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Wireless Sensor Network Implementation for IoT-Based Environmental Security Monitoring

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Abstract. The use of Wireless Sensor Network (WSN) technology with Internet of Things (IoT) technology has been developed. Internet of Things (IoT) is a technology that enables control, communication and collaboration with various hardware devices over computer networks. The Internet of Things (IoT) has been a form of transformation and development of information technology and Internet networks. This article uses IoT-based environmental monitoring networks to monitor environmental safety in real time. The proposed WSN network is structured to allow continuous monitoring of environmental safety and environmental issues, such as: For example, the potential risk of fire or crime in the environment and many others. In practice, the WSN network consists of sensors and local servers connected via the Internet. The generated data comes from several electronic sensors, such as proximity sensors and fire sensors, all of which are connected to the local server via the gateway. A number of interesting experimental results, including the analysis of energy consumption, are discussed in detail.

1. Introduction

The use of Wireless Sensor Network (WSN) technology with the Internet of Things (IoT) technology has been developed. Internet of Things (IoT) is a technology that enables control, communication and collaboration with various hardware devices over computer networks. The Internet of Things (IoT) has become a form of change and the development of information technology and Internet networks. This makes it easy to connect electronic devices directly to the Internet and meet the addressing and connectivity requirements [1].

Safety is a very important aspect wherever we are, especially in the environment in which we live. The IoT-based security control system is an additional solution from the previous system that continues to use CCTV. In this study, we built a wireless system to control the environmental safety of equipment installed in crime-prone areas. The generated data comes from several electronic sensors, such as proximity sensors and fire sensors, all of which are connected to sensor nodes that are continuously sent to the local server via the gateway connected to the Internet. A series of experimental results that determine the power consumption of the device to be built.



2. Related Work (State of the Art of the Research)

Some safety surveillance system investigations have been conducted with all cases, conditions and problems to be resolved. This can be seen in the research [2] on system design by analyzing and defining roles in the campus security planning process, analyzing users' security needs, and awareness of campus public areas. In addition, investigations were carried out in the context of the IoT platform, which was designed in the form of modules for the integration of temperature sensors, humidity sensors, CO₂ sensors [3]. Subsequent research will focus on the design and implementation of tools through the combination of RFID tag-chip technology, GSM communication technology, keyboard input and LCD screen. The GSM module sends a confirmation message to the specified handset. The module is used in campus environment for campus security [4].

Other studies design and implement an intelligent Campus Security Tracking (iCST) system based on RFID and ZigBee networks. iCST reads data from RFID tags through FRID and ZigBee nodes and then sends them to PC nodes using ZigBee. Research into the use of LoRA technology is also being conducted by assessing the best topology for communication between sensors using LoRa, especially in high-building environments, in this case, the campus environment.

3. Architecture

The architecture model of the system we build is shown in Figure (1) and shows the conditions under which sensors are placed on vulnerable points. Figure (2) shows the configuration models of sensors, node sensors and gateways.

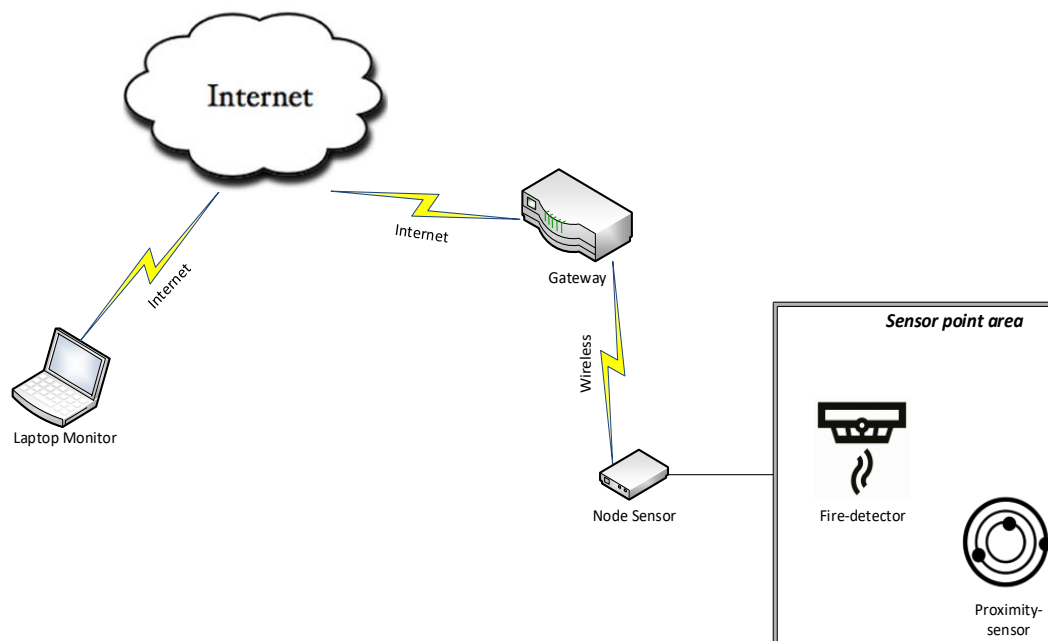


Figure 1. Architecture system IoT security monitoring

Figure 1 shows the conditions for sensor placement at the points to be monitored. Each sensor is connected to the sensor node. The sensor data is then recorded by the sensor node and processed into digital data and then forwarded wirelessly to the gateway. Based on LoRA, data is then sent to the Internet so that it can be accessed in real time.

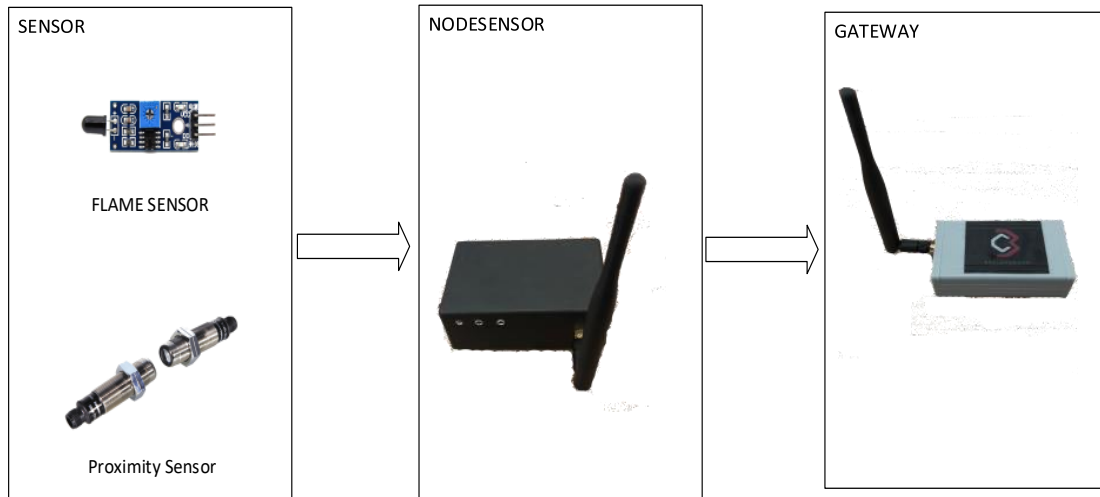


Figure 2. Device configuration model (sensor, node sensor and gateway)

Components on the sensor node are Arduino Uno, Dragino LoRA Shield 915 MHz, Arduino Uno Sensor Shield, external antenna 3 dBi 915 MHz, proximity sensor and flame sensor. While at the gateway are Arduino Uno, ESP32 Devkit, Dragino LoRA Shield 915 MHz, external antenna 3 dBi 915 MHz.

4. Method

We have taken several steps to achieve the research goals. This is to make sure that the tool is working properly. Form of communication between sensor sensors using Wireless Sensor Network (WSN) based on LoRa using the LoRa chip module RFM95-915MHz. Each sensor is connected to node sensor, which acts as a receiver of information from the sensor, and then converts information from the sensor into data that is transmitted to the server. The server uses the Internet via a LoRa ESP32 915MHz-based gateway. The working system of the sensor is as follows:

- The fire detector detects if a fire occurs in places that are considered vulnerable.
- Proximity sensors mark areas that are considered at risk.

The device we built uses batteries as the main power supply connected to the node sensor and the gateway.

5. Result and Discussion

The built-in system creates a power consumption test for the node sensor and the gateway as shown in Table 1 and Figure 3.

Table 1. Power consumption of network node sensor and gateway

| Power | Node Sensor | | | Gateway |
|-------|-------------|----------|----------|---------|
| | 0 Sensor | 2 Sensor | 3 Sensor | |
| Watt | 0.35 | 0.36 | 0.74 | 0.65 |

Power consumption is measured at sensor nodes with three conditions, namely without sensors, with 2 sensors and with 3 sensors. The tool used is Adafruit INA219 Current Sensor Breakout, which can measure the performance of DC devices. When measuring the power consumption at the same gateway, the location is the difference between the measured components, so that for the measurement of the gateway, the sensor node module is simply replaced by the gateway module.

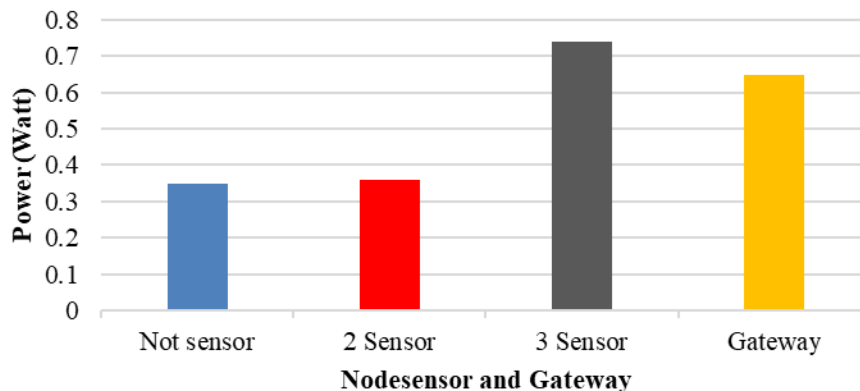


Figure 3. Power consumption diagram for sensor and gateway nodes

Table 1 and Figure 3 shows performance measurement data for node sensor and gateways. The measurement results show that the current consumption of the node sensor is very low even under 1 watt and that the placement of the sensor on the node sensor affects the performance of the node sensor. The power consumption at the gateway is also less than 1 watt.

6. Conclusion

The design of the safety control system proposed in this article will improve the monitoring process in relation to environmental safety issues. This provides real-time information such as potential fire hazards or short circuit problems and environmental crimes. This information can then be used by the authorities to take immediate action, such as the evacuation of persons or dispatch of emergency security teams. Based on the test results, it has been determined that the device developed is suitable for use in all regions or environments. The device's power consumption has been tested, which shows that the device's power consumption is so low that it can be used for a long period of time. Design development can also be done by adding more sensors to improve environmental safety monitoring.

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