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Automated Real-time Headcount in Building using RFID: A Scalable Approach for Occupancy Tracking

Varnith Yemula
dept. Electronics and Communications
Malla Reddy Institute of Technology
Secunderabad, India

Faith Anuhya Mallavarupu
dept. Electronics and Communications
Malla Reddy Institute of Technology
Secunderabad, India

Manoj Kumar Yaramala
dept. Electronics and Communications
Malla Reddy Institute of Technology
Secunderabad, India

***Abstract*—Real-time headcount in buildings is crucial for ensuring safety and security, as well as optimizing operations in various industries. Traditional methods of headcounting are often time-consuming, inaccurate, and labor-intensive. In this paper, we propose a new solution for real-time headcount in buildings using RFID technology and evaluate its effectiveness. Our proposed system involves providing RFID tags to visitors upon entering the building and installing RFID readers and antennas in each room to track their movement. The data collected is processed and displayed on a dashboard, providing real-time headcount information. Our experiments show that our proposed system is highly accurate in providing real-time headcount in a building, and it has the potential to be used in various settings. Our research contributes to the development of more efficient and reliable headcount systems using RFID technology and identifies future research directions for further improvements.**

***Index Terms*—real-time headcount, building, RFID technology, manual methods, automated methods, accuracy**

I. Introduction

Real-time headcount in a building is a critical component of various industries, including education, healthcare, and retail. Accurate and efficient headcounts are necessary to ensure the safety and security of people within a building and to optimize operations. However, traditional manual methods of headcounting, such as counting people with a clicker or using security cameras, can be time-consuming, inaccurate, and labor-intensive [1]. Moreover, in emergency situations, it can be difficult to obtain an accurate headcount, which can impede emergency response efforts. Therefore, there is a growing need for a reliable, efficient, and real-time headcount system using RFID technology.

The objective of this research paper is to propose a new solution for real-time headcount in a building using RFID technology and to evaluate its effectiveness. Specifically, we aim to address the limitations of existing solutions and propose a new system architecture that can provide accurate and reliable data on the number of people present in a building at any given time. Our research will contribute to the development of more efficient and reliable headcount systems and will have practical implications for various industries.

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To achieve these objectives, we will conduct experiments to test the effectiveness of our proposed solution and analyze the results. In this paper, we will first review the existing literature on RFID technology and its applications in real-time headcounting. We will then describe our proposed solution in detail and explain its advantages over existing solutions. Finally, we will discuss the implications of our research and identify future research directions.

II. Literature Review

RFID technology has become increasingly popular in various industries due to its ability to provide accurate and real-time data on the location and movement of people and objects [2] . RFID technology consists of a tag, which is attached to the person or object being tracked, and a reader, which communicates with the tag to obtain the necessary information. RFID technology has various advantages over other tracking technologies, such as Wi-Fi or Bluetooth, including longer range and the ability to penetrate walls and other obstacles.

Existing solutions for real-time headcount in buildings include manual and automated methods. Manual methods such as clickers and manual counting sheets are simple and inexpensive but are prone to errors and do not provide real-time data. Automated methods, such as using security cameras or Wi-Fi signals, have been developed to address these limitations. However, these methods also have limitations such as low accuracy, high cost, or the inability to handle large crowds [3] .

RFID technology has been proposed as a potential solution for real-time headcount in buildings due to its high accuracy and ability to provide real-time data. A number of studies have been conducted on RFID-based headcount systems, and several systems have been developed for specific applications such as tracking student attendance in classrooms or monitoring the number of people in a shopping mall [4] [5].

Despite the advantages of RFID technology for real-time headcounting, several limitations still exist. For example, the effectiveness of the system may be impacted by the layout of the building, the number of people present, or the presence

of other RF signals. Additionally, the cost of implementing an RFID-based system may be prohibitive for some organizations.

In the next section, we will propose a new solution for real-time headcount in a building using RFID technology and evaluate its effectiveness compared to existing solutions.

III. Proposed Solution

Our proposed solution for real-time headcount in a building using RFID technology is as follows. Every visitor will be given a separate RFID tag upon entering the building from the ground floor, which is the only entrance to the building. The RFID tag will serve as the visitor's identity for our system, allowing us to track their movement within the building. To track the visitors, RFID readers and antennas will be installed in each room under surveillance. Each room will have its own RFID reader to read the tags of the visitors. The RFID readers will be connected to a Raspberry Pi motherboard, which will receive the data from the readers and pre-process it before forwarding it to our system via the internet. The RFID system will enable us to obtain real-time headcount data, which will be displayed on a dashboard. We will be able to monitor the number of visitors in each room and track their movement within the building. This will allow us to ensure the safety of the visitors and efficiently manage the flow of people within the building. The proposed system has several advantages over existing solutions. It provides high accuracy, real-time data, and eliminates the need for manual counting. Moreover, the proposed system is cost-effective and can be easily installed and maintained. However, challenges such as interference from other RF signals or limitations in the range of the RFID technology should be considered during the implementation of the system. Overall, our proposed solution has the potential to revolutionize the way real-time headcount is conducted in buildings using RFID technology. In the next section, we will evaluate the effectiveness of our proposed solution and compare it to existing solutions.

IV. Experiments and Results

We conducted experiments to evaluate the effectiveness of our proposed system in providing real-time headcount in a building. The experiments involved setting up the RFID readers and antennas in each room of the building and monitoring the movement of visitors as they moved through the building. We collected data from the RFID readers and processed it using the Raspberry Pi motherboard. We analyzed the collected data and compared it with the actual number of visitors in the building to determine the accuracy of our system. The results showed that our proposed solution was highly accurate in providing real-time headcount in the building. The experimental results indicate that our proposed system is an effective solution to the problem of real-time headcount in a building. It provides accurate and reliable results and has the potential to be used in various settings such as offices, schools, hospitals, and other public places.

Implications and Future Work

Our proposed system has several practical implications in various settings such as offices, schools, hospitals, and other public places. It provides real-time headcount information that can be used for various purposes such as safety, security, and resource management. For example, in case of an emergency, the real-time headcount can be used to evacuate the building quickly and safely. However, our proposed solution has some limitations that need to be addressed in future research. One limitation is the cost of implementing the system, which may be high for some organizations. Another limitation is the need for visitors to carry RFID tags, which may be inconvenient for some people. Future research can focus on addressing these limitations by exploring alternative solutions such as using smartphone-based tracking systems or developing more cost-effective RFID tags. Another direction for future research is to integrate our proposed system with other building management systems such as access control, HVAC, and lighting systems, to provide a comprehensive building management solution. In summary, our proposed solution has practical implications for various settings and provides a reliable and accurate way to obtain real-time headcount information. However, further research is needed to address the limitations and explore potential improvement

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