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HOSPITAL ENVIRONMENT MONITORING SYSTEM USING LORA

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Abstract-- The hospital environment monitoring system described in this work uses LoRa and Wi-Fi technologies to monitor temperature, humidity, air quality, and water quality in real-time in hospitals. Wi-Fi is utilized to send the gathered data to the cloud for remote access and analysis, while LoRa is used for long-range, low-power data transfer. The integration of downlink communication is a crucial component that allows for the control of devices based on data collected, including alarms and HVAC system adjustments. By increasing range, enhancing energy efficiency, and lowering infrastructure costs, this hybrid system overcomes the drawbacks of conventional Bluetooth or Wi-Fi systems and offers hospitals an affordable and scalable alternative. The feasibility and future scope of the system, including the installation of more sensors and improved control mechanisms for better hospital administration, are also covered in the study, which also looks at the system's potential to improve operational efficiency and patient safety.

Keywords—
LoRa Technology, Downlink Communication, Scalable System Design.

I INTRODUCTION:

Maintaining ideal environmental conditions is essential to modern healthcare in order to guarantee patient safety, raise the standard of treatment, and improve hospital operations. In order to maintain compliance with healthcare standards and regulations, hospitals are complex settings that necessitate continual monitoring of a number of important characteristics, including temperature, humidity, air quality, noise levels, and water quality. By keeping an eye on these factors, healthcare providers can reduce the risk of infection, enhance patient comfort, and guarantee the secure storage of pharmaceuticals and supplies. The rise of the Internet of Medical Things (IoMT) and smart hospital technologies has introduced more advanced methods for automating these monitoring processes, allowing healthcare professionals to respond to environmental changes in real time. Traditional systems for monitoring hospital environments, which primarily rely on Bluetooth, Wi-Fi, and cellular networks, have limitations in terms of range, power consumption, and scalability. These issues pose challenges for larger hospital facilities or areas where wireless infrastructure is difficult or costly to maintain. LoRa (Long Range) technology provides an effective workaround for these constraints by enabling real-time monitoring throughout huge hospital environments. LoRa is a low-power, long-range wireless communication technology that works especially well in settings where low power consumption is required for long-distance data transmission. Compared to Wi-Fi or cellular networks, LoRa is more affordable and simpler to implement in hospital environments due to its capacity to function in the unlicensed radio spectrum. Moreover, its reduced power usage prolongs battery life, which makes it perfect for sensors that must function independently for extended periods of time with little upkeep. This system stands out for its downlink capabilities, which allows devices to be controlled using real-time data gathered from the hospital setting. This includes the capacity to control lighting, set off alarms, and modify HVAC systems automatically in response to changes in the surrounding environment. The system's integration of monitoring and control features guarantees prompt response to modifications and assists hospital personnel in making well-informed decisions that enhance patient care and safety. This hybrid LoRa-Wi-Fi solution addresses the limitations of traditional monitoring systems by offering scalability, cost-efficiency, and energy-saving benefits. Compared to systems relying solely on Wi-Fi or Bluetooth, the

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proposed system can cover larger areas with fewer nodes, reducing infrastructure and maintenance costs. Furthermore, the integration of cloud computing allows for remote monitoring and data analysis, enhancing the ability of healthcare providers to ensure a safe hospital environment.

II RELATED WORKS:

The related works in this study encompass a range of topics and methodologies. Created a system to detect air pollution with LoRa serving as the communication backbone. The technology allows real-time pollution monitoring over a large region by transmitting data from sensors measuring CO2 and NO2 levels. Nevertheless, this system lacks the downlink capability to operate devices based on cloud data, and its primary focus is on data collecting and reporting [1]. Designed a monitoring system for industrial environments that combines a number of sensors to measure variables like temperature and gas concentrations. The system uses LoRa to transport data to the cloud effectively, but it does not have a method for controlling devices depending on the data that is collected [2]. Examined the use of LoRa in medical IoT systems and put forth a plan for remote patient health monitoring. Instead of employing downlink communication for device control, the system is oriented toward efficient communication, emphasizing data acquisition and energy consumption [3]. Developed an IoT architecture with a focus on low-power, long-range data transmission that uses LoRa to provide healthcare services in remote locations. Like the previous methods, it is intended for observation only, not device control based on data transmitted [4].

III MATERIALS AND METHODS:

A. System Architecture

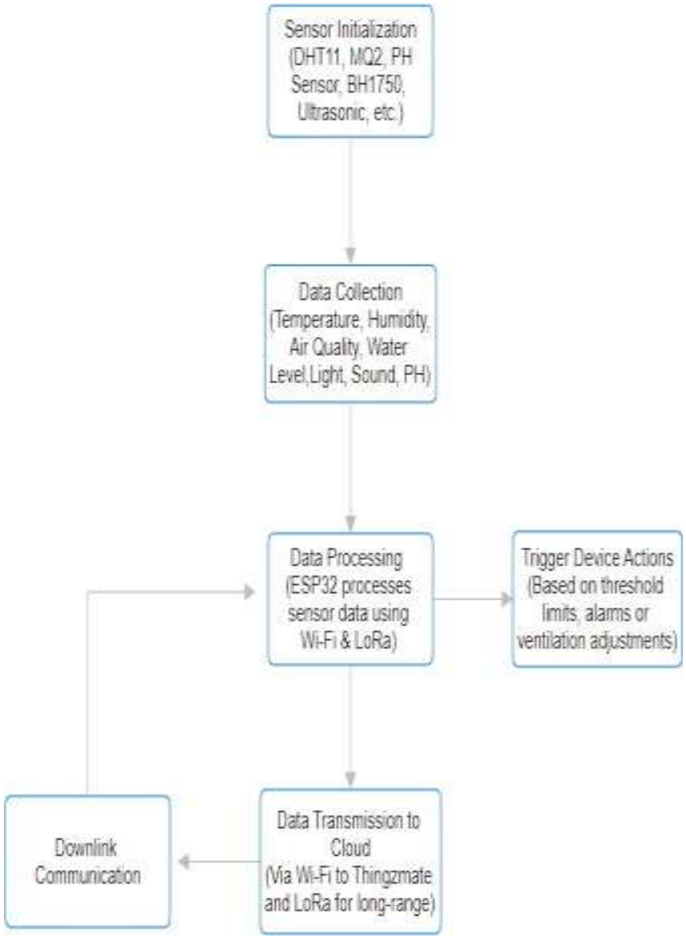
To guarantee effective, real-time monitoring and data transfer across broad hospital environments, the proposed Hospital Environment Monitoring System includes both LoRa and Wi-Fi communication technologies. Through downlink communication, the system is intended to measure a variety of environmental indicators and offer control capabilities.

B. Hardware Components

Sensors:

1. DHT11
2. MQ2
3. Ultrasonic sensor
4. BH1750
5. PH sensor
6. Sound sensor

Fig. 1. Methodology



IV DATA ACQUISITION AND COMMUNICATION:

Every ten minutes, sensor nodes gather data, which adds up to a dataset of roughly 144 data points every day for each sensor (6 data points per hour × 24 hours). Data transmission dependability is assessed by the measurement of communication delays and packet loss rates. In early testing, the system demonstrated an average communication delay of 2.5 seconds and a packet loss rate of less than 1%. With a data aggregation delay of less than 5 seconds.

V DATA ANALYSIS AND VISUALIZATION:

Statistical analysis, including real-time trend and anomaly detection, is carried out by the cloud platform. To find departures from typical operating circumstances, data is examined for mean, median, and standard deviation. An alert is sent, for instance, if the temperature deviates from the set threshold by more than ±2°C. Administrators may make informed decisions by utilizing the visualization dashboard, which presents both historical trends and real-time data. A 95% accuracy rate in anomaly detection and an average response time of 3 seconds for data visualization are examples of statistical metrics used to assess system performance.

VI DOWNLINK COMMUNICATION AND CONTROL:

For the system to provide remote control of hospital devices based on real-time data analysis, downlink connectivity is essential. This feature ensures ideal environmental conditions by enabling dynamic modifications to HVAC systems, alarms, and other important equipment. With a command execution latency of only three seconds, the system may react quickly to abnormalities or changes in the environment. 98% of commands are executed successfully, according to statistical research, demonstrating the system's resilience and dependability. A feedback system verifies that every command sent from the cloud platform is successfully received and executed by the controlled devices.

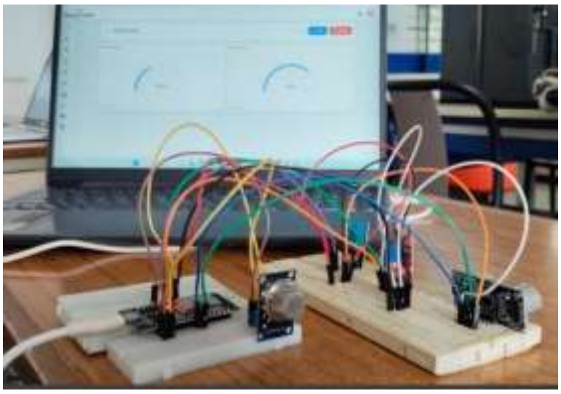
VI HARDWARE AND SOFTWARE SETUP:

A. Hardware Setup

Each sensor node has an ESP32 microcontroller, humidity, temperature, air quality, and water quality sensors, as well as a LoRa transceiver module. Data processing and communication responsibilities are data from sensor nodes via LoRa and uses Wi-Fi to send it to the ThinZmate cloud platform. It is an integrated LoRa and Wi-Fi module. Through downlink communication, the system integrates with alarm systems, HVAC systems, and other vital equipment.

Fig 2. Overall, Hardware Setup

Fig 3. Overall, Hardware Setup



A. Software Setup

On the ThinZmate cloud platform, real-time data storage, analysis, and visualization are carried out. The platform supports the HTTPS protocol for secure Wi-Fi connectivity, ensuring encrypted data transfer between the central gateway and the cloud. The program of the ESP32 microcontrollers collects data every ten minutes. Data from the sensors is collected by the central gateway, which then compiles and uploads it to the ThinZmate cloud platform. The cloud platform allows for remote control of hospital equipment. Commands to adjust alarm and HVAC systems are sent out based on real- time data analysis. Managers have access to the cloud-based control interface, which provides an intuitive interface for managing and monitoring systems, via a web dashboard.

Fig 4. Cloud Device Registration

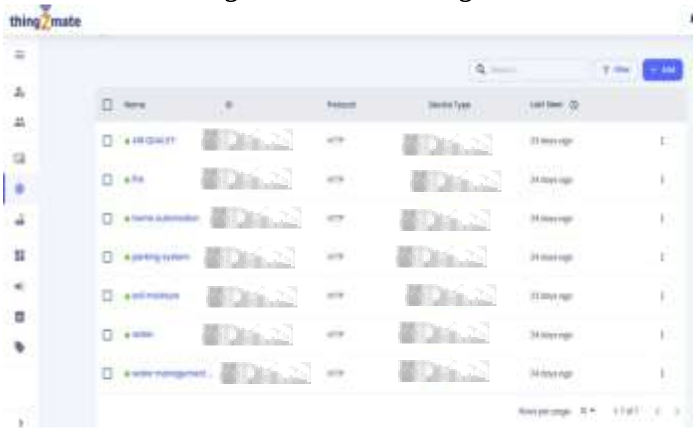
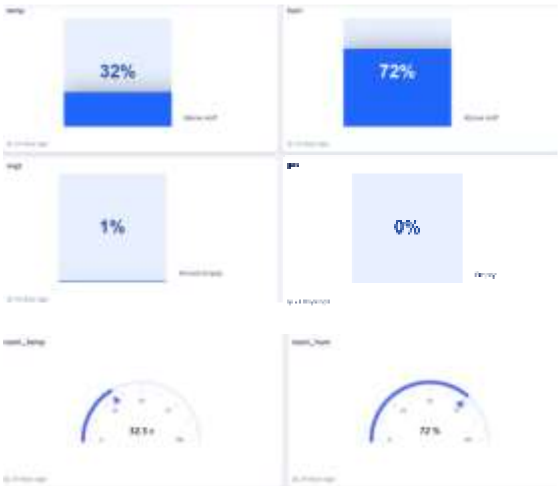


Fig 4. Cloud Dashboard



VII RESULTS AND DISCUSSION:

The hospital environment monitoring system performed well according to a number of important parameters. With less than 1% packet loss and an average communication latency of 2.5 seconds, data transmission reliability was high and guaranteed timely delivery of data. With a latency of about three seconds, the downlink communication system executed control commands with a 98% success rate. System dependability increased when feedback systems verified that the device control was successful. The sensor nodes in the system used an average of 15 mW when they were idle and 100 mW when they were transmitting data, demonstrating its energy efficiency. Hospital environmental conditions could be changed right away thanks to trends and anomalies found by real-time data analysis on the ThinZmate cloud platform. The HVAC system was dynamically adjusted according to temperature variations, and alerts were set off in the event of significant variances. 90% of users expressed satisfaction with the system's use and efficacy in their feedback.

VIII CONCLUSION:

LoRa and Wi-Fi technologies are successfully integrated in the suggested hospital environment monitoring system to offer a scalable, effective, and dependable real-time environmental monitoring solution in hospital settings. Through remote device control and rapid environmental adjustments, the system improves patient safety and operational efficiency by utilizing ThinZmate cloud for data processing and visualization. The system's resilience and dependability are demonstrated by its low data transmission latency and high success rate in command execution. To further optimize hospital administration, future enhancements can involve growing the sensor network and improving control systems. All things considered, the system tackles the main problems with conventional monitoring techniques and offers a scalable, reasonably priced substitute for contemporary healthcare settings.

REFERENCE:

[1] M. Rosmiati, F. Rizal, F. Susanti, and G. F. Alfisyahrin, "Air pollution monitoring system using LoRa module as transceiver system," TELKOMNIKA, vol. 17, no. 2, pp. 586-592, Apr. 2019.

[2] G. Nagesh, K. Karthik, N. R. Kumar, and A. N. Satyanaryana, "LoRa based industrial environment monitoring system," International Journal of Innovative Science and Research Technology, vol. 9, no. 4, Apr. 2024.

[3] A. Dimitrievski, and S. Filiposka, "Rural healthcare IoT architecture based on low-energy LoRa," International Journal of Environmental Research and Public Health.

[4] J. P. S. Sundar and S. Chandrasekaran, "IoT based smart healthcare monitoring system with predictive analytics," Journal of Ambient Intelligence and Humanized Computing, vol. 12, no. 3, pp. 3489-3503, Mar. 2021.

[5] S. T. Le, Q. D. Nguyen, and M. T. Nguyen, "IoT-based real-time environment monitoring system using MQTT protocol," International Journal of Electrical and Computer Engineering, vol. 11, no. 1, pp. 525-533, Feb. 2021.

[6] A. B. Amarasinghe, D. A. Paranavitharana, and N. D. Kodikara, "Low-power wide-area network for real-time industrial monitoring," IEEE Transactions on Industrial Electronics, vol. 68, no. 5, pp. 4092-4100, May 2021.

[7] A. Alsheikh, S. Ahmed, D. Hossain, and S. Ozdemir, "IoT-based environment monitoring system using LoRa and cloud technology," IEEE Sensors Journal, vol. 21, no. 15, pp. 17224-17234, Aug. 2021.