNC router



Plotters



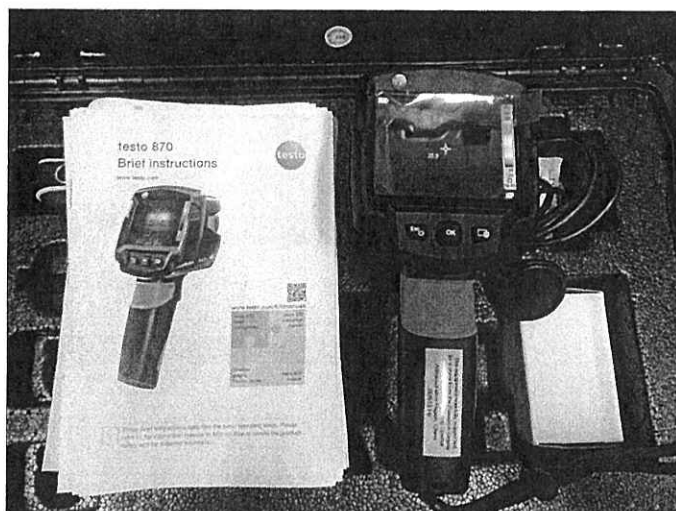
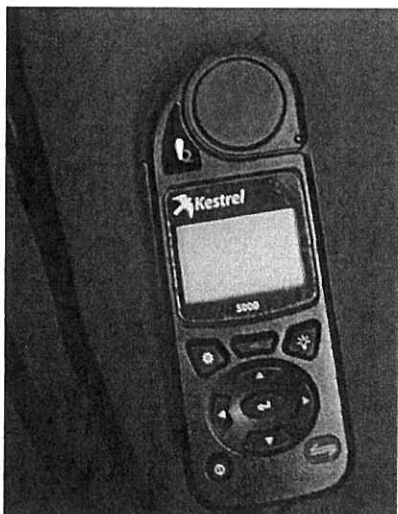


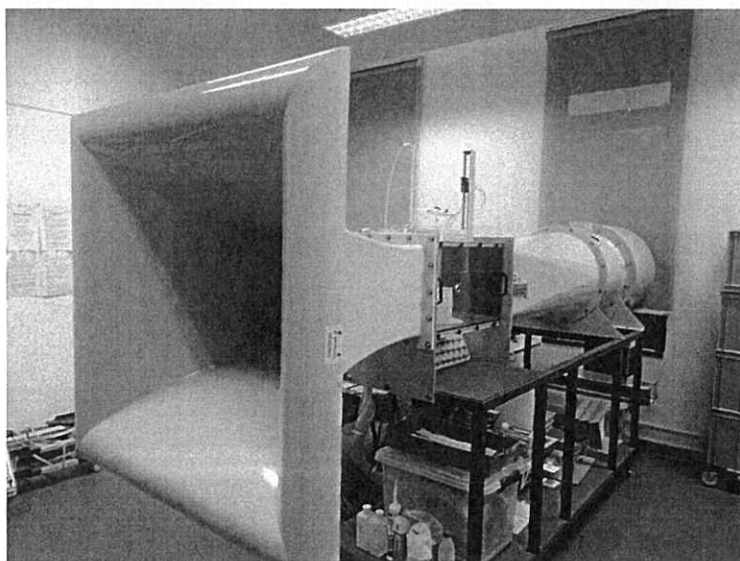
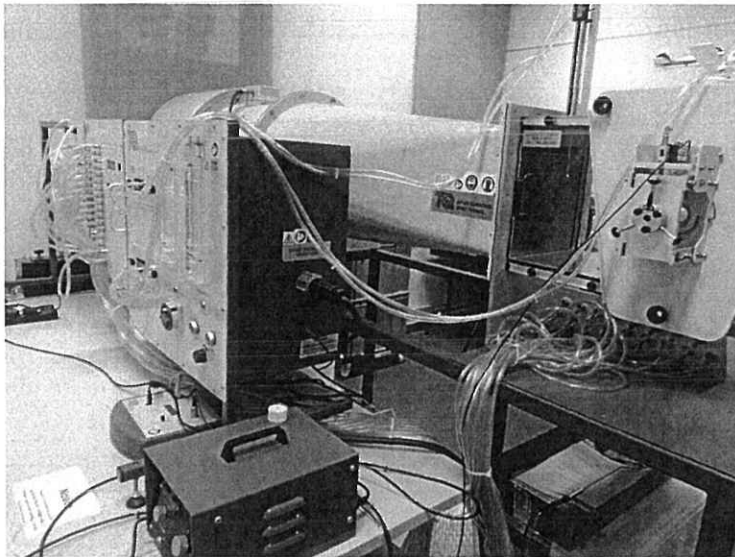
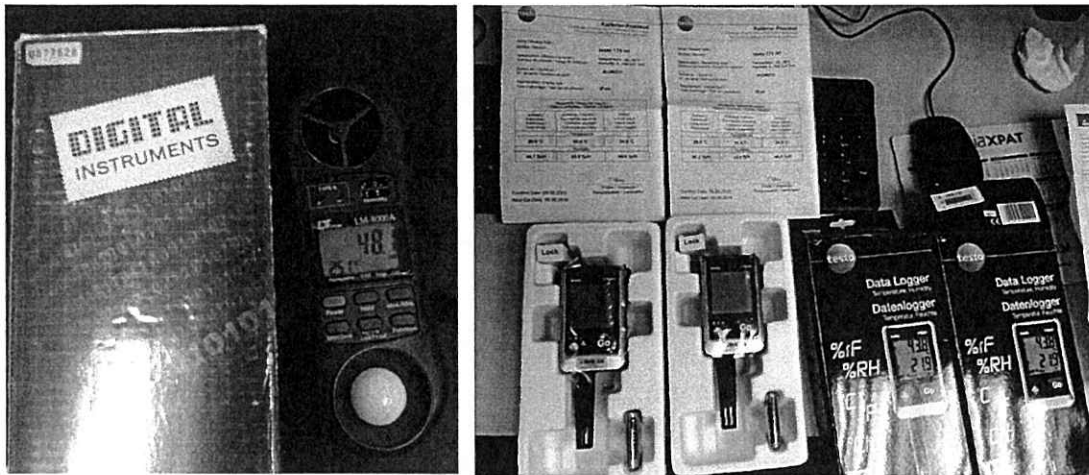
### ***Environmental laboratory facilities***

#### **Wind Tunnel Facility**

Is operated by a full time researcher. This facility is used by students in all years of both bachelor and master degree programme. We have also conducted a number of demonstrations of the wind tunnel to secondary school groups, officials and other visitor groups that visit our college.

Item	Quantity	Usage frequency
Spectrum LightScout Foot-Candle Meter	2	For lectures and research, usage varies. They are being used daily if research data collection is ongoing
Digital environmental sensors (Humidity, Temperature, Wind, Lux levels)	4	
Spectrum IR Crop Temp Meter	2	
Testo 870 thermal camera	1	
Kestrel Rugged Environmental Meter	2	
Desktop logger	1	
Testo data logger	2	





(iii) Please provide reports on research activities carried out (if applicable).

### **Stage 1 – January to December 2015**

1. Initiate and prepare the project
  - (a) Recruitment of administrative personnel
  - (b) Recruitment and training of Research Assistants
2. Establish sustainability research supporting environment
  - (a) Purchase of equipment, facilities and software
  - (b) Lectures and workshops to build up research methodology
  - (c) Forming the IDS Research Team in the Department of Computer Science

Having completed the set-up of the High Performance Computing Systems for the IDS project, the Department of Computer Science has formed a research team to support the research work of the IDS project, the research mainly focusing on the research of image processing and machine learning. Some international experts have been invited to join the group and the research team will explore the applications of image processing, mathematical models and machine learning algorithms for intelligent monitoring of some environmental conditions of Hong Kong. List of members are summarized as follows:-

Name	Department / Institution	Position	Specialization
Dr. Hong FU	Dept. of Computer Science, Chu Hai College of Higher Education, HK	Associate Professor <i>*Research Group Coordinator</i>	Computer vision, image processing, neural network, machine learning
Dr. Kenneth C.Y.Lau	Info. Tech Service Center, Chu Hai College of Higher Education, HK	Manager <i>*Research Group Coordinator</i>	HPC Server and Computer Clusters Applications
Dr. Shen Wai Tak	Dept. of Computer Science, Chu Hai College of Higher Education, HK	Research Assistant	Video, Audio and Image processing
Mr. LIU Mengyang Leon	Dept. of Computer Science, Chu Hai College of Higher Education, HK	Research Assistant	Image processing, Video Finger Print Applications
Dr. WK Yu	Dept. of Computer Science, Chu Hai College of Higher Education, HK	Associate Professor	Mathematical Modeling
Prof. WL Lo	Dept. of Computer Science, Chu Hai College of Higher Education, HK	Head of CS Dept. <i>*Research Team Leader</i>	Applications of Genetic Algorithms, Fuzzy Systems
Prof. Ah Chung Tsoi	Faculty of Information Technology, Macau University of Science and Technology, Macau	Professor	Machine Learning and Data Science
Dr. Markus Hagenbuchner	Faculty of Engineering and Information Science University of Wollongong, Australia	Associate Professor	Machine Learning

3. Conduct Phase-I research - preliminary studies of research theme
  - (a) Conducted literature review to refine the methodology and parameters for urban air ventilation assessment.
  - (b) Initial simulation studies to define the assessment area for urban air ventilation
  - (c) The final-year dissertation study of four Year 4 students of the BEng (Hons) in Civil Engineering are supported by the IDS project to investigate the water quality near the

outlets of the box culverts and to carry out drogue tracking to investigate tidal current movement in Rambler Channel. The students commenced the study in September 2015. Purchase of monitoring equipment is being undertaken to support students to collect field data.

#### 4. Organise Stage-one scholarly activities

- (a) Conducted sessions to demonstrate how to use these pieces equipment and their functions.
- (b) Research presentation at international academic conference
- (c) Attended and presented in the 9th International Conference on Auditorium Acoustics on 29-31 October 2015 in La Philharmonie, Paris, France.
- (d) Attended and presented in the 8th International RILEM Symposium on Testing and characterization of sustainable innovative bituminous materials and systems, Ancona, Italy (October 2015).

### **Stage 2 – January to December 2016**

#### 1. Conducted detail research tested and agreed during Phase I

Dept. of architecture completed developing of digital urban models representing every ten year intervals of physical development in Tsuen Wan district and conducted urban scale wind analysis for the period of 1960-2015. Research was extended to conduct the impact from different building typologies evolved from 1960 -2015

Further research was conducted to examine the effect from hyper podium and tower developments on urban pedestrian wind environment. A number of design modifications were tested to develop recommendations for the CDA policy to improve pedestrian wind speed

#### 2. Organize Stage-two scholarly activities

Conferences hosted

Dept. of Architecture (Conference organizer & Chair Dr. Ruffina Thilakaratne)

In March 2016 the dept. of Architecture hosted a one-day conference on the theme Climate Change Adaptation: Creating a Resilient Hong Kong which was attended by around 125 participants.

In December 2016, Dr. Ruffina Thilakaratne and Ms. Yana Xiao attended 50th International Conference of the Architectural Science Association in Adelaide, Australia to present Phase I & II findings of the project. The research paper titled "Optimization of Hong Kong residential building design guidelines to improve urban air ventilation"

Award submissions & winnings

In September 2016, the project team (Mr. Paul Chu, Dr. Ruffina Thilakaratne, Mr. Ma Cho Pai and Ms. Yana Xiao) submitted Phase I & II findings for Green Building Awards hosted by Hong Kong Green Building Council. The award submission titled, "Improving pedestrian wind environments: analysis of the effect of building typologies on urban air ventilation from 1960 to 2015" The team was nominated as one of the finalists in the research & planning category for Green Building Awards 2016.

#### 3. Recruitment and training of Research Assistants. Procurement of instrument and equipment for IAQ Monitoring.

#### 4. **Department of Computer Science**

- (a) Visibility Evaluation based on Webcam image: The estimation methods of meteorological visibility currently in use on digital image are mainly based on the meteorological laws



- and the corresponding features are extracted manually to calculate the visibility. However, besides the parameters of camera setting, the environmental and weather conditions will also affect the image quality and cause different kinds of noise to influence the evaluation accuracy. We are working on an intelligent digital method to estimate the visibility on webcam weather image.
- (b) Facial expressions recognition with light field imaging: Facial expressions recognition has gained a growing attention from industry and also academics, because it could be widely used in many field such as Human Computer Interface (HCI) and medical assessment. In this paper, we evaluate the strength of the Light Field Camera for facial expression recognition. The light filed camera can capture the directions of the incoming light rays which is not possible with a conventional 2D camera. In addition, the light filed camera could estimates depth maps which provide further information to handle the facial expression recognition problem. Firstly, a new facial expression dataset is collected by the light field camera. The depth map is estimated and applied on Histogram Oriented Gradient (HOG) to encode these facial components as features. Then, a linear SVM is trained to perform the facial expression classification. Performance of the proposed approach is evaluated using the new dataset with estimated depth map. Experimental results show that significant improvements on accuracy are achieved as compared to the traditional approach.
  - (c) Cuffless Blood Pressure Estimation: In personal healthcare, blood pressure (BP) is an important vital sign to be monitored frequently. However, traditional BP measurement devices require cuff's inflation and deflation that is very uncomfortable for many users. Cuffless noninvasive BP estimation methods are very attractive especially on using Photoplethysmography (PPG) approach for achieving continuous BP monitoring and minimal user's inconvenience. From recent studies on the second derivative of PPG (SDPPG) for vascular aging, SDPPG contains the information about aortic compliance and stiffness, which is highly related to blood pressure. We proposed 14 new SDPPG based features are proposed in this paper. They are combined with conventional 21 time-scale PPG features to develop a Support Vector Regression based BP estimator. Experimental results demonstrated that the combined features based BP estimator could improve accuracy of the conventional time-scale PPG based BP estimation by 40%.

### Stage 3 – January to December 2017

1. A research on how the urban ventilation at pedestrian level has been influenced by urban development and the emergence of various residential typologies and their tower geometries was conducted. Number of designed cases were tested to assess the effect of podium porosity on urban ventilation and tower geometries on urban ventilation.
2. Air quality monitoring experiment was conducted on Chu Hai campus from .... To ....
3. Organised Stage-three scholarly activities
  - a. Presented a paper "Effect of Residential Tower Geometries on Urban Wind Environment" at the Hong Kong Green Building Council conference titles "Transforming our built environment through Innovation and Integration: Putting ideas into action" on 5 – 7 June 2017.
  - b. IDS Workshop on Deep Learning and Recursive Neural Networks was held on 21 April 2017.
  - c. Conference "Resilient & Robust Cities" was held on 7 December 2017.

- 6.2 Please describe where and how the IDS project assisted in building up the research capacity of the institution in its strategic areas (e.g. has the IDS project facilitated the academics in formulating their research proposals under the Faculty Development Scheme, etc.).

### **1. Establish a high-performance computing platform in an advanced model creation and testing environment for the Faculty of Science and Engineering**

- a. As one of the participating departments in the RGC IDS research project, the Department of Computer Science has designed and set up the High-Performance Computing (HPC) clusters and servers so as to provide a parallel computing environment and services for the IDS project.
- b. Having considered different types of computer models and hardware specifications, the Department of Computer Science has ordered and purchased the computing facilities as shown below for this IDS project. Furthermore, the computer clusters and the server have been configured and set up appropriately so as to provide High Performance Computing service to the research staff
- c. Two computing clusters are set up. One cluster is composed of compute nodes with Graphic Processing Units (GPUs) for supporting high performance computing studies. Another cluster with large data storage capability is designed for big data analysis and virtualization studies. For the computer clusters, various users' accounts for the research staff and the academic staff for the IDS project are available.
- d. The research team of Computer Science has also updated the cluster system operation so as to make it compatible with most updated software. The ROCKS Cluster ver. 6.0 has been updated to OpenHPC configuration after the first year of project period. Finally, the cluster system was updated to ROCKS Cluster ver. 7.0 before the end of the research project. The reconfiguration can make the system more stable and efficient for future research work in our faculty.
- e. Two computer systems have been used. The clusters installed in the Faculty of Science and Engineering use the configuration of Rocks cluster architecture (Fig. 1). Open Stack Architecture (Fig. 1a) has been used for the other computer system but it was also updated to Rocks cluster ver. 7.0 (Fig. 1) in the last year of the project.
- f. After the reconfiguration of cluster system, the list of software for our research and academic staff are summarized as follows. The following softwares were installed and the computer clusters have been made ready and available so as to provide High Performance Computing service to the research staff in the Department of Civil Engineering and the Department of Architecture.
  - TensorFlow and Keras (Keras 2 and Sugartensor operate in all GPU node)
  - MATLAB cluster and Parallel program services (parallel\_test.m)
  - GPU CUDA Development environment (Nsight)
  - JCUDA 0.8 and Java SDK SE 10
  - Python Development Environment (Python 3.6.4.)

Details please refer to **Appendix 2**.

### **2. Setting up Sustainable Systems and Technology Research Centre (SSTRC)**

In order to make continuous development of research capacity of the institution, a Sustainable Systems and Technology Research Centre (SSTRC) has been setup in our College. The information of the SSTRC research centre was summarized in the College \*website. The objectives of setting up the SSTRC are to

- a. Conduct research in the three domains: Architecture, Civil Engineering and Computer Science
- b. Integrate and combine research outcomes from the three major domains to pursue research activities in the area of sustainable systems and technologies
- c. Promote research culture in the Faculty of Science and Engineering to align with the College mission and vision
- d. To acquire financial research funding supports from internal and external sources
- e. Set up a research platform in the Faculty of Science and Engineering to exchange research ideas among the academic departments in the Faculty
- f. Set up a research platform to establish links and research collaborations with other local or foreign institutions

*\*Note: SSTRC Website: <https://sstrc.chuhai.edu.hk/>*

### **3. Facilitate the Machine Learning Research work in Department of Computer Science**

As the HPC infrastructure has been developed in this IDS project, the HPC outcomes of this IDS research project greatly facilitate the research work of the following RGC research project 1-4 in CS department.

- Project no. 4 is an extension of the preliminary research outcomes of this IDS research project. According to the outcome of the preliminary research in IDS project, the image data set for ANN training is based on the Webcam-based weather photos obtained from Hong Kong Observatory.
  - These weather photos are mainly in relatively low resolutions. It is expected that further improvement in estimation accuracy be achieved if the training data set is based on more high-resolution digital image.
  - Furthermore, in order to solve the problem of neural network (ANN) training for visibility estimation, we propose to use the modified PSO algorithms which is implemented in High Performance Computing Clusters (HPC). It is expected that the PSO algorithm can train the ANN for visibility estimation with better accuracy. Therefore, the outcomes of the IDS research project led to the further research in the above RGC project no. 4.
  - Project no. 1 needs extensive neural network model training for analyzing the behavior of DCD subjects for assessment. Large set of video database needs to be developed for model training. In this case, the HPC system highly facilitates the research work in Project no. 1. Project no. 2 and 3 also needs support from HPC for machine learning and analysis of large set of Strabismus and DCD testing data. Therefore, the HPC also assisted in building up the research capacity of the institution in machine learning research.
- [1] Digitalized Assessment Developmental Coordination Disorder with Integrated Eye-Motion Tracking Technology: System and Algorithms (Co-Investigator, FDS RGC Hong Kong, UGC/FDS13/E02/16, HK\$ 1,035,675, 01 January 2017 - 31 December 2019)
  - [2] Automatic stimulus and synchronous pupil-iris-head tracking for intelligent assessment of strabismus: principle, algorithm and system (Co-Investigator, FDS RGC Hong Kong, UGC/FDS13/E01/17, HK\$ 655,600, 01 Jan 2018 - 31 Dec 2021)
  - [3] Intelligent assessment of Attention Deficit Hyperactivity Disorder (ADHD) based on gaze-posture-movement tracking fusion: principle, algorithm and system, UGC/FDS13/E04/18, Dr. Hong FU (Principle Investigator), Prof. W.L.LO (Co-Investigator), Research Grant Committee, Hong Kong, Jan 2019-Dec 2021, 36 months, HK\$ 937,350

- [4] Meteorological Visibility Estimation by using Particle Swarm Optimization and Neural Network, UGC/FDS13/E02/18, Prof. W.L.LO (Principle Investigator), Dr. HONG FU (Co-Investigator), Jan 2019-Dec 2020, 24 months, HK\$ 580,275.

4. With the purchase of remote data acquisition system and sensors for gases, temperature and humidity, and the existing sensors for water level, deformation and force monitoring, an IoT laboratory was established for teaching and research study on civil and environmental work.

Several pieces of advanced equipment (Nottingham Asphalt Universal Testing Machine, portable falling weight deflectometer, and computer software for pavement analysis) were bought using the funding of this project to support researches of road engineering.

- 6.3 If the project has not met its original objectives, why?

- 6.4 (a) Please provide details e.g., title, authorship, publication dates, etc. and attach an abstract of each publication reported. Please place asterisks on publications involving inter-institutional collaborations.

#### **DEPARTMENT OF ARCHITECTURE**

- [1] Booth, D. (2015) Schools in Hong Kong: acoustics case Study. 9th International Conference on Auditorium Acoustics, La Philharmonie, Paris, France, 29-31 October 2015
- [2] Thilakaratne, R., Chu, P. & Xiao, Y. (2017). Effect of Residential Tower Geometries on Urban Wind Environments. WSBE Conference, 5-7 June.
- [3] Thilakaratne, R., Chu, P. & Xiao, Y. (2016). Optimization of Hong Kong Residential Building Design Guidelines to Improve Urban Air Ventilation. Architectural Science Association Conference, Adelaide 8-10 Dec. 2016
- [4] Thilakaratne, R., Chu, P. & Xiao, Y. (2016). Impacts of building typologies on pedestrian wind environments in high density urban areas. Submitted for RIBA President Award for Research. Only the abstract was published in the book of abstracts.

#### **DEPARTMENT OF CIVIL ENGINEERING**

- [1] Leung G.L.M., Wong A.W.G. (2016) Effect of Pine Aggregate Composition on Moisture Susceptibility of Hot Mix Asphalt. In: Canestrari F., Partl M. (eds) 8th RILEM International Symposium on Testing and Characterization of Sustainable and Innovative Bituminous Materials. RILEM Bookseries, vol 11. Springer, Dordrecht
- [2] Gao Y., Lam R., Lam L. Indoor air quality monitoring by internet of Things methodology (submitted)

#### **DEPARTMENT OF COMPUTER SCIENCE**

- [1] T. Shen, H. Fu, J. Chen, W. Yu, C. Lau, W. L.LO and Z. Chi, "Facial Expression Recognition Using Depth Map Estimation of Light Field Camera", 2016 IEEE International Conference on Signal Processing, Communications and Computing (ICSPCC), Hong Kong, 2016, pp. 1-4.
- [2] M. Liu, L. Po, and H. Fu, "Cuffless Blood Pressure Estimation Based on Photoplethysmography Signal and Its Second Derivative", The 9th International Conference on Advanced Computer Theory and Engineering (ICACTE 2016), Hong Kong, August, 2016. This paper is also accepted by International Journal of Computer



Theory and Engineering.

- [3] Shixiong Zhang, Ah Chung Tsoi, "A Novel Object Tracker Designed Based on a Complementary Framework", Proceedings of the IEEE International Conference on Multimedia and Expo Workshops (ICMEW) 2017 10-14 July 2017, pp. 686-691.
- [4] S. Y. Li, H. Fu and W. L. LO, "Meteorological Visibility Evaluation on Webcam Weather Image using Deep Learning Features", The 10th International Conference on Advanced Computer Theory and Engineering (ICACTE 2017), Jeju Island, South Korea, August 10-13, 2017. (\*Also appear in International Journal of Computer Theory and Engineering IJCTE, 2017).
- [5] M.Liu, H.Fu, Y.Wei, Yasar Abbas Ur Rehman, L.M.PO, W.L.LO:"Light field-based Face Liveness Detection with Convolutional Neural Networks" Journal of Electronic Imaging (Accepted).

- (b) RGC funding should have been acknowledged in all activity(ies) / publication(s) / conference(s) papers listed in (a) above. If no acknowledgement has been made in any of the event / publication / paper, please indicate and provide explanations.

#### 6.5 Research staff trained

*(Please provide names and capacities of research staff trained and elaborate on what training has been provided.)*

#### DEPARTMENT OF ARCHITECTURE

Mr Ma Cho Fai (Research Assistant)	Was assisting the project in digital model making, developing design modifications and test models, field data collection establishing infrastructure and organizing activities and preparing award submissions. Mr Ma Cho Fai's contract ended in 2016.
Mr Mig Lau (Research Assistant)	Was assisting the project in digital model making, developing design modifications and test models, field data collection establishing infrastructure and organizing activities and preparing award submissions. Mr Mig Lau joined in September 2016 and his contract ended in 2017.
Ms Yana Xiao (Research Assistant)	Was recruited in January 2016 for conducting urban air ventilation simulation experiments, field data collection, conducting literature reviews and assisting the project leader in preparing publications.
Dr Lin Ping Yin (Research Fellow)	Was recruited in September 2016 for conducting literature reviews and exploring other research areas for extending urban ventilation research into urban thermal comfort research.

#### DEPARTMENT OF CIVIL ENGINEERING

Ms Huen Wing Kee (Research Assistant)	Joined in June 2015. Was trained to assist students in their study and investigation of the water quality and current properties via water sampling in typhoon shelters and box culverts (stormwater outlets) as well as drogue tracking in local waters. Her contract ended in August 2016.
Mr You Sizeng (Research Assistant)	Joined in June 2015. Was trained to assist in carrying out various laboratory tests and analysis works for the study, and assist in supervising students to carry out experimental work. His contract ended in May 2017.
Mr LAM Chun Yu	Was recruited in October 2016 and trained to carry out air



(Research Assistant)	quality experiments in Chu Hai new campus. Was also trained to develop and design a dimensional digital visualization model of Chu Hai's campus to illustrate and to display the readings captured from the air quality sensors. His contract ended in December 2017.
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#### DEPARTMENT OF COMPUTER SCIENCE

Dr. Shen Tak Wai (Research Assistant)	Derive computing algorithms, programming, technical support, scholarly activities coordination, technical workshop
Mr. Liu Mengyang (Research Assistant)	programming, technical support, scholarly activities coordination, technical workshop
Mr. Pascal Zhang (Research Assistant)	programming, technical support, scholarly activities coordination, technical workshop
*Dr. LI Shengyan (Senior Research Assistant)	Derive computing algorithms, programming, technical support, scholarly activities & technical workshop coordination

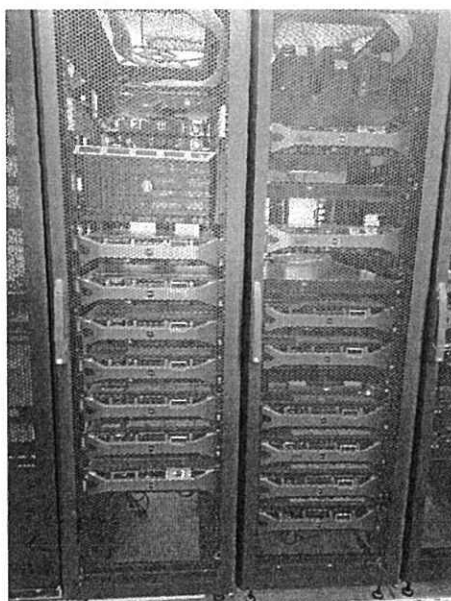
*\*Note: Dr. LI Shengyan has postdoctoral research experience was employed as Senior Research Assistant*

#### 6.6 Specific products

*(e.g. patents, software or netware, instruments or equipment, infrastructure developed)*

#### High Performance Computing Infrastructure for future research work

After the completion of this IDS research project, a High-Performance Computing (HPC) clusters and servers have been setup which provide a parallel computing environment and services for research work in the Department of Civil Engineering, Department of Architecture and Department of Computer Science.



#### High Performance Computing (HPC)

**clusters and servers** - HPC servers for parallel computing as the platform to support teaching and learning HPC has one frontend node and seven compute nodes.

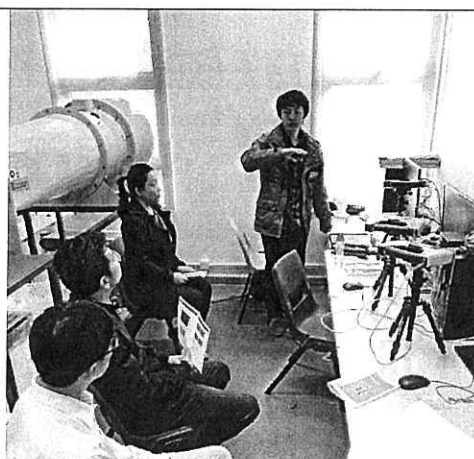
#### 6.7 Other education activities and / or training and development

#### DEPARTMENT OF ARCHITECTURE

A number of secondary school delegates and government official visited our environmental laboratory facility and fabrication facility to learn from new technology used in tertiary education institutions. Totally, 25-30 demonstration sessions have been conducted since these facilities were established in the new campus premises.



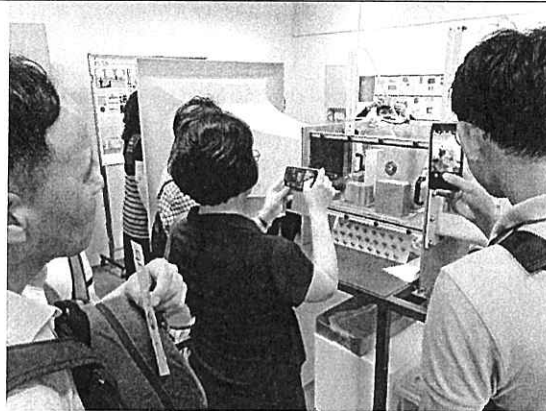
29/10/2016 Hong Kong Architecture Centre Visit



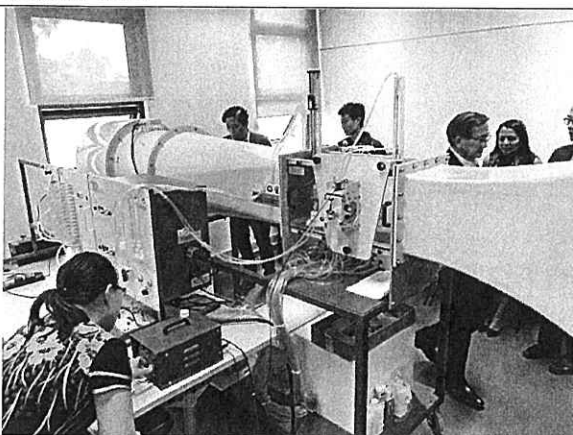
23/01/2018 Wind Tunnel and 3D scanner workshop



2/2/2018 CNC demonstration during secondary school visit



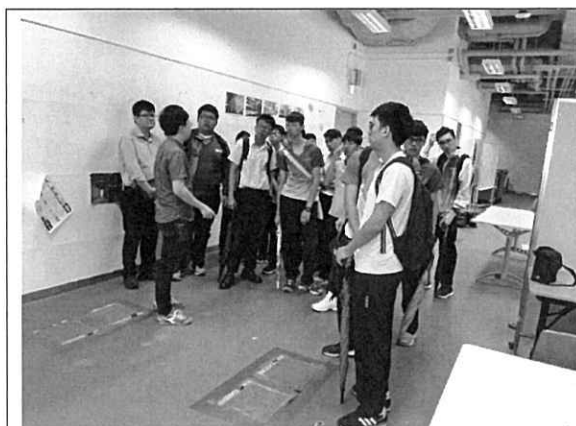
29/06/2018 wind tunnel demonstration during Dankook university (Korea) visit and interflow



19/07/2018 Association of Architectural Professionals (AAP HK) visit



16/11/2018 international design workshop using CNC as a means for digital fabrication



27/09/2017 secondary school visit to department of architecture and to fabrication facilities and laboratories



28/07/2017 secondary school visit to department of architecture and to fabrication facilities and laboratories

- 6.8 Please highlight any deliverables indicated in the project implementation timetable endorsed by RGC, which have not been covered or achieved as per sections 6.1 to 6.7 above, and explain / elaborate.

NIL

- 6.9 Please elaborate the role of the managing team in coordinating and managing the project.

The management team comprised all departments of the Faculty of Science and Engineering, namely, Department of Architecture, Department of Civil Engineering and Department of Computer Science.

- i. To ensure and oversee the progress of the IDS project versus the goals, milestones and achievement targets of the implementation timetable;
- ii. To ensure achievement of deliverables indicated in the project proposal;
- iii. To review the future planning of activities and its implementation and
- iv. To collaborate and review reports and presentation of the project.

## 7. Awards And Recognition

- 7.1 Have any research grants been awarded that are **directly** attributable to the results obtained on this IDS project? (*Please provide details*)

The following RGC project is the new projects evolved directly from the IDS research project. According to the result of the preliminary research in the IDS research project, the following RGC project is an extension for further research in meteorological visibility estimation.

Meteorological Visibility Estimation by using Particle Swarm Optimization and Neural Network, UGC/FDS13/E02/18, Prof. W.L.LO (Principle Investigator), Dr. HONG FU (Co-Investigator), Jan 2019-Dec 2020, 24 months, HK\$ 580,275.

- 7.2 Other awards and recognitions as a result of this IDS project (*Please specify*)

Hong Kong Green Building Awards 2016. The team received Finalist Award under

Research & Planning Category. See **Appendix 3**.

## 8. Other Impacts

- 8.1 What are the current and expected impacts of the project in terms of its contribution to the local and regional economic and societal well-being? (*e.g., technology transfer, collaboration with external organizations, etc.*)

Findings from this study revealed implications of massive podium structures on pedestrian level wind performance. Therefore, these findings can be applied for forming and revising current Comprehensive Development Area Policy allowing 100% site coverage podium buildings.

Tower geometry effect on pedestrian ventilation also supported the positive effect of certain tower geometries over others. Cruciform towers and cruciform towers with balconies outperformed wind speed around square and cylindrical towers. Cylindrical towers indicate the lowest wind performance due to the laminar wind flow facilitated by the smooth building envelope. These findings also support the positive impacts created by balconies in residential buildings as a green feature promoting urban ventilation. Findings from this study provides references for designing sustainable and liveable neighbourhoods.

- 8.2 Others (*Please specify*)

NIL

## 9. Sustainability Of The IDS

- 9.1 Whether there are new ideas evolved **directly** from the project?

### **Further Research in Meteorological Visibility Estimation**

Meteorological Visibility is a measure of the greatest distance at which an object near the ground can be recognized under a bright background. The uses of the Visibility can be used as safety indicators for road, sea and flight traffic. Furthermore, visibility can also be used as an environmental parameter to monitor weather or pollution condition.

The conventional digital image estimation methods for visibility is based on the manual extraction of images' features and the meteorological laws calculation. Past research has found that the evaluation accuracy of this approach is influenced and affected by the image quality and different kinds of noise. Since it is difficult to extract all these factors manually and involve them into a certain equation for visibility estimation, intelligent approach should be used to extract the useful factors for visibility estimation.

Preliminary research work has been done to develop an algorithm for visibility estimation by using webcam images. Effective area is extracted from digital images which forms the input for a pre-trained Convolutional Neural Network (CNN). Features are then extracted based on single variable correlation. A Generalized regression neural network (GRNN) is then designed for visibility estimation based on deep learning methods. The selected weather photos with ground truth provided by Hong Kong Observatory are then used to train an Artificial Neural Network so that visibility can be estimated. The results of the



preliminary research work show that the method with deep learning feature is applicable for visibility prediction and it can give an accuracy higher than that of the traditional hand-crafted features method. However, the effective area is extracted by using expert judgment instead automatic extraction methods. The set of feature vectors are also chosen from CNN by single value correlation values. The digital image for training neural network are based on Webcam capturing, it cannot provide details information for training as the image resolution are relatively low. Furthermore, the ground truth visibility values are provided by Hong Kong Observatory and the observing sites are fixed by HKO.

In this proposed project, a Visibility Monitoring System (VMS) with hardware visibility meter and High Resolution Digital Camera will be developed to monitor the visibility variations at the chosen site. The data obtained from VMS will act as reference models or ground truth data for Neural Network training. An intelligent method will be developed to extract the effective area from the digital image captured by the high resolution Digital Camera. The image matrix of the effective regions will act as the input to a pre-trained Neural Network named AlexNet network. Based on the multiple correlation and the Particle Swarm Optimization methods, an intelligent method will be developed to extract a smaller set of features values from the feature values generated by the Alexnet. The features vectors together with the measured visibility values will acts as a referenced model for ANN training and visibility estimation. Simulation results and the estimated visibility will be compared with the data measured by standard visibility meter.

It is expected that the proposed intelligent Meteorological Visibility Estimation methods can outperform the algorithm derived by our preliminary research. The overall research outcomes of this project can contribute to the area of environment monitoring and sustainable technology.

## 9.2 Whether there are new projects evolved **directly** from the project?

### **DEPARTMENT OF ARCHITECTURE**

Findings from this study was furthered to explore more of the fenestration effect on wind ventilation. This study is funded through Chu Hai College SEED funding.

### **DEPARTMENT OF CIVIL ENGINEERING**

From the finding, the 3D printer's emission effect in the indoor environment was further studied, which is funded by Chu Hai College SEED funding.

### **DEPARTMENT OF COMPUTER SCIENCE**

The following RGC project is the new projects evolved directly from the IDS research project. According to the result of the preliminary research in the IDS research project, the following RGC project is an extension for further research in meteorological visibility estimation.

Meteorological Visibility Estimation by using Particle Swarm Optimization and Neural Network, UGC/FDS13/E02/18, Prof. W.L.LO (Principle Investigator), Dr. HONG FU (Co-Investigator), Jan 2019-Dec 2020, 24 months, HK\$ 580,275.

## 9.3 Whether there are new collaborations developed **directly** from the project?



**DEPARTMENT OF ARCHITECTURE**

We have established collaboration with the Asian Disaster Preparedness Centre (ADPC), Bangkok through Dr. Senaka Basnayake, the speaker whom we invited for Climate Change Adaptation Conference in 2016. Now the Master of Architecture programme conducts a project in Thailand annually coordinated by the ADPC to meet government officials and community in Thailand.

**DEPARTMENT OF COMPUTER SCIENCE**

As Prof. Henry S.H.Chung is one of the Co-Investigator of the following research project, the IDS research project led to research collaborations with Prof. Henry S.H.Chung in the department of electronic engineering of City University of Hong Kong.

Meteorological Visibility Estimation by using Particle Swarm Optimization and Neural Network, UGC/FDS13/E02/18, Prof. W.L.LO (Principle Investigator), Dr. HONG FU (Co-Investigator), Prof. Henry S.H.Chung (Co-I), Jan 2019-Dec 2020, 24 months, HK\$ 580,275.

- 9.4 Please give details on how much money and from which sources has been obtained for the specific purpose of continuing the work started under this IDS.

A total amount of HK\$ 580,275 has been obtained from RGC for the specific purpose of continuing the work started under this IDS research project.

Meteorological Visibility Estimation by using Particle Swarm Optimization and Neural Network, UGC/FDS13/E02/18, Prof. W.L.LO (Principle Investigator), Dr. HONG FU (Co-Investigator), Jan 2019-Dec 2020, 24 months, HK\$ 580,275.

SEED Funding (2017) from Chu Hai College of Higher Education - 30,000HKD

**10. Public Access Of Completion Report**

*(Please specify the information, if any, that cannot be provided for public access and give the reasons.)*

<b>Information that Cannot Be Provided for Public Access</b>	<b>Reasons</b>
NIL	

RGC Ref. No.:

UGC/IDS/13/14

(please insert ref. above)

**INSTITUTIONAL DEVELOPMENT SCHEME (IDS)****Summary of Completion Report***(Please list all the stages since project inception)*Project Title: Programme for the Enhancement of Research Capacity in Sustainable Systems and Technologies

Stage Completed	Period	Milestones	
	(Month / Year) to (Month / Year)	Deliverables to be Achieved <sup>2</sup> (Please summarize in <u>three</u> bullet points where details should be left to the report proper)	% of Each Deliverable Achieved <sup>3</sup>
Stage 1 / 2015	January To December / 2015	1. Establish sustainability research supporting environment 2. Conduct Phase-I research – preliminary studies of research theme 3. Organise Stage-one scholarly activities	1. 100% 2. 100% 3. 100%
Stage 2 / 2016	January To December / 2016	1. Conduct Phase-II research = detail studies of the research theme 2. Develop project website and database 3. Organise Stage-two scholarly activities	1. 100% 2. 100% 3. 100%
Stage 3 / 2017	January To December / 2017	1.....	1.....

Stage Completed	Period		Milestones	
			Deliverables to be Achieved <sup>2</sup> (Please summarize in <u>three</u> bullet points where details should be left to the report proper)	% of Each Deliverable Achieved <sup>3</sup>
	(Month / Year) to (Month / Year)			
Total to-date:				

- Note:
- <sup>1</sup> Justifications for significant under-spending or over-spending ( $\geq \pm 10\%$ ) should be given in **section 5.1** of the completion report.
  - <sup>2</sup> The key milestones to be achieved by the project within the respective stage as indicated in the approved implementation timetable.
  - <sup>3</sup> Justifications for significant slower rate of progress compared with the approved implementation timetable should be provided in detail in **section 4** of the completion report.

**RESEARCH GRANTS COUNCIL  
COMPETITIVE RESEARCH FUNDING SCHEMES FOR  
THE LOCAL SELF-FINANCING DEGREE SECTOR**

**INSTITUTIONAL DEVELOPMENT SCHEME (IDS)**

**Completion Report - Attachment**  
*(for completed projects only)*

<b>RGC Ref. No.:</b>	UGC/IDS13/14
<b>Institution:</b>	Chu Hai College of Higher Education
<b>Project Title:</b>	Programme for the Enhancement of Research Capacity in Sustainable Systems and Technologies 持續系統及技術之研究能力提昇計劃

**Statistics on Research Outputs**

	Peer-reviewed Journal Publications	Conference Papers	Scholarly Books, Monographs and Chapters	Patents Awarded	Other Research Outputs (Please specify)
No. of outputs arising directly from this research project [or conference]	3	7	2	NIL	1 Submitted Journal paper