Smarter cities for a new generation

The application of Smart City technologies creates tangible financial benefits for society, such as developing smart grids for smart energy conversion and utilisation and for high-speed transceivers for transmitting huge amounts of data.

The general idea behind Smart City is to minimise the demand for resources, promote a low-carbon economy, enhance city efficiency, promote business productivity, improve the quality of living, and enhance climatic resilience. Combine all these items together and you can create a Smart City.

“Our researchers are working to provide innovative solutions to address concerns about sustainable economic development, high quality of life, and harmony of the built environment with nature, and the way forward is smart technology,” explains Professor Lu Jian, Vice-President (Research and Technology) and the Dean of the Chow Yei Ching School of Graduate Studies.

In the past five years CityU has received around HK$300 million from external organisations to support various research initiatives related to Smart City.

For Smart City, CityU possesses a whole roster of teaching and research expertise to build capacity. “The key to our work is to integrate our research capabilities and programme strengths so that we can respond to societal challenges and address critical global issues in the highly connected world in which we live,” Professor Lu says.

The funds have come from the Research Grants Council, Innovation and Technology Fund as well as contracts and grants from the mainland and donations. By combining expertise on campus, CityU can make strong gains in several areas. (See box, opposite page).
The other two CityU research pillars are closely related to the Smart City initiatives. One Health focuses on infrastructure for the transmission of huge volumes of big data for further analysis while the development of new technology will have a direct impact on Digital Society.

**Smarter homes**
The Centre for Smart Energy Conversion and Utilization Research at CityU aims to set up a smart home to provide information for constructing low-cost and zero carbon emission homes. This prototype will include many smart and "green" devices including renewable micro-power sources, smart appliances, smart energy storage systems, advanced metering infrastructure, and energy management.
systems. It will also serve as a test bed for studying and researching new technologies for smart energy conversion and utilisation.

The Centre also focuses on the fluctuating patterns of electricity usage throughout the day. Using AI devices, it is possible to estimate usage during quiet periods and thereby facilitate the storage of excess electricity for release during peak periods. AI is also used to calculate the appropriate power rate in order to effectively stabilise demand.

The Centre is now co-operating with General Electric in the US to develop the “Sustainable Development Smart Campus” with the aim of creating a community energy control system that can help reduce waste and make the most efficient use of our energy resources.

To get things started at CityU, smart power meters have been installed in many areas on campus.

**Smart grids, power electronics and nanotechnologies**
A collaboration with Alstom, a global leader in the world of power generation, power transmission and rail infrastructure, has been set up with CityU. The partnership will develop Advanced Open Systems for Smart Cities with special emphasis in the fields of smart grids, power electronics and nanotechnologies.

“The Advanced Open Systems for Smart Cities will establish a Community Energy Management System, saving energy consumption at all levels,” says Professor Henry Chung Shu-hung of the Department of Electronic Engineering. The two parties will jointly apply for funding from Hong Kong’s Innovation and Technology Fund, the Ministry of Science and Technology (MOST) on the mainland, and other government-level agencies.

“The research results will constitute the cornerstone of future smart cities, and will be implemented first at CityU, thereby providing models for other government organisations and commercial buildings in Hong Kong,” Professor Chung says.

Currently CityU is conducting research into energy optimisation by modeling electricity usage in classrooms and lecture theatres, which accounts for 34% of our overall electricity usage. The project, closely related to the Advanced Open Systems for Smart Cities, is funded by Alstom and aims to provide a forecast model.

**Low-carbon living**
Greater public awareness about greenhouse gas emissions and climate change is the aim of a project developed by the School of Energy and Environment (SEE) and funded by the Sustainable Development Fund. The project is titled “Carbon Footprint Management at Home for Sustainable Low-Carbon Living”.

The Centre is now co-operating with General Electric in the US to develop the “Sustainable Development Smart Campus” with the aim of creating a community energy control system that can help reduce waste and make the most efficient use of our energy resources.

To get things started at CityU, smart power meters have been installed in many areas on campus.
Professor Michael Leung Kwok-hi, Associate Dean of SEE, and his research team have developed an online carbon audit toolkit that helps to provide tips for carbon reduction. Taking electricity consumption as an example, the user of the toolkit has to choose first the electricity company, either CLP Power Hong Kong Limited or The Hong Kong Electric Company Limited, and input either the units consumed or the amount of the electricity bill. The toolkit then automatically calculates the CO₂ emission equivalent.

In fact, CLP awarded CityU HK$10 million for conducting Green Energy Research and Development projects and setting up a Green Energy Showcase Centre.

**Wireless technologies and applications**
The State Key Laboratory of Millimeter Waves has been working on the Internet of Things (IoT) since 2008 before the term became fashionable, says Professor Chan Chi-hou, Director of the laboratory.

He and his team have developed a wireless sensor network system that can accommodate over 20,000 sensors for applications such as smoke detectors, burglar alarms, and temperature and humidity detectors. The sensing data are collected at gateways which can be accessed and monitored through the internet.

“The key aspect of smart city is the development of wireless technologies and the use of mobile devices. There are many applications available now, for example, making sure the elderly are safe or that children have reached school safely. Using Bluetooth, Wi-Fi, mobile communications and GPS technologies, we have developed powerful systems that can locate and follow people with a high degree of accuracy,” Professor Chan says.

Working on 5G technology, Professor Chan says we need faster speeds for download because of big data, and millimeter-wave technologies are a crucial factor in this development.

“Our wireless technologies, all of which are part of the smart city concept, are specifically designed to help people and make society safe,” he adds.

**Spreading the word**
CityU aims to learn from others and share our own expertise in the area of Smart City. President Way Kuo, Professor Lu Jian and Professor Yan Hong, Dean of the College of Science and Engineering, explored collaboration opportunities with prestigious universities and other key institutions in France during a visit in January 2016. The delegation discussed the possibility of setting up collaborations for student projects and internship with Bouygues Construction, a global player in construction with business in 80 countries.

“Bouygues has already participated in many large infrastructure projects in Hong Kong including the Kai Tak Cruise Terminal Building, the Hong Kong Zhuhai Macao Bridge, and the Asia-World Expo Hong Kong,” Professor Lu explains.

By bringing together strengths in these diverse areas, Smart City initiatives have the potential to radically change the way we live, making daily life more convenient, efficient and less stressful.

“CityU can really make a difference in creating smarter cities,” Professor Lu says.
智能城市技術的應用為社會帶來實際經濟利益，例如研發智能電網與高速收發器，前者可用於智能能源轉換及使用，後者可傳送大量數據。

智能城市的主要概念是盡量減少資源需求，促進低碳經濟，提升城市效率，加強企業生產力，改善生活質素及提高氣候韌性。將上述各項結合起來，就能創建一座智能城市了。

副校長（研究及科技）兼周亦卿研究生院院長呂堅教授解釋說：「城大研究人員正努力研發多種創新方法，去處理一些備受關注的事項，包括可持續經濟發展、高質素生活、建築環境與自然的和諧，而未來發展之路就是智能技術。」

城大《2015–2020年策略性發展計劃》提及智能城市的概念，與數碼化社會、健康一元化並列為三大跨學科交叉領域主題。

城大擁有雄厚的教研實力及傑出學者，從事智能城市的研究。呂教授說：「我們研究工作的關鍵，是結合城大的研究實力與課程優勢，以回應社會難題，處理這個緊密聯繫的世界所面臨的全球性重大議題。」

他補充說：「過去五年，我們獲得校外機構約3億港元資助，支持有關智能城市的各種研究。」

撥款來自研究資助局和創新及科技基金，另有來自內地的合約和撥款，以及各種捐贈。城大結合本校專長，可在幾個領域內取得豐碩成果（參看右框）。
城大其他兩個研究重點亦與智能城市息息相關，例如「健康一元化」，注重傳送大量大數據以作進一步分析的基礎，而新技術的發展將直接影響數碼化社會。

智能家居
城大智能能源轉換及應用研究中心旨在創建一個智能家居模型，為構築低成本、零排放住宅提供資訊。這個模型將包含多項智能及環保裝置，例如多種可再生微電源、智能電器、智能儲能系統、先進計量基礎設施，以及能源管理系統。它還可作為一個試驗場所，供人學習和研究智能能源轉換及應用的新科技。

該中心的另一研究重點是全天用電量的波動模式。人工智能設備可用於估算平期的用電量，有助於儲存多餘電力，到了峰期再釋放。人工智能亦可用來計算合適的電費，以有效地穩定需求。

中心正與美國通用電氣公司合作，研發「可持續發展智能校園」，旨在創建一個社區能源控制系統，協助減少廢物，善用現有資源。

城大已走出第一步，在校園多處安裝了智能電錶。

智能電網、電力電子學及納米技術
城大與國際著名的發電、輸電、鐵路基建企業阿爾斯通控股公司（阿爾斯通）結為協作夥伴，共同研發「智能城市先進開放系統」，重點在於智能電網、電力電子學與納米技術等領域。

電子工程學系鍾樹鴻教授說，「設立『智能城市先進開放系統』是為了建造一個社區能源管理系統，以便全面節省能源。」城大與阿爾斯通將聯手向香港創新及科技基金、國家科學技術部及其他政府機構申請研究資助撥款。

鍾教授續說，「研究成果將用以建構未來的智能城市，並將先在城大作應用示範，以供香港的政府組織及商業大廈參考。」

城大正進行優化用電研究，目標是降低大學總用電量中佔34%的課室及演講廳耗電。這項研究與「智能城市先進開放系統」關係密切，由阿爾斯通資助，目的在於提供預測模式。
低碳生活
能源及環境學院推出一項計劃，名為「家居碳足跡管理：推動可持續低碳生活」，並已獲得可持續發展基金的資助。該計劃旨在提高公眾對室內氣體排放及氣候變化的認知。

該學院副院長梁國熙教授及其研究團隊設計了一個網上工具箱，為減少家居的碳排放提供建議。例如，使用者先選擇電力公司（中華電力有限公司（中電）或香港電燈有限公司），然後輸入耗電度數或電費單所示的應繳款額，計算器即可自動算出相應的二氧化碳排放量。

中電已向城大提供1,000萬港元資助，用於綠色能源研究及發展計劃，以及成立綠色能源展示中心。

無線技術與應用
毫米波國家重點實驗室主任陳志豪教授指出，該實驗室從2008年起便致力於「物聯網」研究，當時這概念仍未為人熟知。

陳教授及其團隊研製了一個無線感應器網絡系統，可供逾20,000個感應器同時操作，用途包括煙霧、溫度與濕度探測以及防盜警報等。數據從各網關收集後，可通過網絡提取並監察。

陳教授表示：「研發無線技術與流動器件的交互效用是智能城市概念中重要的一環。目前，已有很多應用程式可供應用，如保障長者安全，或確保學童安全抵校等。」

在研發中，我們應用了藍牙、無線網絡、流動通訊及全球定位技術，已成功研發的系統便可非常精確地追蹤及定位偵測。

陳教授目前正從事5G技術研究。他表示，由於大數據的出現，我們需要提升下載速度，而毫米波技術正是這方面發展的關鍵因素。

他補充說：「我們已研發的無線技術，便是智能城市的組成部分，並專為助人及維護社會安全而設計。」

推廣合作
城大希望在智能城市領域既向其他機構學習，同時分享本校專長。2016年1月，郭位校長、呂堅教授與科學及工程學院院長嚴洪教授前往法國，造訪知名的大學及機構，探索合作機會。代表團與布依格建築公司探討雙方在學生專題研習及實習方面的合作。該公司是全球知名的建築公司，業務遍佈80個國家。

呂教授說：「布依格曾參與香港多個大型基建工程，包括鑲德郵輪碼頭大樓、港珠澳大橋，以及亞洲國際博覽館。」

智能城市項目集上述各領域之長，有潛力徹底改變我們的生活方式，使日常生活更加方便、更有效率、更少壓力。

呂教授說：「城市在創建高智能城市上，肯定大有作為。」