5G 智慧聯網技術與應用研究中心

5G-AIoT Technology and Application Research Center

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The research center considers research problems in 5G/B5G mobile networks, Unmanned Aerial Vehicle (UAV) communications, Internet-of-Things (IoT) in smart cities, smart agriculture, and other applications enabled by Artificial Intelligence (AI). In the past three years, we have made tremendous research achievements, including 43 articles in peer-reviewed international journals, 70 papers in the proceedings of international conferences, six patents, 18 industrial joint projects (with a total amount exceeding 45 million NTD), 7.5 million NTD of technology transfer funds, and extensive international collaborations with, e.g., Nagoya University, York University, University of Waterloo, Peking University, and University of Oslo.

The team of 14 professors from the CS and EE departments has made nontrivial research achievements. For example, our intelligent robotics research focuses on four aspects: (1) perception, (2) localization, (3) navigation, and (4) control. The research team has received 1st place in the 2018 NVIDIA Jetson Robotics Challenge and 2nd place at 2020 NVIDIA AI at the Edge Challenge. The proposed solutions have been implemented on real robots, as illustrated in Figure 1. We have also studied the social Internet-of-Things, which aims to identify proper IoT devices to complete complex tasks. In one of the projects, a deterministic algorithm with a performance guarantee is devised. In addition, a machine learning-based approach with reinforcement learning and meta-learning to effectively extract the suitable group of IoT devices based on their relationship was also proposed. As summarized in Figure 2, this work has been accepted for journal publication in IEEE TKDE. Furthermore, we have established solid foundations of AIoT-5G technologies, including (1) LoRaWAN/NB-IoT sensor hubs, (2) LoRaWAN/NB-IoT wearable sensors, (3) LoRaP2P-based precision irrigation/fertilization control, (4) crop identification/grading, (5) cloud-based agriculture IoT data analysis, (6) blockchain-based traceability services, (7) smart agriculture digital twins, and (8) 5G smart agriculture, which is summarized in Figure 3.

Next, we describe two sample projects on (i) UAV communications and (ii) smart city. As illustrated in Figure 4, UAVs have been adopted in cellular applications as temporary Base-Stations (BSs) for data offloading and relays for coverage extension in remote areas. UAVs have also been used as mobile aggregators or sink nodes in IoT or Wireless Sensor Networks

(WSN) for efficient data collection. We have developed various trajectory planning and wireless resource allocation algorithms for UAV communications, including (i) a multi-UAV cooperative precoding algorithm for cellular applications, (ii) a single-UAV trajectory algorithm for field data reconstruction, (iii) a multi-UAV temporal routing algorithm, and (iv) a UAV deployment and device association algorithm for data-gathering in WSNs. We have published three articles in IEEE TGCN and submitted another one to IEEE TMC. Preliminary results also appeared in top conferences such as ICC and IEEE GLOBECOM.

Figure 1 Real implementations of our proposed intelligent robotics algorithms.

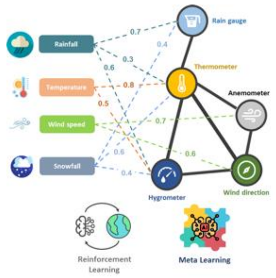

Figure 2 Our social Internet-of-Things research.

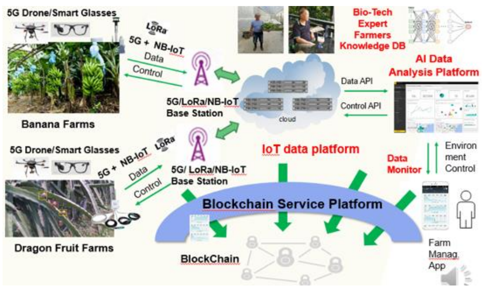

Figure 3 5G-AIoT smart farm architecture.

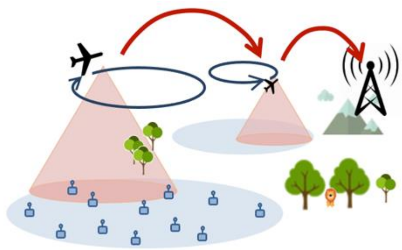

Figure 4 A flying wireless communication platforms.

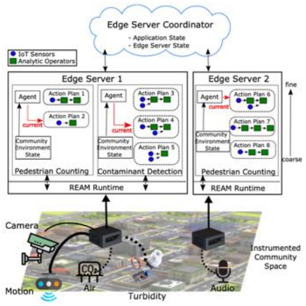

Figure 5 REAM monitoring framework.

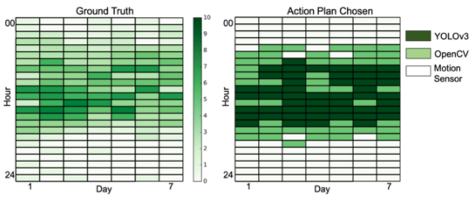

Figure 6 Comparisons of ground truth and action plans chosen by REAM for a pedestrian counting application.

We have studied the resource allocation problem in smart cities. In particular, we developed a Resource Efficient Adaptive Monitoring (REAM) framework at the edge, as depicted in Figure 5. REAM adaptively selects workflows of devices and analytics (action plan) to maintain an adequate quality of information for the applications while judiciously consuming the limited resources on edge servers. We utilized the LiteOn testbed with eight smart street lamps next to the Delta building for a pedestrian counting application to profile the movement of people at main intersections. Figure 6 shows the comparisons of hourly pedestrian count ground truth and chosen action plans. Our results were published at the IEEE SMARTCOMP Conference (which won the best paper award that year) and the Elsevier PMC Journal.

The work done by the members of our research center has been well recognized by the domestic and international research communities, which can be observed by the awards we have received in the past three years. For example, 5 out of 14 professors are IEEE Fellows, Prof. Yao-Win Peter Hong received a MOST Outstanding Researcher Award, Prof. Jang-Ping Sheu received a TECO Award and CIEF Fellow, Prof. Wen-Tsuen Chen was selected as a CIEE Fellow, Prof. Chia-Ya Shen received an Outstanding Young Electrical Engineer Award from CIEE and an Exploration Research Award from the Pan Wen-Yuan Foundation.