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Integration of Intelligent IOT & Smart Industrial Wireless Sensor Network

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ABSTRACT

IOT (Internet of Things) is the interconnection of physical objects such as wireless sensors, vehicles, industrial machines, and people that are embedded with electronics and software, allowing them to communicate and interact via the Internet. The combination of sensors, linked to gateways and with the cloud, enable businesses and cities to collect and analyze data to enable smarter decisions. IoT devices have sensors and processors integrated with them to send and receive information and act on it. IoT can also be used in various applications ranging from smart homes, industrial automation, smart cities, asset tracking, healthcare and so on. With the help of IoT, end users are able to effectively control devices remotely. In this research, we discussed WSN and IoT networks in deep, their working, applications and techno and their relationship. We provided the comparison between these two networks. WSN is a particular type of IoT network, but there are key differences between them. IT professionals can use the information here to get a better understanding of WSN and IoT.

Keywords: IOT (Internet of Things), WSN (Wireless Sensor Network), Smart Cities

INTRODUCTION

The idea of the Internet of Things can be traced back to 1982, when the British engineer and inventor Kevin Ashton coined the term ‘RFID’ (Radio Frequency Identification). This was a technology that allowed users to automatically identify and track objects for the first time [1].

In 1999, an excellent article by Bruce Sterling called 'Shaping Things' introduced the concept of the Internet of Things for a large audience. He proposed that technology had the potential to bring objects to life and open new possibilities for controlling and monitoring them [2].

Around the same time, MIT researchers made a major breakthrough by developing a network protocol called 'Constrained Application Protocol' (CoAP). It was designed to allow devices connected to the Internet to communicate and exchange data more effectively.

Since then, the Internet of Things has grown quickly, with a wide range of technologies, products and services being developed to make things smarter, more connected, and more automated [3]. These range from connected cars and smart fridges to personal fitness devices and wireless sensors for industrial applications [4].

The connection between IoT and WSN is that WSN is a type of IoT, or an Internet of Things network. WSNs are composed of sensor nodes which are connected directly to network devices and deployed at a location to monitor a certain parameter or condition [5]. Each node records data from its environment and communicates it over a wireless network. These data points can then be aggregated together through a gateway and sent to a remote analytics processor.

Meanwhile, IoT is a sprawling network of connected devices and networks, which use sensor technology to send and receive data [6]. IoT also encompasses a wide range of objects and applications, including vehicles, appliances, cameras, and other everyday items, as well as more specialized uses like industrial and manufacturing automation [7].

The link between WSN and IoT is that both seek to achieve the same goal of gathering data, communicating it, and then analyzing it. WSNs provide the means to record, transmit, and interpret data from the environment, while IoT networks can use this data to enable automated systems, generate insights, and much more [8].

Over the past decade, rapid advancements in the Internet of Things (IoT) and wireless communication technologies have led to a number of scientific challenges. These challenges include maintaining control and security of the data sent and received within IoT implementations, enabling reliable and secure communication links between connected devices, and efficiently managing the amount of power consumed by IoT systems [9]. Furthermore, the ability to detect, identify and classify information sources is key in performing decision making, interactive object tracking and environmental monitoring. Additionally, scalability, reliability and customization of the sensing task is crucial in ensuring IoT implementations run optimally [10]. Research and development in this field significantly contributes to the development of innovative and intelligent applications in areas such as industrial automation, emergency rescue, home automation and smart cities [11].

The Internet of Things (IoT) paradigm covers a range of technologies, such as sensors, automation, machine-to-machine communication protocols, and cloud computing and analytics services [12]. These technologies enable physical objects, such as machines, appliances, vehicles, and everyday objects, to exchange data with each other, permitting intelligent and automated interactions. Through IoT systems, it is possible to collect, transmit, analyze, and act on data from hundreds or even thousands of different devices connected via the Internet [13]. The result is the potential for the rapid development of IoT applications that could significantly improve efficiency, safety, and convenience in numerous sectors, from healthcare, to transportation, to manufacturing [14].

This includes Bluetooth Low Energy (BLE) and Near Field Communication (NFC) technologies. Accordingly, new techniques and systems have been developed to gradually achieve full interoperability, while offering channels of communication with both existing and new standards [15]. Also, edge computing technology has recently been proposed to offer a distributed data processing model, aimed at providing computing resources closer to the point of data production and ingestion [16].

In addition to developing reliable communication capabilities for the IoT, research has also been devoted to the automatic data analysis and decision making of these systems. An effective combination of machine learning and IoT systems can enable reliable detection and classification of objects, contextual awareness and correct algorithm-driven decisions [17]. This is enabled by the combination of embedded and distributed learning algorithms, enabling more effective monitoring and control over reconfigurable processes without the need for direct human interaction [18].

Finally, efforts from the research and engineering communities are increasingly devoting towards the path of creating energy efficient IoT systems. This enabled the development of low-cost and energy-conserving solutions, which in turn will enable scalable and long-lived IoT infrastructures [19]. This involves architectures leveraging advanced techniques such as power-saving scheduling and optimization techniques, as well as computational and storage optimization approaches to reduce device power consumption [20].

Technological Evolution in IOT

The evolution of IoT is continuously driven by the development of new technologies such as sensors, 5G networks and cloud computing. The improvements in all these underlying technologies are allowing for ever more sophisticated IoT devices and applications [21].

Sensors have become more powerful and adept at measuring a wider range of parameters, such as temperature, motion, light, and air quality. This has enabled IoT to be used effectively in sectors such as agriculture, where sensors are used to measure and monitor soil and plant health. 5G networks have provided the bandwidth necessary for a large number of devices to communicate with each other [22]. This is particularly important for large scale, real-time IoT applications such as smart cities and traffic management systems. Cloud computing provides the underlying platform for data collection and analytics, further extending the reach of IoT.

Overall, the continual development of these technologies has allowed IoT to progress from being an aspirational concept to a reality [23]. By leveraging the capabilities of these various technologies, IoT can be used to create real and meaningful applications that have the potential to transform the way we live and work [24].

Integrating the IoT concept and industrial WSNs (IWSNs) is an attractive choice for industrial processes because it allows for efficient monitoring, control and communication between devices on a production line or within a factory [25]. IWSNs, through their use of sensors, enable real-time data collection and analysis to detect and respond to production issues or changes in environmental conditions. They can also be used to optimize production processes to improve efficiency and reduce costs. Additionally, IWSNs facilitate secure communication between devices, which is essential for industrial environments [26]. Finally, IWSNs create the infrastructure and platform upon which more sophisticated and innovative applications can be developed, such as predictive maintenance and automated decision making [27].

Internet of Things (IoT) is an emerging field of technology which enables interconnected devices, such as machines, computers, and other electronic devices, to connect and exchange data [28]. This network of connected objects can be utilized to optimize various aspects of industrial operations. Through networked communications between devices, operators can remotely monitor and control equipment, enabling predictive maintenance and automation [29]. IoT also allows for intelligent decision making, creating the ability to optimize productivity, identify problems, or adjust production based on data collected. Further, connected devices can automate processes and provide real-time insights into trends or abnormalities which may be leveraged for further optimization [30]. This can help reduce costs, take corrective action if needed, and help increase overall operational efficiency.

The combination of Industrial Wireless Sensor Networks (IWSNs) and wired/wireless Fieldbus Networks (WFNs) form what is commonly called an Industrial Internet of Things system (IIoT) [31]. IWSNs make use of wireless technologies, such as Bluetooth, Wi-Fi, and cellular networks, to allow data communication without the need for wired connections. These networks provide flexibility and form the basis for remote monitoring and control of industrial equipment and systems. WFNs, on the other hand, use physical wires and connectors to provide a more reliable and rigorous communications backbone for industrial applications [32]. Used in conjunction, these two networks can create an IIoT system, with each network providing different levels of connectivity, security measures, and robustnesss [33]. The IWSN provides flexibility and faster response time, while the WFN provides more reliable communication and higher throughput. Together, these networks provide IIoT systems with the key characteristics of scalability, reliability, reliability, and compatibility [34].

Data collection and processing are crucial to effective IIoT since the success of the IIoT depends on the ability to capture and analyze the data generated by the systems. Data collection involves gathering the data from various sources, ranging from manual collection from sensors to automated collection from code written for remote devices [35]. Once the data is collected, it must then be processed so that it can be used to derive meaningful insights. This processing can include data cleaning and statistical/analytical techniques such as machine learning and artificial intelligence. The data analytics then serve to provide decision makers with actionable insights and to develop strategies for improving the performance of the IIoT system [36].

To make the system work and receive the desired data and predictions, there are multiple stages such as data collection, preprocessing, analytics, inference, visualization, decision making and action that need to be taken [37]. Data collection is the first step in developing an effective IoT system. It collects data from sensors and other sources using communication protocols. The collected data then needs to be pre-processed for further analysis. Data pre-processing typically involves cleaning the data and preparing it for analytics and visualization [38].

Data analytics is the core of IIoT. It finds patterns and creates meaningful insights from the data. It also provides information to make predictions, to improve the performance of the system, and to infer whether any changes should be made. AI (Artificial Intelligence) and ML (Machine Learning) can be used to process the data. AI is used to automate the decision-making process by inferring new information from the data and ML is used to create predictive models from the data [39].

The output from the analytics can then be used to make decisions and actions [40]. The visualization of the data allows the decision makers to easily understand the results of the analytics and to take the necessary actions. Finally, the action stage interprets the decisions and commands the system to make the necessary changes [41].

A WSN platform designed for a range of long-term environmental monitoring IoT applications needs to include a combination of hardware, software and communication protocols [42] . The hardware elements of the platform should include a range of sensors, as well as data sending and receiving devices such as gateways and routers. It should also contain a variety of software components that can be used to enable data processing, analytics, and communication [43]. Additionally, the platform should have standardized communication protocols to enable the different components to communicate with each other. Finally, data security should be a priority, and the platform should include secure communication protocols and data encryption algorithms to ensure data is protected from unauthorized access [44].

CONCLUSION

IoT technology has enabled the connection of not only physical devices but also to the virtual world that is the “Internet of Things”. IOT is a concept that helps in enabling a large number of physical objects to be connected to the network. The technology enables sensors, actuator and other electronics to be connected over a network and to transmit or receive data. It helps in integrating both the physical and digital worlds, thus improving user experience. The platform designed with such a concept could include a range of sensors, communication protocols and data encryption. In addition, the platform should be connected by a series of gateways and routers that enable data transmission. This communication should be secure and should include protocols such as IP, Bluetooth and LTE/4G. Lastly, the platform should also include data analysis capabilities to take advantage of the data collected. This can include using big data analysis tools such as Hadoop and machine learning.

Through our research, we aim to focus on the essential components of IoT technology and look at how these can be used to their fullest potential. Our research will seek to provide an overview of the basic architecture of IoT, examine its various components such as sensors, gateways and routers, as well as the communication protocols such as IP and Bluetooth. We will also look at the importance of data encryption and data analysis, and the relevance of big data analytics and machine learning. Our research will provide an insightful overview of IoT technology and hopefully provide a better understanding of its implementation, advantages, and potential pitfalls.

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