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Intelligent Residential Environment Monitoring System Using Cloud Computing and Internet of Things

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ABSTRACT

The improvement in modern lifestyles has increased the need for maintaining safe and comfortable indoor environments. People are now more aware of how environmental conditions influence health, productivity, and overall well-being. Therefore, continuous monitoring of residential environments has become essential. This study presents the development of an intelligent monitoring system that utilizes Internet of Things and Cloud Computing technologies. The system collects real-time data using sensors and transmits it through IoT networks for further processing in a cloud platform. This approach enables efficient storage, analysis, and remote access to environmental data. A structured system design is proposed, including hardware components, software configuration, and data integration techniques. The system is implemented in a residential setting, where environmental parameters are monitored over time. The use of a fuzzy-based data fusion method improves measurement accuracy, maintaining error levels within 0 to 0.01. Additionally, the system evaluates indoor comfort using a standardized index, ensuring reliable and intelligent monitoring.

1. INTRODUCTION

Handling explosive devices and dangerous materials is one of the riskiest jobs in both civilian and military sittings. Often, trained people have to get close to unknow objects, putting themselves in a lot of danger. Even with safety procedures in place, these situations can be unpredictable, making it very unsafe to handle them by hand. To make things safer, robotic systems have become a trusted option. These robots can be operated from a distance, allowing people to inspect and manage hazardous items without being nearby. One example is a robot made for handling explosives. It uses a moving base, an arm, and a camera, showing how important remote control is such risky areas.

[1]. Improvements have also come from using real-time video. A study showed that live video helps operators see and control robots better from a safe place.

[2]. Additionally, some robots use internet-connected systems, where they can be controlled via apps or web pages, making them easier to use.

[3]. More recent robots also use image processing and sensors to better identify and manage dangerous materials, models, like the "wheelbarrow" robot, helped show In recent years, maintaining a healthy indoor environment has become a major concern due to its direct impact on human life. Conventional monitoring methods are limited in functionality and fail to provide continuous and real-time information. As a result, they

are not suitable for modern smart living requirements. The emergence of Internet of Things allows devices to interact and exchange information automatically. At the same time, Cloud Computing offers powerful tools for processing and storing large datasets. Combining these technologies enables the creation of intelligent monitoring systems capable of delivering accurate and real-time insights. Despite existing solutions, many systems suffer from issues such as limited scalability, reduced accuracy, and high implementation cost. This research aims to overcome these challenges by proposing a reliable and cost-effective monitoring system that ensures efficient environmental tracking and improved user comfort.

2. METHODOLOGY / SYSTEM DESIGN

This section explains the overall working procedure of the proposed intelligent residential environment monitoring system. The methodology combines sensing technologies, wireless communication, and cloud-based data processing to achieve accurate and real-time monitoring of indoor environmental conditions.

2.1 SYSTEM OVERVIEW

The proposed system is designed as an integrated framework that continuously observes environmental parameters within a residential space. It consists of three main layers: the sensing layer, the communication layer, and the cloud processing layer. The sensing layer includes multiple sensors that measure parameters such as temperature, humidity, and air quality. The communication layer enables the transfer of collected data through IoT networks. The cloud layer is responsible for storing, processing, and analysing the received data. These layers work together to ensure efficient and reliable monitor.

2.2 SYSTEM INTIALIZATION

The cloud platform receives the incoming data streams and stores them for further processing. This mechanism supports remote access, allowing users to monitor environmental conditions from any location.

2.3 COMMUNICATION MECHANISM

The communication process is carried out using wireless networking technologies. Sensor data is transmitted from the microcontroller to the cloud server through IoT protocols. This enables seamless and continuous data transfer without manual intervention. The cloud platform receives the systems suffer from issues such as limited scalability, reduced accuracy, and high implementation cost. This research aims to overcome these challenges by proposing a reliable and cost-effective monitoring system that ensures efficient environmental tracking and improved user comfort. Despite these advancements, existing environmental monitoring systems still face several challenges, including limited scalability, high implementation cost, and insufficient data accuracy. Many systems lack efficient data integration techniques, which can result in inconsistent or unreliable outputs. Additionally, the absence of intelligent decision-making mechanisms reduces their effectiveness in providing meaningful insight and automated control incoming data streams and stores them for further processing. This mechanism supports remote access, allowing users to monitor environmental conditions from any location.

2.4 Data Collection and Processing

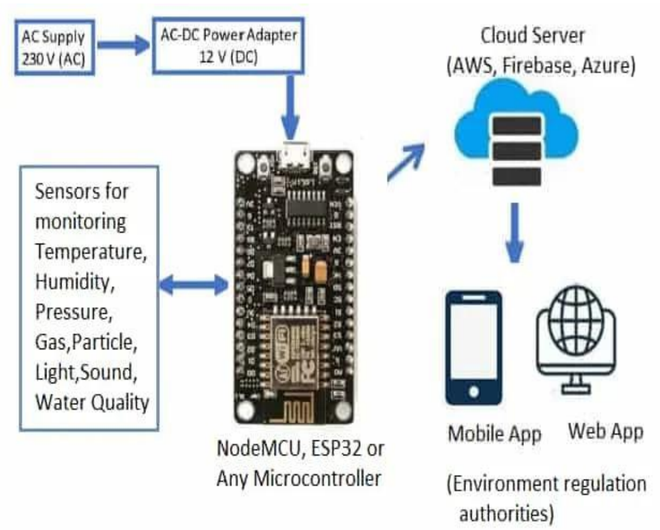
The sensors continuously gather environmental data regular intervals. These readings may contain noise or minor variations due to environmental fluctuations. To improve accuracy, a fuzzy-based data fusion technique is applied. This method combines multiple sensor readings to generate a refined output that closely represents actual environmental conditions. The processed data is then organized and stored in the cloud database for analysis and visualization.

2.5 Monitoring and Alert System

The system provides a user interface that displays real-time environmental data in an easy-to-understand format. Users can observe current conditions and historical trends through this interface. Additionally, the system includes an alert mechanism that is triggered when environmental parameters exceed predefined thresholds. These alerts help users take immediate action to maintain a safe and comfortable environment.

2.6 VISUAL FEEDBACK SYSTEM

The system collects real-time data using sensors and transmits it through IoT networks for further processing in a cloud platform. This approach enables efficient storage, analysis, and remote access to environmental data.



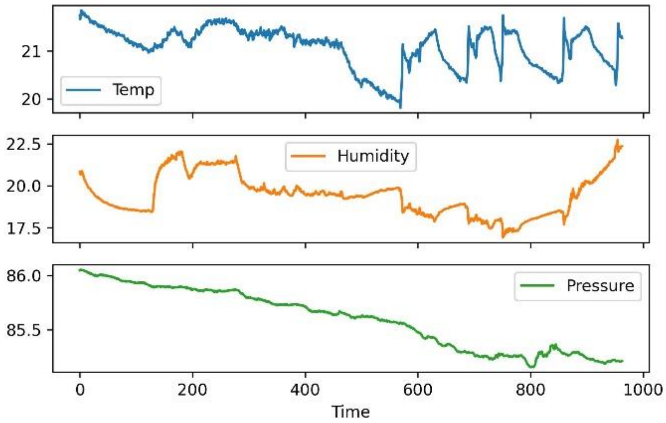
2.7 OPERATIONAL WORK FLOW

The complete operation of the system follows a structured sequence:

1. The system is powered on and initialized.
2. Sensors begin collecting environmental data.
3. Data is transmitted through IoT communication.
4. Cloud server processes and stores the data.
5. Processed data is displayed on the user interface.
6. Alerts are generated if abnormal conditions are detected.

3. RESULTS

The proposed intelligent residential environment monitoring system was implemented and evaluated in a real indoor setting to analyze its performance and accuracy. Various environmental parameters, including temperature, humidity, and air quality, were recorded at different time intervals throughout the day. The collected data was transmitted through the IoT network and processed using the cloud platform system successfully demonstrated continuous monitoring and real-time data transmission without noticeable delay. The sensor readings were stable and consistent across multiple observations, indicating reliable performance of the sensing and communication modules To improve measurement accuracy, a fuzzy-based data fusion technique was applied to the collected data. The results show that the processed values closely matched the actual environmental conditions. The error margin was maintained within the range of 0 to 0.01, which confirms the high precision of the system. The cloud platform efficiently stored and organized the data, enabling users to access both real-time and historical information through the interface. This feature enhances the usability of the system and supports better decision-making. Overall, the experimental results demonstrate that the proposed system provides accurate, reliable, and efficient monitoring of residential environmental conditions. The integration of IoT and cloud technologies ensures seamless data flow, improved accuracy, and effective environmental assessment. In addition, the system effectively evaluated indoor comfort levels using a predefined index. The comfort index value remained close to 1 under optimal conditions, indicating a suitable indoor environment. When environmental parameters deviated from acceptable limits, the system generated alerts, allowing timely corrective action. The error margin was maintained within the range of 0 to 0.01, which confirms the high precision of the system.



4. DISCUSSION

The experimental evaluation of the proposed system demonstrates that the integration of Internet of Things and Cloud Computing provides an effective solution for real-time residential environment monitoring. The system successfully collected, transmitted, and processed environmental data with high reliability and minimal delay, indicating strong coordination between hardware and software components. One of the key observations from the results is the stability and consistency of sensor data over time. The sensing units were able to capture environmental variations accurately, and the communication mechanism ensured uninterrupted data transfer to the cloud platform. This confirms that the system is capable of continuous monitoring without significant data loss or latency issues.

5. CONCLUSION

This paper presented the design and implementation of an intelligent residential environment monitoring system that integrates Internet of Things and Cloud Computing technologies. The system was developed to address the need for continuous, accurate, and real-time monitoring of indoor environmental conditions. Abbreviations should be defined upon their first appearance information and can be of interest to readers. Authors have the choice.

6. ACKNOWLEDGMENT

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