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Smart Digital Display for Real Time Information

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Abstract: In the era of rapid digital transformation, traditional manual notice boards in educational and public institutions serve as a bottleneck for efficient communication, often leading to outdated information and excessive paper waste. This paper proposes the design and implementation of a "Smart Digital Display for Real-Time Information," an IoT-enabled system aimed at automating information dissemination. The proposed architecture integrates a P10 LED display matrix with an HD-W02 Wi-Fi controller to facilitate instant, wireless updates. Unlike conventional static displays requiring physical connectivity, this solution leverages the LED ART mobile application, allowing administrators to broadcast announcements, schedules, and alerts directly from a smartphone via a secure peer-to-peer Wi-Fi link. The system processes incoming data packets to drive dynamic scrolling text and visual effects, ensuring immediate visibility. Experimental results demonstrate that the system operates effectively with low power consumption, significantly reducing manual maintenance while ensuring the reliable, eco-friendly delivery of real-time information.
Keywords: IoT, Smart Digital Display, HD-W02 Controller, P10 LED Matrix, Wireless Communication.

I. INTRODUCTION

Communication is a vital requirement in educational institutions and public offices, yet traditional paper-based notices suffer from significant inefficiencies due to manual delays and waste. These methods often result in outdated information remaining on display, causing confusion among students and staff while requiring constant physical maintenance. Current digital displays often depend on clumsy cable connections, which renders them useless for urgent alerts. We need a wireless system that allows for instant updates without the technical hassle. This paper proposes a "Smart Digital Display for Real-Time Information" framework using an HD-W02 Wi-Fi controller and P10 LED panels to capture and display live updates. By integrating with the LED ART mobile application, the system allows administrators to broadcast schedules and notifications directly from a smartphone, ensuring a scalable and eco-friendly solution.

II. LITERATURE REVIEW

Various automated systems for information dissemination have been proposed using Raspberry Pi and IoT technologies to replace manual notice boards. One significant contribution was a model capable of handling multiple media formats to improve remote communication.

[1] Ganesh elaborated on a digital notice board using Raspberry Pi that allowed administrators to send text, images, and PDFs remotely, while also incorporating speech-to-text capabilities.

Another study was devoted to enhancing communication efficiency by integrating IoT technology directly with LED displays. This method focused on reducing manual intervention and ensuring timely updates.

[2] Koppolu Sai Tej et al. introduced an integrated wireless LED notice board that facilitated real-time information dissemination and minimized the need for manual maintenance.

Hybrid displays proved effective for handling both quick alerts and detailed updates simultaneously.

[3] Bhamre et al. proposed a system utilizing an ESP32 LED matrix for immediate alerts and a Raspberry Pi screen for detailed notices, all updated wirelessly through a web interface.

Another approach used microcontroller-based architectures to interpret context information for college displays. This model relied on Wi-Fi modules to transmit text commands to LED boards without complex computing units.

[4] Recent surveys examined an IoT-based college display system controlled by an Atmega32p microcontroller interfaced with a Wi-Fi module to handle text-based commands.

A more advanced multimedia technique used Android applications to facilitate the transmission of diverse content formats. This system ensured that authorized users could send data remotely to digital monitors.

[5] Ram Raju et al. designed a digital notice board that allowed users to send text, images, and videos from an Android application to a Raspberry Pi-based monitor.

Unlike complex Raspberry Pi-based models, this design simplifies the process using the HD-W02 controller. This provides a direct, cost-effective mobile interface for real-time updates, effectively bridging the gap in current technology

III. SYSTEM ARCHITECTURE

A. Overview

The design of this system prioritizes simplicity by removing the need for physical cables. The architecture operates through a straightforward, three-step wireless loop:

1) Input & Formatting: The process begins on the user's smartphone, where the message is drafted and customized (font, speed, borders) using the mobile interface.
2) Wireless Transfer: Once the user hits "send," the data packet is transmitted directly to the controller via a secure peer-to-peer Wi-Fi connection.
3) Data Processing: The onboard controller instantly decodes these signals and triggers the LED matrix to light up, rendering the text or animation in real-time.

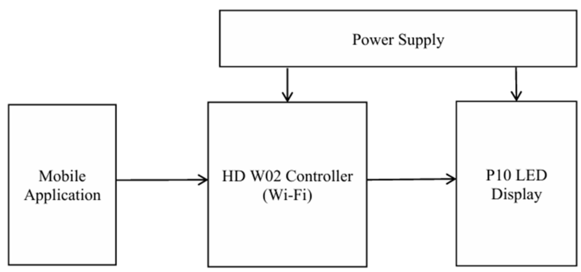

Figure 1: Block Diagram of the Smart Digital Display System

B. Components Hardware

The hardware components used in the system include the HD-W02 Wi-Fi Controller, P10 LED Display panels (32 x 16 modules), and a 5V 10A Switched-Mode Power Supply (SMPS) for stable power distribution.

SOFTWARE : These are the software components used in the system: LED ART mobile application for content creation and wireless transmission, and the internal firmware of the HD-W02 controller for data decoding and display driving.

IV. METHODOLOGY

A. Data Generation (Mobile Application)

The workflow begins with the user interface, where the administrator acts as the primary controller. Using the LED ART mobile application, the user drafts the desired announcement or schedule directly on their smartphone. This stage allows for complete customization, enabling the user to define font styles, scroll speeds, and animation effects to ensure the message is clear and engaging before it is ever sent to the screen.

B. Communication and Transfer (WI-FI Protocol)

Once the content is finalized, the system executes a wireless transfer process to update the display:

1) Wireless Initiation: The user triggers the "Send" command on the app, which initiates a direct peer-to-peer connection with the display's Wi-Fi hotspot.
2) Protocol Handling: The application automatically packages the text and formatting instructions into a data stream compatible with the hardware, eliminating the need for manual coding or physical cables.
3) Signal Conversion: Upon receiving the data, the controller interprets the wireless packets and converts them into the specific electrical signals (Data, Clock, and Latch) needed to drive the LED panel.

C. Processing And Storage (Hd-W02 Controller)

The core intelligence of the system lies in the HD-W02 controller, which functions as the backend processing unit. Crucially, the controller stores the decoded program into its onboard flash memory immediately upon receipt. This storage capability ensures that the display continues to run the message autonomously and reliably, even if the smartphone disconnects or the Wi-Fi signal is lost.

V. RESULTS

The system was put through its paces in a real-time environment and performed exactly as intended. The P10 LED panels lit up with sharp, bright text, ensuring that the messages were easy to read and uniformly illuminated across the board. We found that the wireless connection between the smartphone and the controller was seamless; whenever we sent a new message from the app, the display updated almost instantly without any noticeable lag

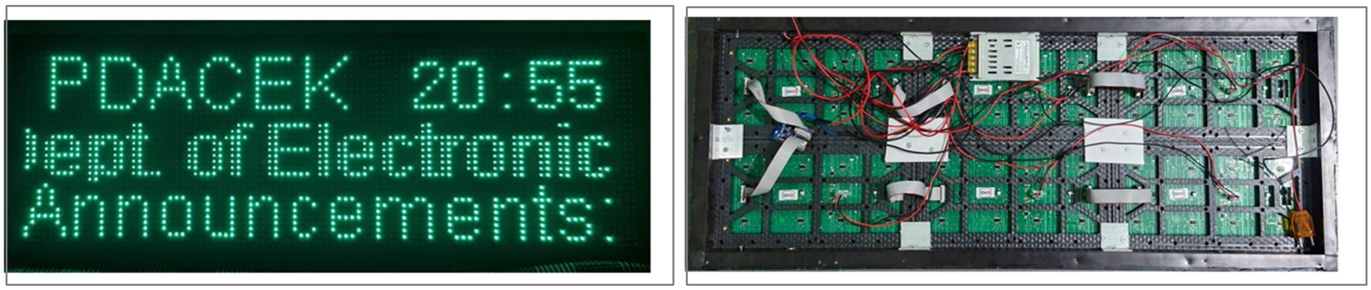

Figure 2: System output showing the LED scrolling message with clear visibility, and the internal wiring of the panels

A. *Observed Performance*

1) Visual Quality: The display maintained high contrast and clarity, making the scrolling text legible even from a distance.
2) Responsiveness: The system showed excellent reaction time; data transmission via Wi-Fi was smooth, executing updates without delay.
3) Hardware Endurance: While the panels operated efficiently, we noticed the power supply unit (SMPS) getting slightly warm after running for many hours, indicating that ventilation is important for long-term use.

B. *System Stability*

The internal wiring and power setup proved to be robust, delivering a steady voltage that kept the screen from flickering or resetting. Overall, the tests confirmed that the system is not only reliable for continuous use but also user-friendly enough for non-technical staff to operate.

VI. CONCLUSION

The study presented here demonstrates that the "Smart Digital Display for Real-Time Information" offers a secure, efficient, and eco-friendly alternative to traditional manual notice boards. The integration of the HD-W02 Wi-Fi controller with P10 LED panels has shown ample potential in overcoming the inefficiencies of paper-based systems, offering instant wireless updates, centralized control, and reduced maintenance efforts. These results support the efficiency and suitability of the design to be deployed within educational institutions, public offices, and transportation hubs where timely communication is critical. Future research could aim at cloud-based deployment for managing multiple displays simultaneously, AI-driven content scheduling, and higher-resolution full-color panels to further improve visual performance and user engagement.

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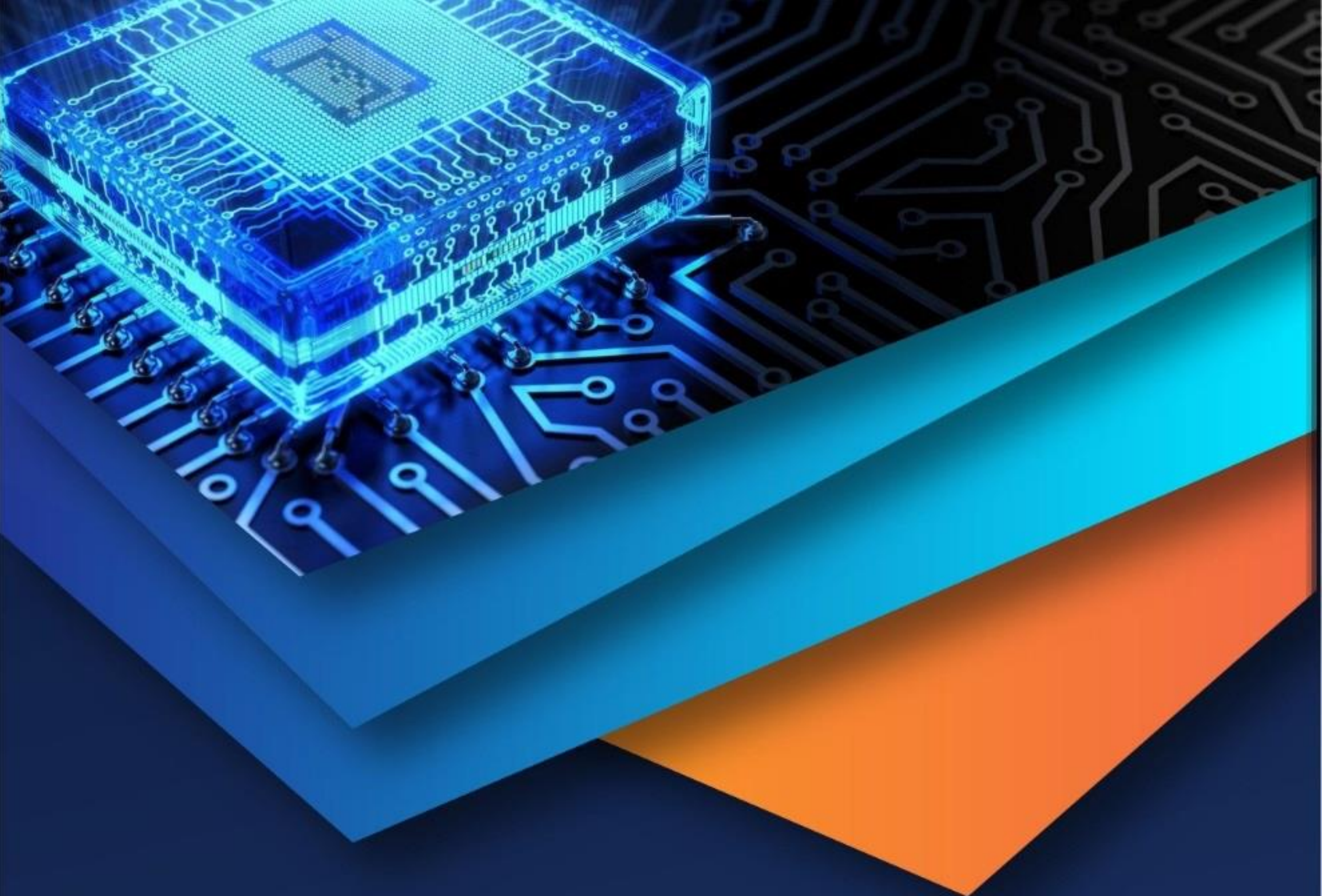

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