Journal of
Sensor and Actuator Networks

MDPI

Editorial

Smart City: The Different Uses of IoT Sensors

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Citation: Pau, G.; Arena, F. Smart City: The Different Uses of IoT Sensors. *J. Sens. Actuator Netw.* **2022**, *11*, 58. https://doi.org/10.3390/jsan11040058

Received: 31 August 2022
Accepted: 19 September 2022
Published: 22 September 2022

We refer to an interconnected city with shared intelligence when discussing Smart City and Internet of Things (IoT) sensors—a city governed in real time thanks to the recently gained ability to gather data through thousands of deployed sensors. The result is a set of urban planning activities and strategies capable of improving the services offered, respecting the environment with more thoughtful use of resources, offering more specific and intuitive services, thanks to new technologies, and increasing energy efficiency [1].

For years, many research centers and international companies have been studying solutions not only focused on the Smart City concept, especially with a view to "smart" public lighting, but also from a Smart Industry point of view for intelligent services through sensors and connectivity with Low-Power Wide-Area Networks (LPWAN). Thanks to the IoT, the digital and technological world and information and communication are closely conjoined to the real world. The concept of IoT is based on the pervasive presence around us of various things or objects that, through single addressing schemes, can interact with each other. Hence, objects become intelligent thanks to their ability to transmit data, receive instructions, and access aggregate information from other interconnected systems, thus creating a network that employs multiple communication technologies [2].

The research and development sector also concerns the management and redevelopment of public lighting systems from a smart point of view [3]. It starts with energy saving through dedicated sensors for managing the switching on and off of the systems based on the amount of light detected or sensitive areas, but not only. Through Smart Lighting, it is also possible to conveniently manage maintenance interventions aimed at the systems through a smartphone via app notifications. In addition, there is also the possibility of integrating other detection devices within the same system, such as, for instance, air pollution, noise pollution, or traffic monitoring [4].

Strongly linked to Smart Lighting are the air detection systems. Specific sensors are easy to install without needing a power supply, which can also be placed directly on IP systems. These detectors can monitor air quality, such as pollution, CO_2, temperature, and humidity, by periodically sending the gathered data and setting alert levels via apps or web portals. In addition, with the data collected, it is possible to create precise and replicable pollution control and prevention models on a scale. However, if used indoors, they can detect the quality of air recirculation and contribute to improving health in closed places. All this, in many cases, allows low costs, ease of installation and management, and low maintenance [5].

Smart Metering encompasses all the intelligent monitoring and management of meters in private homes and public buildings. It is a centralized and automated measurement system that maximizes measurement performance, achieves energy efficiency, and ensures various benefits for the final consumer. Therefore, creating a Smart Metering system means developing a network through which an advanced and efficient measurement system can implement automation, remote control, and management of utility meters [6].

Smart Security refers to sensors dedicated to surveillance and security in private homes and public buildings. Alarm systems that are too complicated, in fact, often require much maintenance and risk only complicating the life and habits of users. IoT devices, on the other hand, are supported, for instance, by a reasonable control and management system via an app, can be easily installed and managed even without a power supply, and, by communicating on a line independent of the Internet, they are much safer. These devices are suitable for monitoring doors and windows, such as motion detectors or alarm devices under certain conditions that require mobile notifications, or for managing wireless cameras via smartphone [7].

We talk about Smart Parking when the sensors are dedicated to counting passing vehicles and available parking spaces, the management of parking areas for campers, and the administration of the various payments related to parking. Intelligent parking management allows traffic to be decongested by directing users to available parking spaces and considerably increases the level of service provided. A minimal and easily positioned parking monitoring IoT sensor can detect information on parking space availability and send it to the central system to process a vacancy map. In addition, this map can be sent to parking managers or directly to drivers via the app on their mobile devices. Finally, IoT sensors make it easy to identify violations or expired tickets, directly on the management system, without needing further movements [8].

Another feature concerns the intelligent management of waste, i.e., Smart Waste. Usually, waste collection is managed on a cyclical basis, with collection vehicles that follow a predetermined path at regular time intervals, emptying all the bins regardless of their filling level. It may happen, therefore, that some containers are practically empty and others overloaded for some time. Thanks to dedicated sensors located inside the bins, it is possible to detect the actual filling level and plan an intelligent collection, reducing accumulation times and costs for unnecessary travel [9].

Another use of sensors by public administrations involves the Smart Governance of public parks. The intelligent management of urban green irrigation can save costs and environmental solutions. Dedicated sensors can adjust irrigation based on atmospheric conditions or the state of the soil and plants [10].

Another essential sector concerns Smart Mobility. It is a term that encompasses many facets related to the mobility of large cities. It is alternative mobility, with sharing and rental of vehicles, such as, for instance, car sharing, but also sustainable mobility, such as electric vehicles or scooters, up to the management of parking, which was examined previously. Furthermore, it is possible to monitor city traffic and divert it as needed using dedicated sensors [11].

Smart Building is a sector that includes different types of IoT sensors. The main objective is the intelligent management of energy and the efficiency of buildings. This circumstance offers the best possible comfort to those who live there. Many aspects revolve around this use of IoT sensors: from the control of building lights to temperature control, from access control with dedicated sensors to the management of security and video surveillance, up to the management of fire prevention systems, to name a few [12].

Smart Agrifood, or the IoT sensors applied to the world of agriculture, allows reducing the passage times of the product from the producer to the consumer, thus providing a healthier, fresher, and better-quality product. Through IoT sensors, it is possible to monitor the maturation of products by predicting and organizing the harvest periods. In addition, containers equipped with IoT sensors allow products to be tracked along the entire supply chain from collection to the consumer, monitoring times and environmental conditions to ensure rapid delivery and high-quality standards. Furthermore, thanks to ad hoc applications, all these data can be easily accessible, for instance, on mobile devices [13].

Smart Health encompasses all the IoT sensors applied to medicine concerning the monitoring and management of patients. Sensors applied directly to patients or machines allow collecting information that can be analyzed to prevent illness or help the medical staff diagnose disease more quickly. A significant contribution is made by analyzing Big Data to aid scientific research in this sector. In fact, in the future, thanks to IoT sensors and artificial intelligence, it will be possible to accurately predict, for instance, the onset of a heart attack or stroke [14].

IoT sensors can be used in many areas and have numerous advantages related to the small and manageable size and the absence of wires, which make them easy to position [15].

Furthermore, they do not require special maintenance, as they are equipped with long-lasting batteries capable of powering the sensors for up to 10 years, and, thanks to the LPWAN network, communication is also possible over long ranges. Finally, through integration with web applications, the data collected can be stored in a database, analyzed, and consulted at any time through any mobile device. Therefore, a world of advantages is worth exploiting to evolve toward the Smart City concept [16].

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This work was partially supported by project PON "SAMANTA—SmArt MAiN-Tenance plAtform"—F/ 190197/01-03/X44.

Conflicts of Interest: The authors declare no conflict of interest.

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