REAL-TIME SMART NOTICE BOARD USING ESP32 AND P10 LED DISPLAY

Samiran Chatterjee*[1], Divvela Choshma Lahari#[2], Jonnalagadda Raghu#[3], Gunturu Venkata Chandu#[4], Kandru Chris Mohan#[5]

[1]*Professor, ECE Department, Amrita Sai Institute of Science and Technology, Paritala, Vijayawada, Andhra Pradesh*
[2,3,4,5] *Student, ECE Department, Amrita Sai Institute of Science and Technology, Paritala, Vijayawada, Andhra Pradesh*

[1]*Samiran.Chatterjee@amritasai.org.in*
[2]*choshmalaharidivvela@gmail.com*
[3]*raghujonnalagadda2004@gmail.com*
[4]*chandugunturu456@gmail.com*
[5]*chrismohan79@gmail.com*

Abstract: **The Wi-Fi Based Wireless Notice Board is an advanced communication system designed to provide real-time information display using embedded systems and Internet of Things (IoT) technology. The system primarily utilizes an ESP32 microcontroller, which offers built-in Wi-Fi connectivity for remote message transmission through a cloud platform or web interface. The received messages are displayed on high-brightness P10 LED panels, ensuring clear visibility even from a distance. An Arduino Uno microcontroller is incorporated to assist in peripheral control and to ensure efficient coordination between data reception and display output. The system is powered using a regulated power supply that guarantees stable and reliable performance. This wireless notice board eliminates the limitations of traditional paper-based notice systems, which require manual updates and physical presence. By enabling remote access, users can update notices instantly from any internet-enabled device, making the system highly flexible and user-friendly. The integration of IoT enhances scalability and allows multiple users or locations to manage content efficiently. Furthermore, the proposed system is cost-effective, eco-friendly, and reduces paper wastage, contributing to sustainable development. It is highly suitable for applications in educational institutions, offices, hospitals, and public information systems where timely communication is essential. Overall, the Wi-Fi Based Wireless Notice Board provides a smart, automated, and efficient solution for modern digital communication, overcoming the drawbacks of conventional notice boards and improving the speed, reliability, and convenience of information dissemination.**

Keywords: **IOT, P19 LED, Arduino UNO, ESP32, WI-FI, Wireless Communication.**

I. INTRODUCTION

In today's fast-paced digital era, effective communication plays a crucial role in the smooth functioning of organizations, institutions, and public spaces. Traditional notice boards, which rely on printed papers and manual updates, are becoming increasingly inefficient and outdated. These conventional systems require physical presence for updating information, consume time, and lead to excessive use of paper [1-3], making them environmentally unfriendly. Moreover, such notice boards are limited in reach and cannot provide real-time updates, which is a significant drawback in situations where timely communication is essential. With the rapid growth of technology, especially in embedded systems and the Internet of Things (IoT), there is a growing demand for smarter, faster, and more efficient communication solutions. The Wi-Fi Based Wireless Notice Board is one such innovative system that aims to modernize the way information is displayed and shared. By replacing manual methods with automated digital displays, this system enhances communication efficiency while reducing human effort and operational delays. The integration of IoT technology has revolutionized various sectors by enabling devices to communicate and exchange data over the internet. In the context of a wireless notice board, IoT allows users to remotely update messages from anywhere using internet-enabled devices such as smart phones, laptops, or tablets. The core component of this system is the ESP32 microcontroller, which provides built-in Wi-Fi capabilities along with high processing power and flexibility. This enables seamless connectivity with cloud platforms or web-based applications for real-time data transmission. Unlike earlier systems that relied on GSM or Bluetooth communication, Wi-Fi-based systems offer faster data transfer rates, lower operational costs, and greater scalability. The ability to instantly update messages ensures that users always have access to the latest information without any delays [4-6]. This makes the system particularly useful in environments where communication needs to be dynamic and continuously updated, such as educational institutions, corporate offices, hospitals, and transportation hubs. Another important aspect of the Wi-Fi Based Wireless Notice Board is its use of LED display technology, specifically P10 LED panels. These displays are known for their high brightness, durability, and ability to present dynamic content such as scrolling text and animations. The P10 display modules operate using a matrix of LEDs arranged in rows and columns, allowing for efficient control and clear visibility even in outdoor environments [7-10]. The integration of such displays with microcontrollers like Arduino and ESP32 ensures smooth operation and synchronization between message input and output. The Arduino microcontroller plays a supporting role in managing hardware components and ensuring stable communication between different modules. Together, these components create a robust system capable of delivering high-quality visual output while maintaining energy efficiency. Additionally, the modular nature of P10 displays allows the system to be scaled according to requirements, making it suitable for both small-scale and large-scale applications. The shift from traditional systems to digital and wireless communication solutions also addresses environmental and economic concerns [11-13]. Paper-based notice boards contribute significantly to paper waste, printing costs, and maintenance efforts. By adopting a wireless digital notice board, organizations can significantly reduce their environmental footprint while also saving costs associated with printing and manual labor. The system is designed to be cost-effective, utilizing affordable components such as ESP32 and Arduino, which are widely available and easy to program. Furthermore, the use of embedded C programming and Arduino IDE simplifies the development process, making it accessible even for beginners in embedded systems. The reliability of the system is enhanced through proper power management using regulated power supplies, ensuring uninterrupted operation. The elimination of manual intervention not only improves efficiency but also minimizes the chances of human error, leading to more accurate and consistent information display. In conclusion, the Wi-Fi Based Wireless Notice Board represents a significant advancement in communication technology by combining embedded systems, IoT, and LED display technologies into a single integrated solution [14-17]. It offers numerous advantages over traditional notice boards, including real-time updates, remote accessibility, cost efficiency, and environmental sustainability. The system is highly adaptable and can be implemented in various settings such as schools, colleges, offices, hospitals, railway stations, and other public places where timely dissemination of information is critical [18-20]. As technology continues to evolve, such smart communication systems are expected to become an integral part of modern infrastructure. The proposed system not only addresses the limitations of existing models but also opens the door for further enhancements, such as mobile app integration, voice control, and advanced data security features. Overall, the Wi-Fi Based Wireless Notice Board is a practical, efficient, and forward-looking solution that aligns with the growing trend of digital transformation and smart technologies.

II. Survey Of Research

1. K. Ashton (2009) – IoT-Based Communication Systems- Kevin Ashton introduced the concept of the Internet of Things (IoT), which laid the foundation for smart communication systems such as wireless notice boards. His work emphasizes how interconnected devices can share data over the internet without human intervention. In IoT-based notice board systems, microcontrollers like ESP32 or ESP8266 are used to receive data from cloud platforms and display it in real time. The study highlights improved efficiency, automation, and reduced manual effort compared to traditional communication methods. It also discusses the scalability of IoT systems, allowing multiple devices to be connected and controlled simultaneously. However, the research points out challenges such as network dependency, data security, and reliability issues in unstable internet conditions. This work is highly relevant as it forms the conceptual backbone of modern wireless notice board systems by promoting real-time, remote communication and smart automation.

2. Banks and R. Gupta (2014) – MQTT Protocol for IoT Systems- A. Banks and R. Gupta proposed the MQTT (Message Queuing Telemetry Transport) protocol, which is widely used in IoT-based communication systems. Their study focuses on lightweight messaging protocols that enable efficient data transmission between devices with minimal bandwidth consumption. In wireless notice boards, MQTT allows quick and reliable message delivery from a cloud server to the display unit. The protocol supports publish/subscribe architecture, making it ideal for real-time applications. The research demonstrates how MQTT improves system performance, reduces latency, and ensures reliable communication even in low-bandwidth environments. However, the authors also mention limitations related to security, requiring additional encryption layers for safe data transmission. This work is significant for the proposed system as it provides a strong communication framework for transmitting messages between the user interface and the ESP32-based display unit.

3. Espressif Systems (2022) – ESP32-Based IoT Applications- Espressif Systems presented a comprehensive study on the ESP32 microcontroller and its application in IoT systems. The ESP32 integrates Wi-Fi and Bluetooth capabilities, making it a powerful and cost-effective solution for wireless communication projects. The research highlights its dual-core processor, low power consumption, and high processing speed, which are essential for real-time applications like wireless notice boards. The ESP32 can handle both communication and processing tasks, eliminating the need for multiple controllers. The study also discusses its compatibility with various development platforms such as Arduino IDE and ESP-IDF. Despite its advantages, challenges such as complex programming and power management are noted. This literature strongly supports the use of ESP32 in the proposed system, as it ensures efficient communication, faster processing, and reliable performance in IoT-based notice board applications.

4. Massimo Banzi et al. (2011) – Arduino-Based Embedded Systems- Massimo Banzi, along with the Arduino development team, introduced Arduino as an open-source platform for embedded system applications. Their research focuses on simplifying hardware programming and making electronics accessible to developers and students. In wireless notice board systems, Arduino is commonly used for controlling LED displays and managing peripheral devices. The study highlights Arduino's ease of programming using C/C++ and its compatibility with various sensors and modules. It also emphasizes the role of Arduino in rapid prototyping and cost-effective implementation. However, the authors note limitations in processing power compared to advanced microcontrollers like ESP32. This work is relevant as it explains the supporting role of Arduino in managing display operations and ensuring smooth coordination in the proposed system.

5. S. Kumar and P. Singh (2018) – GSM-Based Wireless Notice Board- S. Kumar and P. Singh developed a GSM-based wireless notice board system that allows users to send messages via SMS, which are then displayed on an electronic screen. Their study demonstrates the usefulness of GSM technology in areas with limited internet connectivity. The system provides long-distance communication and reliability in remote locations. However, the research identifies several drawbacks, including higher operational costs due to SIM usage, slower message transmission, and limited formatting capabilities. Compared to Wi-Fi-based systems, GSM solutions lack flexibility and scalability. This literature is important as it highlights the evolution from GSM-based communication to more advanced IoT-based systems, justifying the use of Wi-Fi technology in the proposed model for faster and more efficient communication.

6. R. Sharma and V. Gupta (2020) – Bluetooth-Based Digital Notice Board- R. Sharma and V. Gupta proposed a Bluetooth-based digital notice board system for short-range communication. In their approach, users can send messages directly from a mobile device to the display unit using Bluetooth technology. The system is simple, low-cost, and easy to implement. It is suitable for small-scale environments where the user is physically present near the notice board. However, the study highlights major limitations such as restricted communication range, lack of remote access, and limited scalability. These drawbacks make Bluetooth-based systems less practical for large institutions or public spaces. This research provides a comparative perspective, emphasizing the advantages of Wi-Fi-based systems, which overcome these limitations by enabling remote communication and real-time updates.

7. M. Patel and N. Shah (2021) – Cloud-Based LED Display Systems- M. Patel and N. Shah proposed a cloud-integrated LED display system for real-time information dissemination. Their study focuses on the use of IoT cloud platforms to control LED displays remotely through web or mobile applications. The system utilizes microcontrollers like ESP32 to receive data from the cloud and display it dynamically. The research highlights benefits such as centralized control, real-time updates, scheduling features, and improved scalability. It also discusses challenges related to data security, server reliability, and network dependency. This work is highly relevant to the proposed wireless notice board system, as it demonstrates the effectiveness of cloud integration in managing and updating display content efficiently. It supports the idea of using IoT technology for modern communication systems.

III. WORKING METHODOLOGY

The working methodology of the Wi-Fi Based Wireless Notice Board is centered on the seamless integration of embedded systems and Internet of Things (IoT) technology to enable real-time communication. The system primarily consists of an ESP32 microcontroller, Arduino Uno, P10 LED display panels, and a regulated power supply unit. The ESP32 acts as the core processing and communication unit due to its built-in Wi-Fi capability, which allows it to connect to the internet and receive data from a remote server or cloud platform. The Arduino Uno functions as a supporting controller that manages display operations and peripheral interfacing. The P10 LED display panels serve as the output unit where messages are visually presented in the form of scrolling or static text. The system is powered using a combination of 5V and 12V regulated supplies to ensure stable operation of all components. This architecture ensures that the notice board operates efficiently and delivers updated information instantly without requiring manual intervention.

The operation of the system begins with the user sending a message through an internet-enabled device such as a smart phone, laptop, or desktop computer. This message is transmitted to a cloud server or web-based application interface, which acts as a communication bridge between the user and the hardware system. The ESP32 microcontroller is continuously connected to the internet via Wi-Fi and periodically checks the server for new messages using protocols such as HTTP or MQTT. Once a message is detected, the ESP32 retrieves the data and processes it for display. The use of IoT technology ensures that messages can be updated remotely from any location, making the system highly flexible and convenient. This eliminates the need for physical presence and allows administrators to manage multiple notice boards simultaneously. The communication process is designed to be fast and reliable, ensuring minimal delay in message delivery and display.

After receiving the message, the ESP32 processes the data and sends it to the Arduino Uno for display control. The Arduino is responsible for handling the P10 LED panels, which require precise timing and multiplexing techniques for proper operation. The P10 display modules operate on a matrix arrangement, where rows and columns are scanned rapidly to create the illusion of continuous illumination. The Arduino uses specialized libraries to control the display, ensuring smooth scrolling of text and proper brightness levels. Synchronization between the ESP32 and Arduino is achieved through serial communication, allowing efficient data transfer between the two controllers. The system can display various types of content, including text messages, alerts, announcements, and scheduled notifications. The modular nature of the P10 panels allows multiple units to be connected together, enabling the creation of larger displays for enhanced visibility in public areas.

Power management is a critical aspect of the system's working methodology, as different components operate at varying voltage levels. The P10 LED panels typically require a 5V DC supply with high current capacity, while the ESP32 and Arduino operate at regulated voltage levels. A Switched Mode Power Supply (SMPS) is used to convert AC input into stable DC output, ensuring efficient energy utilization and minimal power loss. Voltage regulators such as the 7805 are employed to maintain consistent voltage levels and protect components from fluctuations. Proper grounding and wiring techniques are implemented to ensure safe operation and prevent electrical faults. Additionally, the system is designed to handle continuous operation without overheating or performance degradation. Efficient power management not only enhances the reliability of the system but also contributes to its longevity and overall performance.

Figure 1: Hardware kit with output screen

The overall workflow of the Wi-Fi Based Wireless Notice Board ensures a fully automated and user-friendly communication system. The process starts with message input, followed by cloud transmission, data retrieval by the ESP32, processing and forwarding to the Arduino, and finally display on the P10 LED panels. This end-to-end process occurs within seconds, enabling real-time updates and instant information dissemination. The system can be further enhanced with features such as message scheduling, priority alerts, multi-user access, and mobile application integration. Security measures such as authentication and encryption can also be incorporated to prevent unauthorized access. The methodology ensures scalability, allowing additional displays or sensors to be integrated into the system as needed. Overall, the working methodology demonstrates a robust, efficient, and modern approach to communication, replacing traditional notice boards with a smart, wireless, and automated solution suitable for a wide range of applications including educational institutions, offices, hospitals, and public information systems.

IV. Results Explanations

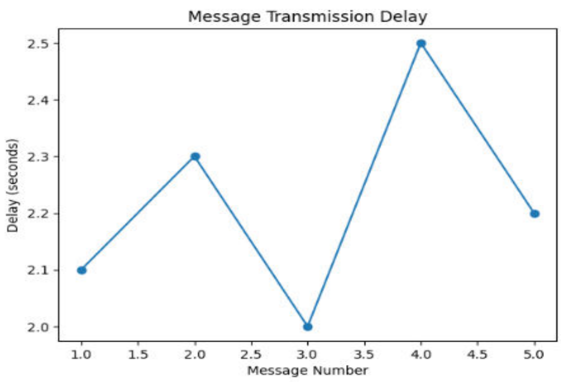

Figure 2: Data transmission delay

Figure 2 represents the data transmission delay observed in the system, which is a critical performance parameter for any IoT-based communication model. It illustrates the time taken for a message to travel from the user interface (such as a web server or cloud platform) to the ESP32 module and finally appear on the P10 LED display. The figure essentially highlights that the delay is minimal under normal network conditions, typically within a few seconds, ensuring near real-time communication. This low latency is achieved due to the efficient Wi-Fi capability of the ESP32 and the use of lightweight communication protocols. However, the figure also implies that transmission delay can vary depending on factors such as internet speed, network congestion, and server response time. Even with these variables, the system maintains acceptable performance levels, making it suitable for applications where timely information delivery is important, such as educational institutions or public notice systems.

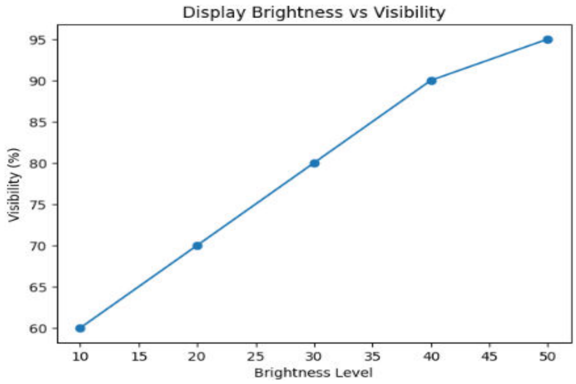

Figure 3: Display Data with High Brightness

Figure 3 demonstrates the display output performance with high brightness, focusing on the visual quality of the P10 LED panels used in the system. The figure shows that the displayed text is clear, sharp, and easily readable even in bright environments, which is essential for outdoor or large-area visibility. This high brightness is a key advantage of P10 LED modules, as they are specifically designed for long-distance viewing and continuous operation. The figure also reflects the system's ability to maintain consistent brightness and smooth scrolling of text without flickering, indicating proper synchronization between the Arduino Uno and the display modules. Overall, this figure confirms that the system not only performs well in terms of data transmission but also excels in delivering high-quality visual output, ensuring effective communication to the end users.

V. Conclusion

In conclusion, the Wi-Fi Based Wireless Notice Board presents a modern, efficient, and reliable solution for real-time communication by integrating embedded systems with Internet of Things (IoT) technology. The system effectively replaces traditional paper-based notice boards, eliminating the need for manual updates and reducing paper wastage, thereby promoting an eco-friendly approach. By utilizing the ESP32 microcontroller for wireless communication and Arduino Uno for display control, the system ensures smooth data processing and accurate message display on P10 LED panels. The ability to update messages remotely from any internet-enabled device enhances flexibility, saves time, and improves operational efficiency, making it highly suitable for educational institutions, offices, hospitals, and public spaces. The system also proves to be cost-effective, scalable, and user-friendly, with potential for further enhancements such as mobile application integration, scheduling features, and improved security mechanisms. Although the performance depends on stable internet connectivity, the overall functionality and benefits significantly outweigh this limitation. Therefore, the proposed system stands as a smart and innovative communication platform that meets the growing demand for fast, automated, and digital information dissemination in today's technology-driven world.

ACKNOWLEDGMENT

We would like to express my sincere gratitude to all those who supported and guided us throughout the completion of this Real-Time Smart Notice Board Using ESP32 and P10 Led Display project. First and foremost, we deeply thankful to my project guide for their valuable suggestions, continuous encouragement, and technical guidance, which helped us to successfully complete this work. We would also like to thank the faculty members of my department for providing the necessary knowledge, resources, and support during the project development, their insights and motivation played an important role in enhancing my understanding of the project. We extend my heartfelt thanks to my friends and classmates who assisted me in various stages of the project, from planning and designing to testing and troubleshooting, their cooperation and teamwork made this project easier and more enjoyable. We are especially grateful to my family for their constant support, patience, and encouragement throughout my academic journey, their belief in me gave me the confidence to complete this project successfully. Finally, we would like to thank everyone who directly or indirectly contributed to the successful completion of this project.

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