Perception of the Wild Environment and Data Transmission Technique: Internet of Things Gateway

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Abstract
This research focuses on the development of an Internet of Things (IoT) gateway designed to perceive and monitor the wild environment. The gateway comprises various modules, including the Sink Node module, a core ARM control module, a GPRS module, a 3G module, and a power supply module. The proposed data transmission method involves acquiring node data from a monitored region, sending it to the Sink Node module, and further transmitting it to the core ARM control module. The data is then classified and transferred to the GPRS and 3G modules. The GPRS module transmits sensing data to a remote server, while the 3G module sends image data to the same server. Through the GPRS and 3G networks, the gateway uploads the perceived data to a remote server's database, allowing a monitoring center to receive and process the data in real-time, enabling remote supervision.
Keywords: **Internet of Things, wild environment perception, data transmission, IoT gateway, remote server, monitoring center**
DOI Number: 10.48047/nq.2021.19.2.NQ21051 **NeuroQuantology 2021; 19(2): 302-307**

Introduction
The rapid advancement of technology has paved the way for innovative solutions in various fields, and one such area that has gained significant attention is the Internet of Things (IoT). The IoT has revolutionized the way we perceive and interact with our surroundings by connecting physical devices and sensors to the internet, enabling seamless communication and data exchange. In recent years, the application of IoT has extended beyond traditional domains, and researchers have begun exploring its potential in environmental monitoring and management.One critical aspect of environmental monitoring is the ability to perceive and understand the wild environment, which plays a crucial role in biodiversity conservation, ecological research, and natural resource management. To address this need, there is a growing interest in developing IoT gateways that can effectively capture and transmit data from the wild environment to remote servers for further analysis and decision-making(Alam, Shakil, and Khan 2020; Hildayanti and Machrizzandi 2020; Misimi and Xhaferi 2018).
This research focuses on the development of an IoT gateway specifically designed for perceiving the wild environment and proposes a novel data transmission method to facilitate real-time data upload to a remote server. The gateway comprises several essential components, including the SinkNode module, a core ARM control module, a GPRS module, a 3G module, and a power supply module.

These modules work in tandem to capture data from the monitored region, classify it, and transmit it to the appropriate destination(Bhuiyan et al. 2021).The proposed data transmission method involves the SinkNode module acquiring data from the nodes deployed in the wild environment. This data is then sent to the core ARM control module, which performs necessary processing and categorization. Subsequently, the classified data is transmitted to the GPRS module and the 3G module. The GPRS module handles the transmission of sensing data to a remote server, while the 3G module is responsible for sending image data to the same server. Through the GPRS and 3G networks, the gateway uploads the perception data to the remote server's database.The real-time data transmission and processing offered by the IoT gateway open up new possibilities for remote supervision and monitoring. The monitoring center can receive the data from the wild environment in real-time, enabling timely decision-making and environmental management. Additionally, the data can be further processed and analyzed in the remote server's database, providing valuable insights into the wild environment's dynamics and enabling effective conservation strategies(Sookhak et al. 2019).

In the recent years, numerous significant Internet of Things (IoT) initiatives have emerged and exerted their influence on the market. Several noteworthy IoT projects that have gained substantial market share are depicted in **Figure 1**. Within Figure 1, a depiction of the geographical distribution of these IoT projects is presented, highlighting the American, European, and Asia/Pacific regions. A discernible trend is observed, indicating that the American continent demonstrates a higher involvement in healthcare and smart supply chain projects, while the European continent exhibits a greater focus on smart city initiatives(Bhuiyan et al. 2021).

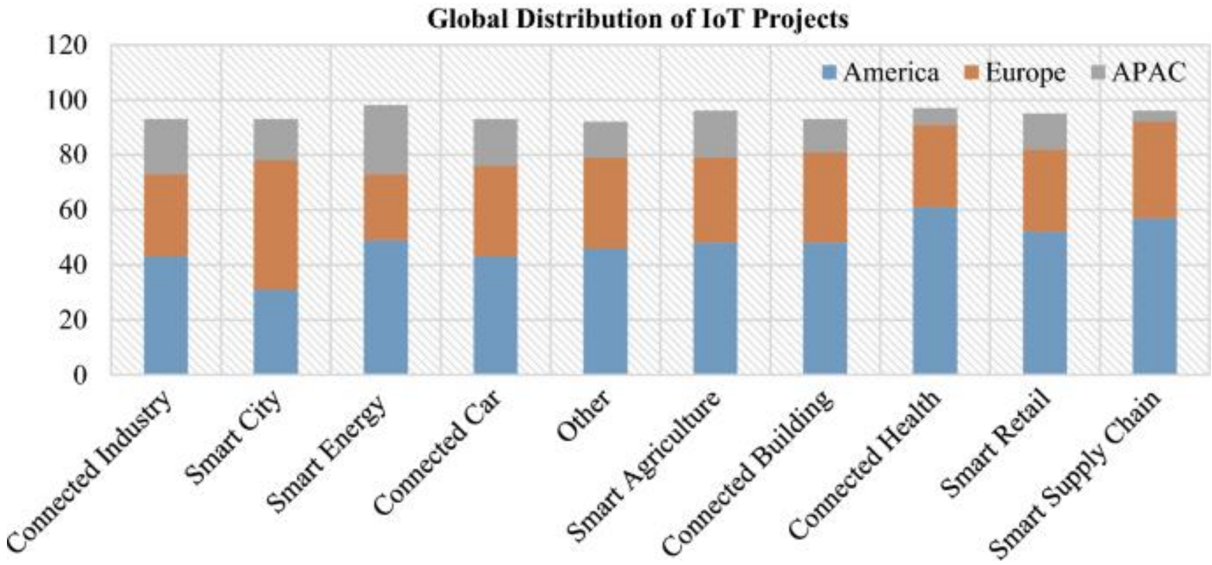

Figure 1. Global distribution of IoT projects among America (USA, South America and Canada), 1Europe and APAC (Asia and Pacific region)

This research aims to contribute to the field of environmental monitoring by developing an IoT gateway specifically tailored for wild environment perception. The integration of various modules and the proposed data transmission method enable efficient and seamless data capture, classification, and transmission. By facilitating remote supervision and timely decision-making, this research can significantly enhance our understanding of the wild environment and support effective management and conservation efforts.In the subsequent sections of this paper, we will delve into the details of the IoT gateway's architecture, the data transmission method, and the experimental results. We will also discuss the implications and potential applications of this research in the field of environmental monitoring and management(Hamad et al. 2020).

Related Work

Wi-Fi detector network is a network composed of numerous microsensor nodes deployed on a large scale. These nodes possess the capability to perceive information, communicate in real-time, and perform simple computing tasks. Each distributed miniature sensor node in the network collaboratively monitors, perceives, and collects environmental data. Communication among the Wi-Fi detector network nodes is facilitated through the Zigbee protocol, and the well-processed information is ultimately sent to the intended user(Ni et al. 2018).

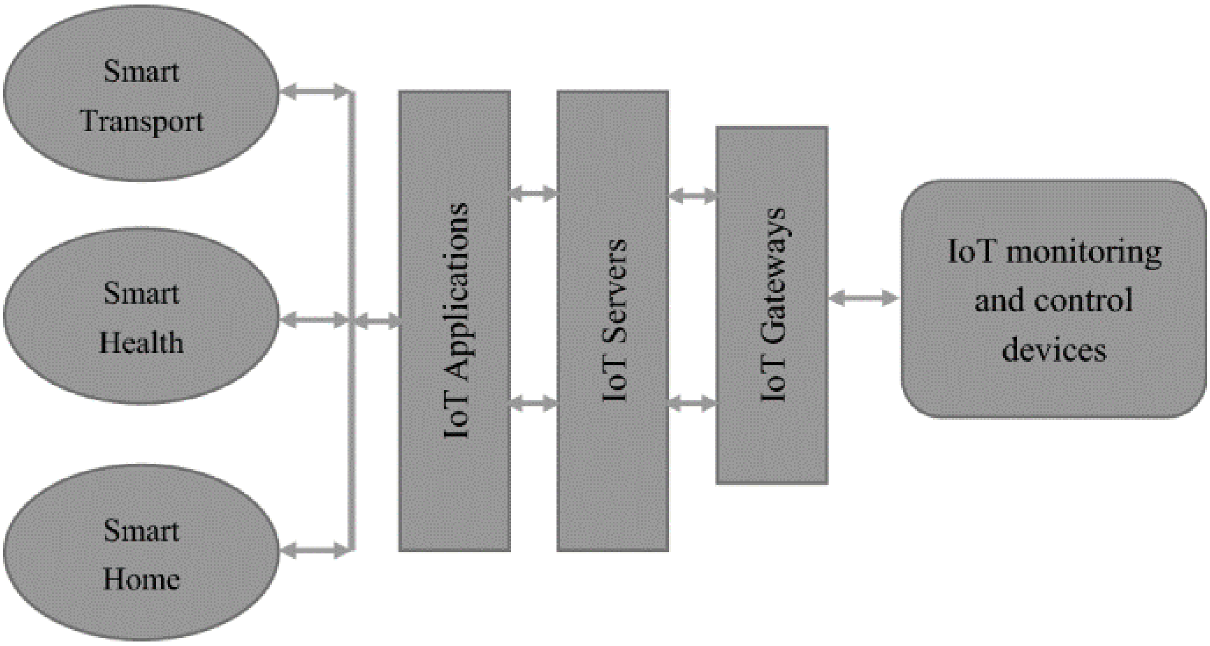

Figure 2. Working structure of IoT

Multiple crucial functional components are accountable for carrying out I/O operations, addressing connectivity concerns, conducting processing tasks, monitoring audio/video inputs, and managing storage. These combined functional blocks form an effective IoT system that is vital for achieving optimal performance. Despite the existence of several proposed reference architectures with their technical specifications, these architectures still fall short of establishing a standardized framework suitable for global IoT implementation. Consequently, there remains a need for the development of an appropriate architecture capable of meeting the requirements of the global IoT landscape. The fundamental operational structure of an IoT system is depicted in Figure 2. Within Figure 2, the interdependence of IoT on specific application parameters is demonstrated. Notably, IoT gateways play a pivotal role in facilitating IoT communication by enabling connectivity between IoT servers and the array of IoT devices associated with various applications(Makhdoom et al. 2019).

The gateway plays a vital role in the hardware infrastructure of a sensor network. It not only aggregates, controls, and sends tasks but also acts as a medium to connect the distant host server with the underlying Wi-Fi detector network nodes. Additionally, it performs the translation function between the lower-layer 802.15.4 protocol and upper-layer protocols.Wi-Fi detector networks have found applications in various fields such as military IoT, intelligent furniture design, and the construction of smart finance systems. The utilization and development prospects of WSNs are extensive. To date, several Wi-Fi detector network gateway devices have been proposed domestically and internationally. Representative gateways include Crossbow's serial PC gateway MIB510, USB PC gateway MIB520, Ethernet PC gateway MIB600, and embedded Wi-Fi detector network gateway NB100CA(Zhou et al. 2019).

However, these typical gateways suffer from certain deficiencies. The serial PC gateway MIB510, USB PC gateway MIB520, and Ethernet PC gateway MIB600 are connected to PCs and can only be used when connected to a PC. Therefore, these gateways are rendered ineffective in the absence of a PC, such as in a remote or wild environment.[1] The NB100 embedded Wi-Fi detector network gateway is an improvement over the previous gateways but still fails to address the challenges of energy supply and the unavailability of Ethernet access points in the field environment.Furthermore, there are some gateway solutions that are still in the development phase or not commercially produced. These solutions mainly rely on GPRS or 3G modes to simply send the collected data to a designated address. While these solutions may resolve the Ethernet access and energy supply issues, they do not adequately meet the requirements of a gateway in a wild environment. Specifically, they do not enable real-time observation of the wild environment through the transmission of both sensing data and real-time image data. GPRS transmission only allows for the transmission of simple sensing data, while 3G transmission can handle tele-video transmission but fails to distinguish between sensing data and view data upon data server reception.[4] Additionally, 3G transmission does not facilitate simultaneous transmission of sensing and view data, leading to increased packet loss and compromised data link quality. The undesirable side effects of frequent switching between 2G and 3G networks include high power consumption and interference with sensing capabilities(Chettri and Bera 2020).

In summary, existing gateway technologies fail to meet the requirements for an Internet of Things gateway in a wild environment. The need for an aware gateway that ensures the transmission of sensing data and real-time image data is not adequately addressed. The current solutions using GPRS or 3G transmission modes are limited in their capabilities(Bhuiyan et al. 2021; Hamad et al. 2020). There is a demand for a gateway that can effectively operate in wild environments, allowing for the simultaneous transmission of sensing and view data while addressing power consumption and data integrity issues.

Research Objective

The research objective of this study is to design and develop an Internet of Things (IoT) gateway that focuses on perceiving and monitoring the wild environment. The primary goal is to create a system that effectively captures data from the environment and transmits it to a remote server for further analysis and monitoring.

To achieve this objective, the study aims to integrate different modules within the gateway. These modules include the Sink Node module, core ARM control module, GPRS module, 3G module, and power module. The Sink Node module collects sensing data from various sensor nodes in the monitored region, while the core ARM control module processes and categorizes this data. The GPRS module is responsible for transmitting the sensing data to a remote server, and the 3G module handles the transmission of image data. The power module ensures a stable power supply for the entire system.Furthermore, the research objective is to establish an efficient data transmission method that enables real-time uploading of perception data to the remote server. This involves developing protocols and mechanisms that facilitate seamless and timely data transfer between the gateway and the server.

By achieving real-time data transmission and processing, the research aims to enable remote supervision by a monitoring center. This means that the monitoring center will be able to receive the perception data in real-time and perform further analysis and processing on the data. This capability can greatly enhance the monitoring and understanding of the wild environment, contributing to better environmental management and decision-making processes.

Research

This Internet of Things gateway, designed for perceiving the wild environment, is composed of several key components. These components include the Sink Node module, the core ARM control module, the GPRS module, the 3G module, and the power module. The Sink Node module and the GPRS module are connected to the core ARM control module, while the Sink Node module and the 3G module are also connected to the core ARM control module. The power module is connected to all the other modules in the system.The Sink Node module is responsible for collecting sensing data from the sensor nodes in the monitored region and capturing image data from the camera nodes. The core ARM control module processes the data collected by the Sink Node module. It classifies the data based on specific flags and stores it accordingly. The core ARM control module also enables interaction with the user and sends the sensing data to the GPRS module and the image data to the 3G module.

The GPRS module is used to transmit the sensing data from the core ARM control module to a remote server. On the other hand, the 3G module handles the transmission of image data from the core ARM control module to the remote server. These modules ensure that the perception data of the wild environment is uploaded to the remote server through the Internet of Things gateway. This allows a monitoring center to receive the data in real-time and process it further in the remote server's database, achieving remote supervision.The power module is responsible for providing power supply to all the other modules in the system. It consists of a storage battery, a solar panel, a DC-DC module, and a power management module. The solar panel is connected to the storage battery through the power management module. The storage battery, in turn, connects to the GPRS module, the 3G module, and the Sink Node module via the DC-DC module. The core ARM control module is directly connected to the storage battery.

The core ARM control module itself includes an ARM9 processor, an LCD display, an outer memory module, and three serial ports. The ARM9 processor is connected to the LCD display, the outer memory module, and the three serial ports. This configuration enables efficient processing, data storage, and communication within the system.In summary, this Internet of Things gateway for perceiving the wild environment is equipped with the necessary components to collect and transmit data. It uses the Sink Node module, the core ARM control module, the GPRS module, the 3G module, and the power module to facilitate data collection, processing, and transmission. The system's power module ensures a stable power supply, while the core ARM control module handles data classification and interaction with the user. The GPRS and 3G modules enable data transmission to a remote server for further analysis and monitoring.

Conclusion

The developed IoT gateway provides an effective solution for perceiving and monitoring the wild environment. By combining the SinkNode, ARM control, GPRS, and 3G modules, the gateway successfully captures and transmits data from the monitored region. The data transmission method ensures efficient classification and transmission of sensing and image data to a remote server. This enables the monitoring center to receive real-time data and perform further processing and analysis. The IoT gateway's capability to upload perception data to the remote server's database through the GPRS and 3G networks enables remote supervision, facilitating timely decision-making and environmental management. Overall, the research demonstrates the effectiveness of the IoT gateway and data transmission method in enhancing the monitoring and supervision of the wild environment.

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