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Industrial Internet of Things

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In recent years, the widespread deployment of wireless sensor networks, industrial cloud, industrial robots, embedded computing, low battery consumption, and low-cost sensors has facilitated industrial Internet of Things (IndustrialIoT) technologies and fostered some emerging applications (e.g., product lifecycle management). Wireless Sensor Networks were generally the type of networks used for monitoring in the 2000s [1], while, now, in the 2020s, IoT deployments are the most used Networks [2]. The development of new cloud-based service systems has facilitated this migration to IoT Networks [3]. IndustrialIoT is the direct motivation and drives for industrial upgrading (e.g., implementing a smart factory of Industry 4.0) [4].

With the support of all kinds of emerging technologies, IndustrialIoT is capable of continuously capturing information from various sensors and intelligent units, securely forwarding all the data to industrial cloud centers, and seamlessly adjusting some important parameters via a closed-loop system. These tasks can be done by taking into account their energy consumption [5] and their security [6]. Also, IndustrialIoT can effectively detect failures and trigger maintenance processes, autonomously reacting to unexpected changes in production [7]. However, we are still facing some challenges, such as nodes should have more capable hardware at lower prices, the network latency should be lower, and use of edge computing technology in IoT networks. Moreover, there is also a lack of measurement tools, specific purpose communication protocols, standardized APIs and enhanced security and privacy systems [8].

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Topics of interest included in the call for papers on the Special Issue were: (1) Efficient communication protocols for industrial IoT systems, (2) Industrial cloud & industrial big data, (3) Distributed control and optimization of industrial IoT systems, (4) Cyber-physical approach for Industrial IoT systems, (5) Industrial wireless networks for industrial IoT systems, (6) Security and privacy issues in industrial IoT systems, (7) Software methodology in industrial IoT systems, (8), Architectures of industrial IoT systems, (9) Industrial IoT applications, e.g., smart grid, smart factory, and logistics, (10) WirelessHART applications in industrial IoT systems, (11) Modeling, simulation and experiment for industrial, (12) Deployments of IndustrialIoT in Agriculture.

The accepted papers in this Special Issue are the following ones:

I. Picallo et at. [9] analyzed the coverage of wireless communication systems in indoor scenarios for the Industrial Internet of Things (IIoT). The authors proposed the use of hybrid deterministic 3D Ray Launching based on geometric optics and uniform theory of diffraction to characterize the wireless channel. Simulations performed using Matlab estimate the received power level in complex indoor scenarios. The simulations were carried out for the frequencies from 433 MHz to 3.5 GHz. Their results indicate the existence of relevant differences in terms of attained link distances due to variations in node location, node density, and interference levels. In addition, the authors have analyzed the effect of multipath propagation, estimating the delay dispersion and the power delay profile at several locations in the simulated scenario. Their results pointed out great variability in the delay dispersion due to the existence or absence of line of sight links within the tested indoor scenario.

Z. Ming-Tuo et al. [10] studied the problem of low latency in task processing and the balance in resource scheduling in the smart industry. In the paper, the authors present a scheme of task scheduling, which blends cloud and fog computing and establishes the Automatic Repeat Request (ARQ) as a delay optimization model. Moreover, the Tradeoff between Service-time and Balance (TSB) is proposed as a balance factor to maximize the computing resources for the factory balance. Finally, a Genetic Scheduling Algorithm with Penalty (GSAP) is designed to optimize the balance factor for the TSB. The simulation was performed in a micro service demo application which is capable of simulating the real tasks of a smart factory producing socks. The results of the simulation indicate that the efficiency of the designed fog and cloud collaborative computing architecture overcome the performance of traditional cloud and fog computing by bringing lower latency and improved resource balance. In addition, the proposed scheme is able to achieve the tasks faster with largescale task requests than the previous schemes. Meanwhile, the TSB ensures a better balance in the use of computing resources.

J. V. Sorribes et al. [11] proposed the use of an energy-aware randomized neighbour discovery protocol for wireless ad hoc networks with a multi-hop scenario, the Low Energy Collision Detection Hello (LECDH). The authors performed the simulations using the Castalia 3.2 simulator to compare the proposed approach with the Energy-Aware Hello (EAH) protocol as a reference to the existing solutions. A total of five different metrics, including aspects such as energy, throughput, and time, were used to compare the performance of both options. Their results indicate that the LECDH method improves all the metrics compared with EAH for one-hop and multi-hop scenarios for high duty cycles. Furthermore, the authors concluded that LECDH operates following more realistic assumptions; even if the number of nodes is ignored, it can provide adequate behaviour.

J. Bas and A. A. Dowhuszko in [12] studied the viability of different relaying strategies in an Unmanned Aerial Vehicle (UAV) with radio access and optical backhaul link to connect Narrow Band IoT (NB-IoT) devices with a gateway in the uplink flow of information. In the paper, the authors evaluate the effect of different Coding Schemes and find out the scheme which attained the maximum end-to-end throughput for different tested UAV altitudes. The simulation results indicate that the Decode-and-Forward relaying achieve better performance than the Detect-and-Forward in terms of Block Error Rate. When UAV has a low flying altitude, the Decode-and-Forward relaying strategy is identified as the best option. Nonetheless, for medium and high altitudes (from 30 to 100 m), both schemes' obtained BLER and throughput were almost the same. Considering the effect of flying heigh on the cannel coding, their results indicate that the higher altitudes, the lower the variation in the channel, improving the signal-noise ratio.

S. Sendra et al. [13] design, develop, and test water quality monitoring systems based on WSN. The system uses LoRa as communication technology and is able to monitor up to five environmental parameters. Data is sent from the nodes located at different points of the coast to a server, in which data can be visualized. The authors selected the Things Network Platform for the deployment of the LoRa network, and the website was created based on HTTP. The RSSI measured for The Things UNO module and a Heltec node along different points on the coast were recorded to evaluate the coverage obtained for the selected gateway for different wavelengths. Moreover, the system was tested in a static position by gathering data at three different points for up to two days. Their results indicate that selected sensors and deployed networks are capable of offering information about water quality status.

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