

智慧邊端運算、大數據、與物聯網技術研究:以智慧城市應用為範例

Research on Smart Edge Computing, Big Data, and Internet-of-Things: Taking Smart City as a Case Study

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Advanced in Artificial Intelligence (AI) has enabled many novel applications in modern smart cities. This project thoroughly investigated the challenges and potential of leveraging AI technologies in various domains, including edge computing, big data, and Internet-of-Things (IoT). We have made significant contributions on (i) *AIoT*, in which we integrated massive IoT devices, advanced networks (like Software-Defined Networks and 5G/6G mobile networks), edge computing, and cloud computing to collect, analyze, and react to various events in smart cities, and (ii) *big data*, in which we systematically accumulate and analyze complex datasets to squeeze more information out of the high volume, velocity, and variety datasets collected from smart cities. See Figures 1 and 2 for an overview of our *AIoT* and *big data* research, respectively.

In terms of *AIoT*, we consider four research directions: (a) heterogeneous network gateways for smart edge computing, (b) smart edge computing in cellular networks, (c) dynamic resource management and virtualized deployment of distributed *AIoT* applications, and (d) design and implementation of an *AIoT* system to validate the practicality and efficiency of our proposed solutions. In terms of *big data*, we consider four research directions: (a) machine learning algorithms tailored for big IoT data, (b) distributed processing and analysis of big IoT data, (c) mission-oriented big IoT data mining, and (d) visualization of big IoT data for digital arts. The developed solutions can be applied to many usage scenarios in smart cities, including smart lighting, parking, traffic, home, agriculture (vertical farms), factory, healthcare, and arts.

We have found that our research outcomes in *AIoT* and *big data* are mutually complementary to each other, e.g., advanced networks with more powerful computing nodes developed in *AIoT* can provide more extensive datasets for *big data* mining, while the *big data* mining results can be employed to optimize the design of advanced networks of *AIoT*. Such accumulation of research momentum wouldn't be possible without the expertise of the ten professors from the CS and EE departments. In particular, our team consists of a Sun Yun-Suan Chair Professor, a Distinguished Chair Professor, a Chair Professor, four IEEE Fellows, a MOST AI-project awardee, and a Columbus Program awardee.

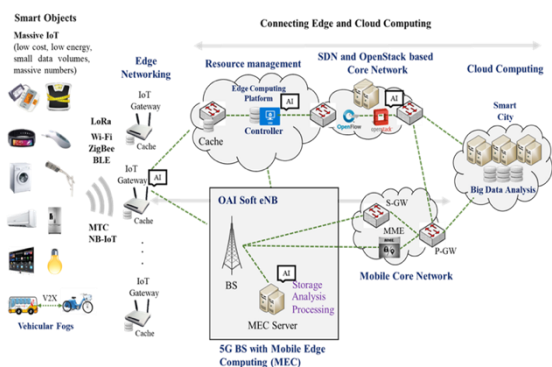


Figure 1 AIoT infrastructure in a smart city.

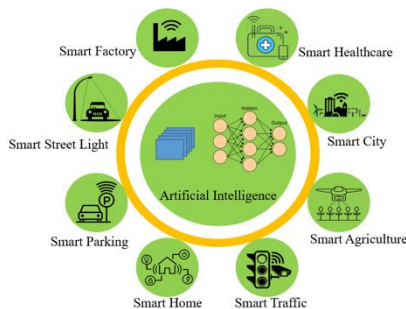


Figure 2 AI Applications of big data in a smart city.



Figure 3 Our smart street light testbed next to the Delta building.

Key Research Outcomes:

- **Scientific Publications:** We have published 51 papers in peer-reviewed international journals and 58 papers in international conferences.
- **Applications:** Jointly with Lite-On Inc., we have implemented and deployed smart street lights and smart displays around the Delta building, as shown in Figure 3. The resulting testbed was used for experimental evaluations in several research papers.
- **Industrial Collaborations:** The project has spun off several joint industrial projects, e.g., with LiteOn Inc. (about 9 millions NTD), Qualcomm Technologies (about 9.6 millions NTD), Foxconn (about 5.5 millions NTD), and Delta Electronics (about 2 millions NTD). These joint industrial projects *quadrupled* the amount of the grant we received from the Sprout Project.
- **International Collaborations:** The project results in international joint projects, with about 5 million NTD support from external sources in total. Sample projects follow:
 - Prof. Chia-Wen Lin visited Prof. Hiroshi Murase's group at the Graduate School of Informatics at Nagoya University in the second half of 2019 to work on research topics in computer vision and scene recognition.
 - Prof. Chia-Wen Lin's students visited Profs. Shin'ichi Satoh's lab at the National Institute of Informatics (Japan) and Prof. Gene Cheung's lab at the York University (Canada) for 3 and 8 months led to joint publications at top multimedia conferences.
 - Prof. Pai H. Chou worked with Prof. Ruey-Kang R Chang's lab at the University of California, Los Angeles (USA) to develop firmware for Asthmagram and BlueBox, currently used in clinical trials.
 - Prof. Shun-Ren Yang worked with Canadian colleagues on Networked Evs for Green Intelligent Transportation with a grant from the MOST.
 - Prof. Cheng-Hsin Hsu worked with Prof. Nalini Venkatasubramanian at the University of California Irvine (USA), Prof. Carsten Griwodz at University of Oslo (Norway), Prof. Hermann Hellwagner at University of Klagenfurt (Austria), and Prof. Alexander Raake at Technische Universität Ilmenau (Germany) on IoT and multimedia, with multiple grants from the MOST.