Guest editorial
IoT sensing, applications, and technologies for smart sustainable cities

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Published in:
IET Smart Cities

Published: 01/09/2021

Published version (DOI):
10.1049/smc2.12017

Publication details:
Hancke, G. P., Salehizadeh, M. R., Liu, X., Hu, J., Abu-Mahfouz, A. M., Thomos, N., Ishihara, S., & Savaglio, C. (2021). Guest editorial: IoT sensing, applications, and technologies for smart sustainable cities. *IET Smart Cities*, *3*(3), 121-124. https://doi.org/10.1049/smc2.12017

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EDITORIAL

Guest editorial: IoT sensing, applications, and technologies for smart sustainable cities

Sensing applications and Internet of Things (IoT) are indispensable for the construction of smart cities and provision of improved public services. Sensors act as the nerves of a smart city, enabling the collection of information that provides for intelligent decisions to be made, both in terms of future planning and immediate actuation. Internet of Things technologies provide the platform for implementing sensing applications, covering everything from embedded software and connectivity for edge nodes to data ingestion and analytics, including embedded OS, sensor interoperability and interfacing, local sensor node networks, wide area networks (e.g., LORA/5G), middleware for data handling and node management, green sensing and wireless networks.

While the research community has not yet settled on a precise definition of what makes a city 'smart', it is clear that IoT Sensing and Technologies are key for a safe, efficient, and environmentally friendly city and crucial for the provision of services in major application areas, such as intelligent transport, smart buildings, utilities, environment, and health.

This Special Issue on IoT Sensing, Applications, and Technologies for Smart Sustainable Cities has four papers accepted after a rigorous review and revision cycle. These papers cover several important application examples. These are summarised as follows:

> 'Smart City Development in Taiwan' by J.-H. Leu, B.-C. Lin, Y.-Y. Liao and D.-Y. Gan.

This paper outlines Taiwan's experience in developing smart cities, including visions, implementation strategies and application cases. To take global trends and local needs into account, Taiwan has applied a dual development model that combines top-down (theme-based)/bottom-up (needs-based) approaches for a synergy effect in balancing innovations and local needs. Furthermore, a PPP program has been adopted to prompt collaboration between central/local authorities with local businesses.

Meanwhile, Taiwan uses a PFI program and a global marketing strategy for strengthening the scalability and sustainability of smart city solutions. Three visions in the project help achieve the transformation to ensure smarter urban governance, more comprehensive industrial business models, and better livelihoods of residents. This paper also presents five application cases in the top-down approach and four application cases in the bottom-up approach with proven track records covering eight industry sectors: agriculture, healthcare, education, mobility, retail, energy, governance, and environment.

> 'A Smart City Application: Waste Collection System with LoRaWAN Network for Providing Green Environment, Cost Effective and Low Power Consumption Solutions' by E. Aktay and N. Yalçın.

The trend towards cities and urbanisation, which increases the number of people living in urban areas, requires local authorities to provide services and natural resources more efficiently and effectively and to develop some strategies for a sustainable environment. The more effective use of resources, growing awareness of sustainable environment, climate confidence and motivation can make cities more liveable.

In this paper, the proposed system supports the garbage collection of the city government and works with a low budget, low energy, and free radio frequencies. The IoT sensor node is assembled, and the network is set up based on the LoRaWAN protocol to connect it to the sample garbage bin and collect data. Instant data collection by this network is done through the IoT and is designed based on the collected data. This builds an ideal system for supporting sustainability in cities by integrating smart garbage collection with city government information systems. The data received from the sensor nodes and the efficiency of the system were demonstrated for local governments. The main outcome of this research is to develop a practical smart city application with minimal resources and support local governments in their daily work. Moreover, it is investigated how a low-power WAN communication network with a frequency of 868 MHz works in İstanbul (Turkey), which serves as an alternative to cellular networks and is the most suitable for excellent communication in smart cities.

'Orchestration-based mechanism for sampling adaptation in sensing-based applications' by H. Harb, H. Baalbaki, C. Abou Jaoude and A. Jaber.

Currently, the world is witnessing a boom in sensing-based applications where the number of connected devices is becoming higher than the number of people. Such small sensing devices are now deployed in billions around the world, collecting data about the surroundings and reporting them to the data analysis centres. This fact allows a better understanding of the world and helps to reduce the effects of potential risks. However, while the benefits of such devices are real and significant, sensing-based applications face two major challenges: big data collection and restricted power of sensor batteries. In order to overcome these challenges, data reduction and sampling sensor adaptation techniques have been proposed to reduce data collection and to save sensor energy. This paper proposes an orchestration-based mechanism (OM) for adapting the sampling rate of the sensors in the network. OM is two-fold: first, it proposes a data transmission model at the sensor level, based on clustering and the Spearman coefficient, in order to reduce the amount of data transmitted to the sink; second, it proposes a sampling rate mechanism at the cluster-head level that allows searching the similarity between data collected by the neighbouring sensors and then to adapt their sensing frequencies accordingly. A set of simulations on real sensor data have been conducted to evaluate the efficiency of OM, in terms of data reduction and energy conservation, compared favourably to other existing techniques.

'Shazam For Bats: Internet of Things for Continuous Real-Time Biodiversity' by S. Gallacher et al.

Biodiversity surveys are often required for development projects in cities that could affect protected species such as bats. Bats are important biodiversity indicators of the wider health of the environment and activity surveys of bat species are used to report the performance of mitigation actions. Typically, sensors are used in the field to listen to the ultrasonic echolocation calls of bats, or the audio data is recorded for post processing to calculate the activity levels. Current methods rely on significant human input and therefore present an opportunity for continuous monitoring and in situ machine learning detection of bat calls in the field. This paper shows the results from a longitudinal study of 15 novel internet-connected bat sensors—Echo Boxes—in a large urban park. The study provided empirical evidence of how edge processing can reduce network traffic and storage demands by several orders of magnitude, making it possible to run continuous monitoring activities for many months including periods that traditionally would not be monitored. The results demonstrate how the combination of artificial intelligence techniques and low-cost sensor networks can be used to create novel insights for ecologists and conservation decision makers.

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Claudio Savaglio received his Ph.D. degree in Computer Engineering from the University of Calabria, Italy, in 2018. He is the main designer of the ACOSO framework and responsible for the open-source contributions. Since 2013, he has international collaborations, having spent several months there as a visiting Scholar, at the University of Texas and New Jersey Institute of Technology, USA, and at Universitat Politècnica de València, Spain. He is involved in several research projects on IoT, including H2020 Inter-IoT, FLUIDWARE P.R.I.N., and ACOSO. He is an IEEE member since 2016. He is the author of more than 40 papers in international journals, conferences, and book chapters. He served as a Post-Doctoral Researcher in Computer Engineering at the University of Calabria, Italy. Currently; he is a Researcher at the ICAR-CNR (Institute for high-performance computing and networking of the Italian National Research Council). His research interests are focussed on Internet of Things and Edge Computing.