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Editorial

Emerging Internet of Things Solutions and Technologies

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The Internet of Things, together with its related emerging solutions and technologies, is driving a revolution with respect to the way people perceive and interact with the surrounding environment. Smart homes, smart offices, and smart factories are effective examples of daily life environments that, enriched with sensing, actuating, communication, and computing capabilities, are able to offer advanced services and applications. In this context, multiple advantages can be achieved. Among these, valuable benefits include improving the quality of life of people, increasing the efficiency of systems and plants, enriching the sustainability of buildings, enhancing the performance and usability of the offered services, and making technological solutions affordable to everyone and available everywhere. Further added value can be achieved by carefully combining the above benefits.

The full potential of the emerging Internet of Things paradigm needs a large industrial and academic research effort directed to the design, development, and assessment of novel architectures, methodologies, solutions, and technologies. Novelties in this field include, but are not limited to, the integration of consciousness and awareness in the Internet of Things, the adoption of machine learning and artificial intelligence, the exploitation of the edge and fog computing paradigms, the development of new standards and protocols, and the use of the digital twin concept to integrate physical and cyber worlds.

This Special Issue includes eight papers that offer an interesting perspective on the field, covering most of the mentioned topics. The issue opens with a paper [1] that deals with the use of IoT for medical healthcare applications, a field referred to as Internet of Medical Things (IoMT). Such applications exploit multiple wearable devices for monitoring physiological signals, for instance, electrocardiogram (ECG), electroencephalogram (EEG), blood pressure, temperature, etc. The contribution of the paper is three-fold: it proposes a novel adaptive battery-aware algorithm that utilizes the charges up to its maximum limit and recovers those charges that remain unused; it presents a novel framework for IoMT-based pervasive healthcare; it describes how the proposed ABA is tested and implemented in a hardware platform that ensures high energy efficiency, long battery lifetime, and reliability for intelligent pervasive healthcare.

Indoor air quality is the main focus of the second paper [2]. The COVID-19 outbreak and its consequent detrimental impacts have brought indoor air quality into the spotlight; indoor air is recycled constantly, causing it to trap and build up pollutants, which may facilitate the transmission of a virus. The paper presents an indoor air quality monitoring and prediction solution based on the latest Internet of Things sensors and machine learning capabilities, providing a platform to measure numerous indoor contaminants. In the proposed architecture, an IoT node consisting of several sensors for monitoring multiple pollutants, including NH_3, CO, NO_2, CH_4, CO_2, and PM 2.5, along with the ambient temperature and air humidity, is presented. The monitored data are delivered in real time to a web portal and a mobile app through GSM/WiFi technology, where alerts are generated after detecting anomalies in the air quality. In order to classify the indoor air quality, several machine learning algorithms have been applied to the recorded data, and the neural network (NN) model outperformed all the others with an accuracy of 99.1%.

The authors of [3] study multiple access control (MAC), which is crucial for devices to send data packets and harvest energy in wireless IoT networks. The paper describes the use of a framed slotted ALOHA (FSA) protocol in a centralized wireless powered IoT network, including half-duplex devices and a full-duplex base station transmitting wireless energy in an intended direction. The main novelty is the development of an algorithm that finds a charging order of half-duplex devices instead of using full-duplex devices to eliminate vain charging, a well-known phenomenon that causes energy losses. Simulation results show that the proposed protocol produces better system performances than a system that does not eliminate vain charging.

In [4], the focus is on school dropout, which causes social, economic, political, and academic damage to those involved in the educational process, mainly in underdeveloped countries. The paper presents an IoT framework for predicting dropout using machine learning methods such as decision tree, logistic regression, support vector machine, K-nearest neighbors, multilayer perceptron, and deep learning. With the use of socioeconomic data, it is possible to identify who are the students likely to drop out. This paper proposes the automation of the prediction process by a method capable of obtaining information that would be difficult and time-consuming for humans to obtain, contributing to a more accurate prediction and allowing personalized follow-up for students to reverse a possible dropout. The approach is validated by analyzing the accuracy, F1 score, recall, and precision parameters.

Differently from most consumer applications, the industrial scenario is generally constrained by time-related requirements and its needs for real-time behavior. Unfortunately, timeliness is generally ignored by traditional service providers, and the cloud is treated as a black box, including "database as a service" (DBaaS). The work reported in [5] provides an experimental measurement methodology based on an abstract view of industrial IoT (IIoT) applications, in order to define some easy to evaluate metrics focused on DBaaS latency. In particular, the focus is on the impact of DBaaS on the overall communication delays in a typical IIoT scalable context. In order to show the effectiveness of the proposed approach, a real use case is discussed, and experiments offer useful insights about the DBaaS performance: evaluation of delays, scalability, constraints of the architecture, and clear information for comparisons with other implementations.

The work presented in [6] focuses on the important role played by IoT technology for the efficient management of energy, in the context of energy communities that include both simple consumers and producers of local renewable energy. Indeed, smart IoT objects are used as a source of real-time information regarding the energy production and the users' requirements, and as actuators that can help to regulate the distribution and use of energy. In this paper, an IoT-aware optimization model is presented; the main novelty consists in modeling the entire energy community as a whole, rather than each prosumer separately, with the goal of optimizing the energy sharing and balance at the community level. Experimental results, performed at a university campus, show the advantages of the approach and its capability of reducing the energy costs and increasing the community's energy autonomy.

The combination of supervisory control and data acquisition (SCADA) and IoT technologies allows end users to monitor and control industrial components remotely. However, this transformation opens up a new set of attack vectors and unpredicted vulnerabilities in SCADA/IoT field devices. Proper identification, assessment, and verification of SCADA/IoT components are a crucial step in risk assessment, an issue that is tackled in [7]. The Omega2, a small Linux server from Onion™, is used to develop various SCADA/IoT systems and is a key component of nano-power grid systems. The paper reports product-level vulnerabilities of Onion™ Omega2 that have been uncovered using advanced vulnerability scanning tools. This research aims to assist vendors, asset owners, network administrators, and security professionals by increasing the awareness about the vulnerabilities of Onion™ Omega2 and by suggesting effective security best practices.

The Special Issue closes with a review paper [8], which offers a survey of the challenges and opportunities for data sharing in an IoT scenario. Data-shared IoT defines a new perspective of IoT applications that can benefit from sharing data among different domains. Data sharing can also enable novel use case applications; for example, applications regarding intelligent logistics management and warehouse management can be used when data are shared between smart transport and smart industry. The benefits of such applications, however, can only be achieved if the shared data are of acceptable quality. This paper aims to describe data-shared IoT while highlighting the importance of keeping a high level of quality across various domains. The article examines trust-based techniques and discusses how such techniques can be combined with blockchain for secure end-to-end data quality assessment.

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References

1. Magsi, H.; Sodhro, A.H.; Al-Rakhami, M.S.; Zahid, N.; Pirbhulal, S.; Wang, L. A Novel Adaptive Battery-Aware Algorithm for Data Transmission in IoT-Based Healthcare Applications. *Electronics* **2021**, *10*, 367. [CrossRef]
2. Mumtaz, R.; Zaidi, S.M.H.; Shakir, M.Z.; Shafi, U.; Malik, M.M.; Haque, A.; Mumtaz, S.; Zaidi, S.A.R. Internet of Things (IoT) Based Indoor Air Quality Sensing and Predictive Analytic—A COVID-19 Perspective. *Electronics* **2021**, *10*, 184. [CrossRef]
3. Lin, Y.J.; Tzeng, S.S. A Framed Slotted ALOHA-Based MAC for Eliminating Vain Wireless Power Transfer in Wireless Powered IoT Networks. *Electronics* **2021**, *10*, 9. [CrossRef]
4. Freitas, F.A.d.S.; Vasconcelos, F.F.X.; Peixoto, S.A.; Hassan, M.M.; Dewan, M.A.A.; Albuquerque, V.H.C.d.; Filho, P.P.R. IoT System for School Dropout Prediction Using Machine Learning Techniques Based on Socioeconomic Data. *Electronics* **2020**, *9*, 1613. [CrossRef]
5. Ferrari, P.; Sisinni, E.; Depari, A.; Flammini, A.; Rinaldi, S.; Bellagente, P.; Pasetti, M. On the Performance of Cloud Services and Databases for Industrial IoT Scalable Applications. *Electronics* **2020**, *9*, 1435. [CrossRef]
6. Giordano, A.; Mastroianni, C.; Scarcello, L. Optimization Model for IoT-Aware Energy Exchange in Energy Communities for Residential Users. *Electronics* **2020**, *9*, 1003. [CrossRef]
7. Upadhyay, D.; Sampalli, S.; Plourde, B. Vulnerabilities' Assessment and Mitigation Strategies for the Small Linux Server, Onion Omega2. *Electronics* **2020**, *9*, 967. [CrossRef]
8. Byabazaire, J.; O'Hare, G.; Delaney, D. Data Quality and Trust: Review of Challenges and Opportunities for Data Sharing in IoT. *Electronics* **2020**, *9*, 83. [CrossRef]