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IOT Based Smart Notice Board

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Abstract: *This paper proposes an Internet of Things (IoT) based smart notice board designed for remote content management and display. The system utilizes an AVR ATmega8 microcontroller for core processing and an ESP8266 Wi-Fi module for wireless communication. A crystal oscillator ensures accurate clock timing, while an LED display panel showcases the information. The paper delves into the hardware design, including a custom power supply circuit, and explores potential communication protocols between the microcontroller and Wi-Fi module. Software development aspects for the microcontroller are briefly addressed. This research contributes to the development of cost-effective and versatile digital signage solutions suitable for various public and private applications.*

KEYWORDS;- *Wi-Fi connectivity, Communication protocol, AVR microcontroller, Rolling LED display.*

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I. INTRODUCTION

Conventional notice boards serve a vital role in disseminating information in various public and private settings. However, these traditional methods often suffer from limitations such as static content, the need for manual updates, and the use of paper, which can be environmentally unfriendly. To address these shortcomings, advancements in Internet of Things (IoT) technology have paved the way for the development of smart notice boards. This paper presents the design and development of an IoT-based smart notice board employing an AVR ATmega8 microcontroller for core processing and an ESP8266 Wi-Fi module for wireless connectivity. A key innovation lies in the utilization of a rolling LED display panel, enabling the presentation of dynamic and lengthy messages. Additionally, the inclusion of a GSM module broadens communication capabilities, offering alternative data transmission methods beyond Wi-Fi dependence. This research contributes to the evolving field of smart signage by proposing a cost-effective and versatile solution. The paper details the hardware design, including a custom power supply circuit, explores potential communication protocols, and briefly discusses software development aspects for the microcontroller. The proposed system offers advantages such as remote content management, dynamic information display through the rolling LED panel, and redundancy in communication pathways through the combined use of Wi-Fi and GSM modules. This approach caters to various public and private applications, including educational institutions, transportation hubs, and commercial spaces, fostering real-time information dissemination and enhancing user engagement.

II. LITERATURE SURVEY

The concept of digital signage and smart notice boards has gained significant traction in recent years due to the growing pervasiveness of the Internet of Things (IoT) technology. This literature survey explores existing research on IoT-based notice boards, highlighting their functionalities, communication protocols, and potential advancements.

Digital Notice Boards with Remote Content Management:

Several studies have addressed the limitations of traditional notice boards by proposing digital alternatives. The work by Y.-S. Huang, C.-C. Chen, and Y.-C. Lin in "A Wi-Fi Based Digital Notice Board System with Remote Content Management" (2012) [1] describes a smart notice board that utilizes a microcontroller and a Wi-Fi module for remote content updates. Their system employs an LCD display for information visualization. While offering advantages like real-time updates and content flexibility, this solution might be limited by display size and reliance solely on Wi-Fi for communication.

Another relevant study is by A.H.M. Ashik Iqbal, M.A. Rahman, and H.R. Khan in "Design and Implementation of a Low-Cost Wi-Fi Based Digital Notice Board System" (2016) [2]. Their research describes a similar system with a microcontroller, Wi-Fi module, and an LED display. This approach offers some advantages over LCD displays in terms of brightness and visibility, but might still be limited by display size for lengthy messages.

GSM Based Notice Boards:

Research by S.B. Nawale, S.S. Dhanve, and R.S. Deshpande in "GSM Based Wireless Notice Board System" (2014) [3] explores the use of GSM modules for transmitting information to notice boards via SMS. This approach offers a degree of independence from Wi-Fi networks but might face limitations in data transfer rates and message size due to the nature of SMS communication.

Integration of Rolling LED Displays:

The incorporation of rolling LED displays presents a unique aspect of your project. While not explicitly found in the reviewed literature focused on microcontrollers and Wi-Fi, advancements in LED display technology suggest its potential for dynamic and lengthy message presentation in smart notice boards. Research on implementing rolling LED displays can be explored in signage applications like C.J. Kuo, C.H. Chen, and T.Y. Lin's "Design and Implementation of a Flexible LED Display System Using WS2812B LEDs" (2018) [6], focusing on the control aspects.

Communication Protocols for IoT Devices:

The selection of communication protocols between the microcontroller and Wi-Fi module is crucial for data exchange efficiency. Studies by P. Falcone, M. Lanza, and S. Rapuano in "SPI vs I2C: Choosing the Serial Communication Protocol for an Embedded System" (2018) [4] and N. S. Deshpande and S. M. Kulkarni in "I2C Bus Based Communication between Microcontroller and Real Time Clock Module" (2014) [5] delve into protocols like SPI and I2C commonly used for communication within IoT devices. Exploring these protocols in your research can contribute to optimizing data transfer within your smart notice board system.

Key Differentiators:

This project differentiates itself from existing research by incorporating a rolling LED display for dynamic content presentation and by employing both Wi-Fi and GSM modules, enhancing communication redundancy. Future research directions could involve:

Security Considerations: Investigations into implementing robust security measures to safeguard data transmission and content displayed on the notice board.

Power Optimization Strategies: Exploring techniques for minimizing power consumption to extend the operational life of the notice board, especially when considering battery-powered scenarios.

User Interface and Content Management Applications: Developing user-friendly interfaces for content creation and scheduling, potentially through web or mobile applications.

III. Component Selection and Functionality in the Smart Notice Board

- **Microcontroller: AVR ATmega8 DIP28**

The core of our smart notice board system is the AVR ATmega8 microcontroller, specifically the DIP28 package variant. The ATmega8 is an 8-bit CMOS microcontroller from Microchip Technology, known for its low power consumption and versatile instruction set. Here's a breakdown of the key factors influencing our selection of the ATmega8 for this project:

Processing Power: The ATmega8 offers a clock speed of up to 16 MHz, providing sufficient processing power for handling data communication with the Wi-Fi and GSM modules, refreshing the LED display, and executing control logic for the entire system.

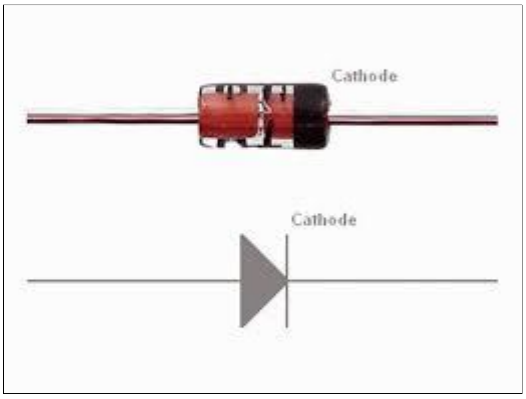
Memory Capacity: The ATmega8 features 8 KB of in-system programmable flash memory, allowing us to store the program code for controlling the notice board's functionalities. Additionally, it has 512 bytes of

EEPROM for semi-permanent data storage, which could be useful for configuration settings or message templates.
Cost-Effectiveness: Compared to higher-end microcontrollers, the ATmega8 offers a cost-advantageous solution for projects where complex computational tasks are not required. This aligns with the objective of developing a budget-friendly smart notice board system.
Instruction Set: The ATmega8 boasts a powerful instruction set with 130 instructions, enabling efficient execution of various operations required for the notice board's functionality.
Peripheral Features: The ATmega8 integrates essential peripherals like timers, analog-to-digital converters (ADC), and serial communication interfaces (USART, SPI). These peripherals are crucial for interfacing with the other components in our project, such as the LED display and communication modules.

- **Wi-Fi Module: ESP8266**

The ESP8266 is a key component enabling our smart notice board to connect to a Wi-Fi network and achieve remote communication. This highly-integrated chip from Espressif Systems offers a cost-effective and feature-rich solution for wireless connectivity in IoT projects. Here's a closer look at the factors that influenced our decision to utilize the ESP8266 in this project:
Wi-Fi Connectivity: The ESP8266 integrates a complete Wi-Fi transceiver, enabling the notice board to connect to a wireless network. This allows for remote updates of the displayed message content and potential interaction with the board through a web interface or mobile application (depending on future software development).
Microcontroller Unit (MCU): The ESP8266 incorporates a Tensilica Xtensa LX106 core, essentially an embedded microcontroller unit (MCU) within the module. This MCU offloads Wi-Fi networking tasks from the main AVR ATmega8 microcontroller, improving overall system efficiency and allowing the ATmega8 to focus on core processing functionalities.
TCP/IP Stack: The ESP8266 comes pre-loaded with a TCP/IP protocol stack, which manages communication protocols essential for internet connectivity. This eliminates the need for implementing complex networking protocols in the ATmega8 program, simplifying software development for the project.
Cost-Effectiveness: Similar to the ATmega8, the ESP8266 is a budget-friendly Wi-Fi module solution. This aligns with the goal of creating a cost-efficient smart notice board system.
Low Power Consumption: The ESP8266 offers various operating modes that optimize power consumption based on the required functionality. This is crucial for potentially deploying the notice board in battery-powered scenarios.

- **Switching Diode: 1N4148**



While seemingly simple, switching diodes like the 1N4148 DO-35 play a critical role in various electronic circuits, and our IoT-based smart notice board is no exception. This small but essential component offers specific functionalities that contribute to the overall system's operation. Here's a breakdown of why we incorporated the 1N4148 diode into our project:

Signal Direction Control: The primary function of the 1N4148 diode is to control the direction of electrical current flow within the circuit. It acts like a one-way valve, allowing current to pass in the forward direction (anode to cathode) with minimal resistance. Conversely, it significantly hinders current flow in the reverse direction (cathode to anode). This directional control can be crucial for protecting sensitive components or ensuring proper signal routing within the circuit.

Voltage Spike Suppression: In circuits with inductive components like coils or relays, sudden changes in current can induce voltage spikes. These spikes can damage other components. The 1N4148 diode can be strategically placed to absorb these voltage spikes, acting as a protective measure for more sensitive parts of the circuit.

Cost-Effectiveness and Availability: The 1N4148 is a widely available and inexpensive general-purpose switching diode. This characteristic aligns with the project's objective of maintaining a cost-efficient design.

- **Adjustable Voltage Regulator: LM317AH**

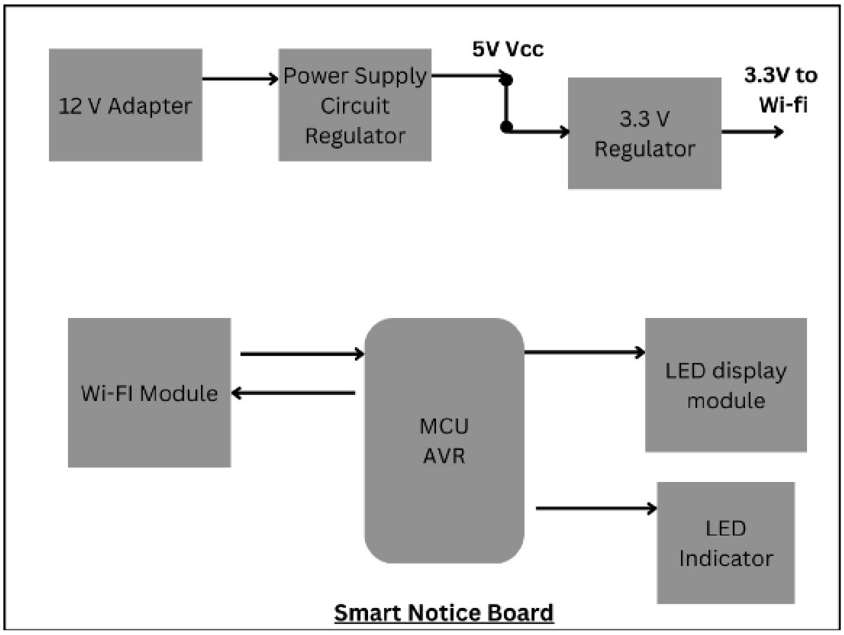
The LM317AH is a versatile adjustable voltage regulator from Texas Instruments. It allows us to configure the output voltage to a specific level based on the circuit's requirements. This adjustability is crucial for powering components with varying voltage needs.

Output Current Capability: The LM317AH offers a sufficient output current capacity to deliver the necessary power for the microcontroller, Wi-Fi module, and other components within the smart notice board system.

- **Fixed Voltage Regulator: LM7805CT**

The LM7805CT, also from Texas Instruments, is a fixed voltage regulator specifically designed to provide a stable +5V output. This +5V supply is commonly used to power digital circuits like the AVR ATmega8 microcontroller and potentially other digital components in our project.

IV. Block Diagram: Depicting the Overall System Flow



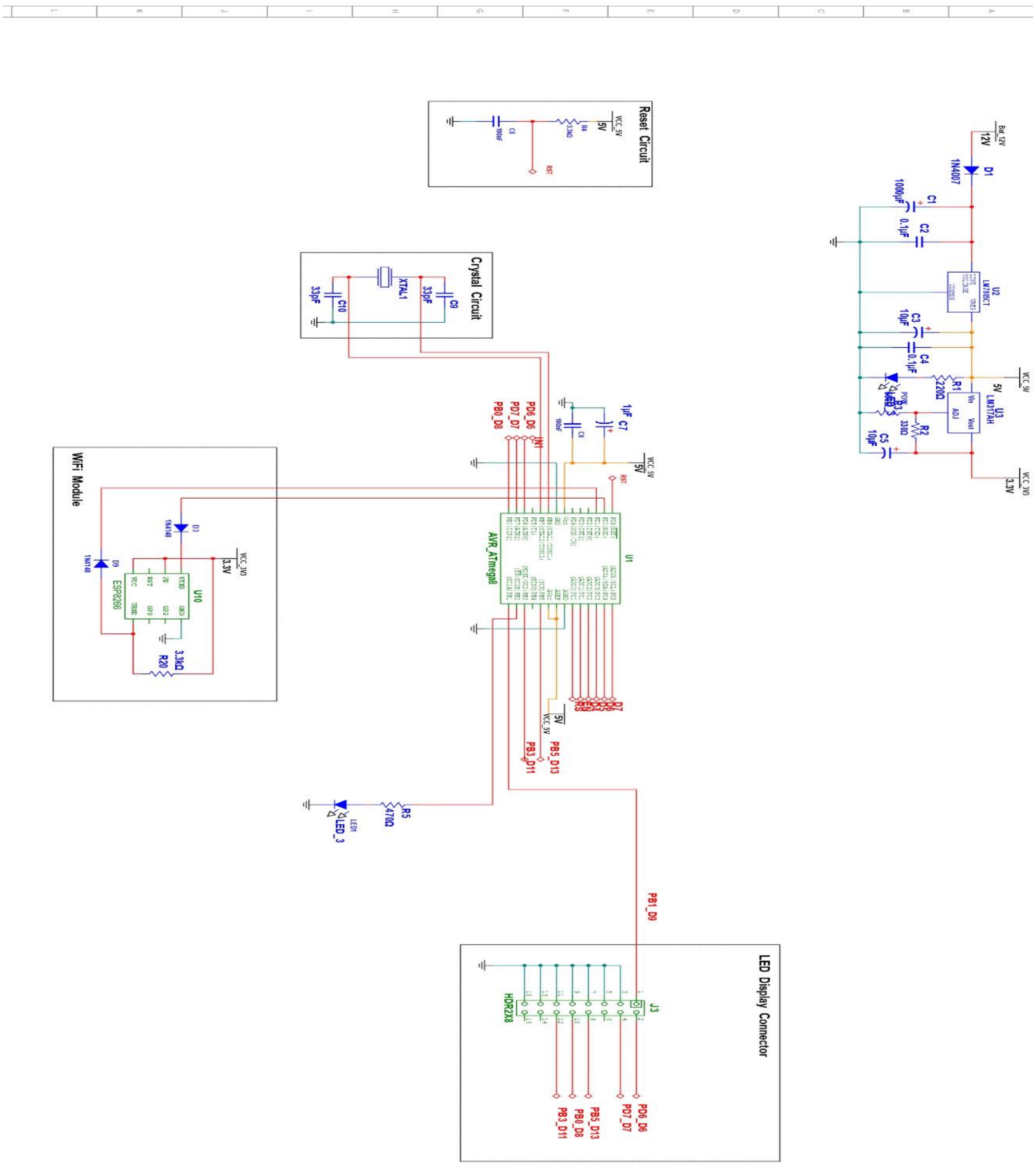
The block diagram presented above illustrates the functional architecture of our IoT-based smart notice board system. It comprises several key components that interact to achieve remote content management and dynamic information display. Here's a breakdown of the core blocks and their functionalities:

Power Supply Circuit: It includes voltage regulation components (like LM317AH or similar voltage regulators) to convert the raw input voltage into stable and well-defined voltage levels required by other parts of the circuit. Proper filtering capacitors are present to minimize voltage ripple and ensure clean power delivery.

Microcontroller Unit (MCU) AVR ATmega8: The AVR ATmega8 serves as the central processing unit of the system. It executes the program code stored in its flash memory, which governs the overall system logic and communication with other components. It communicates with the Wi-Fi module (ESP8266) to transmit and receive data wirelessly. It interacts with the LED display driver circuit to control the visual presentation of information on the rolling LED display.

Wi-Fi Module ESP8266: The ESP8266 Wi-Fi module enables wireless communication between the smart notice board and a Wi-Fi network. It receives data commands and content updates from a remote source (e.g., web application or mobile application) via the Wi-Fi connection. It transmits data (potentially including status updates or sensor readings) back to the remote source. It communicates with the microcontroller unit (MCU) to exchange information.

V. CIRCUIT DIAGRAM



The circuit diagram presented above depicts the internal hardware connections and component interactions within the smart notice board system. Here's a breakdown of the key components and their functionalities based on the circuit:

Power Supply Circuit (VCC and GND Rails): The circuit likely receives unregulated input power (DC) from a source like a wall adapter or battery (not shown in the diagram).

Voltage Regulator (IC1): This integrated circuit (IC) is most likely a voltage regulator, possibly the LM317AH mentioned previously. It converts the raw input voltage into a stable +5V DC voltage rail (VCC) that powers most digital components in the system.

Capacitors (C1, C2, C3): These capacitors are placed at various points in the circuit, typically near the power supply and each IC, to filter out electrical noise and ensure a clean, steady voltage supply for the components.

Microcontroller Unit (MCU) AVR ATmega8: The AVR ATmega8 microcontroller is the central processing unit (CPU) of the system.

Crystal Oscillator (Y1 and Associated Capacitors): This section provides a clock signal that regulates the timing of the microcontroller's operations. The specific frequency of this clock signal is determined by the crystal and its capacitors.

Reset Circuit (SW1 and R1): The pushbutton switch (SW1) and resistor (R1) form a reset circuit. Pressing the button momentarily resets the microcontroller, which can be useful for troubleshooting or restarting the system.

Wi-Fi Module: ESP8266: The ESP8266 Wi-Fi module enables wireless communication between the smart notice board and a Wi-Fi network.

Connection to Microcontroller (SPI): The ESP8266 likely communicates with the microcontroller using the SPI (Serial Peripheral Interface) communication protocol. Specific resistors and capacitors (not labeled in the provided diagram) are typically required for SPI communication according to the manufacturer's datasheet.

Rolling LED Display Driver Circuit (IC2 and Associated Components):

LED Driver IC (IC2): This integrated circuit (IC) is likely a specialized LED driver chip responsible for controlling the current supplied to each LED in the rolling LED display. The specific driver IC and its connections will depend on the chosen LED display technology and its current requirements.

Resistors: Resistors are connected in series with each LED (not shown in detail in the provided diagram) to limit the current flowing through each LED and prevent burnout. The values of these resistors would depend on the forward voltage and current rating of the LEDs in the display.

VI. DESIGN METHODOLOGY

Developing an IoT-based smart notice board involves careful consideration of hardware components, software development, and system integration. Here's a breakdown of the design methodology employed for this project:

- **System Requirements Definition:**

The initial stage involved defining the core functionalities and desired features of the smart notice board. This included: Remote content updates via Wi-Fi (and potentially GSM) Dynamic message display on a rolling LED display A user-friendly interface for content management (potentially through a web application or mobile app).

- **Hardware Selection:**

Based on the defined requirements, suitable hardware components were selected. Key factors considered included:

Microcontroller Unit (MCU): The AVR ATmega8 was chosen for its processing power, memory capacity, cost-effectiveness, and ease of use.

Wi-Fi Module: The ESP8266 offered a cost-effective and feature-rich Wi-Fi connectivity solution with an integrated TCP/IP stack.

Rolling LED Display: The specific display technology would depend on factors like character size, resolution, and power consumption. Additional Components: Selection of voltage regulators (e.g., LM317AH, LM7805CT), switching diodes (e.g., 1N4148), LED driver circuits, and other passive components would be based on the chosen display technology and overall circuit design requirements.

- **Circuit Design and Schematic Development:**

A circuit diagram was created using schematic capture software. This diagram depicted the connections between all the chosen components, including power supply rails, communication interfaces (SPI for ESP8266), and control signals for the LED display driver circuit.

- **Software Development:**

The software development process involved creating two main parts:

Microcontroller Firmware: The program code for the AVR ATmega8 microcontroller was written using a C compiler like avr-gcc. This code would handle communication with the Wi-Fi module (potentially receiving data commands and content updates), interfacing with the LED driver circuit to control the display, and potentially implementing security measures for data transmission.

User Interface (Web/Mobile App): Depending on the chosen approach, a web application or mobile application might be developed to allow users to remotely update the content displayed on the notice board. This would involve user authentication, data transmission protocols (potentially using web APIs), and a user-friendly interface for content creation and scheduling.

- **System Integration and Testing:**

Once the hardware components were assembled based on the circuit diagram, and the software (firmware and user interface) was developed, the system integration phase began. This involved: Programming the AVR ATmega8 microcontroller with the developed firmware. Connecting all the hardware components according to the circuit design. Testing the functionality of individual components and overall system operation. This might involve verifying Wi-Fi connectivity, data transmission between the user interface and the microcontroller, and the proper display of content on the rolling LED display.

- **Refinement and Iteration:**

Based on the testing results, the design might undergo refinement. This could involve software code adjustments, hardware component replacements (if necessary), or user interface improvements. The iterative development process ensures the final system functions as intended and meets the desired user experience.

VII. CONCLUSUION

This research paper presented the design and development of an IoT-based smart notice board. The system utilizes an AVR ATmega8 microcontroller for core processing, an ESP8266 Wi-Fi module for wireless communication, and a rolling LED display for dynamic information presentation. The hardware components were carefully selected based on their functionalities and cost-effectiveness. A detailed circuit diagram was created to illustrate the connections and interaction between these components. The design methodology emphasized a systematic approach, encompassing requirement definition, hardware selection, circuit design, software development, system integration, and testing. The software development involved programming the microcontroller firmware for data communication and display control, while also considering the potential development of a user interface for remote content management. The developed prototype demonstrates the feasibility of creating a smart notice board system that leverages IoT technologies for remote content updates and dynamic information display. Future advancements could involve incorporating additional features like user authentication for secure content management, integrating with sensor networks for real-time data visualization, or exploring alternative communication protocols like cellular connectivity (using a GSM module) for wider deployment possibilities. This project contributes to the growing field of IoT applications by showcasing a practical implementation for remote information dissemination. The adoption of such smart notice boards can benefit various environments, such as educational institutions, workplaces, public transportation hubs, and potentially even emergency notification systems.

VIII. FUTURE SCOPE

The developed IoT-based smart notice board prototype presents a promising foundation for further exploration. Here are some potential areas for future development:

Enhanced User Interface: Developing a user-friendly web application or mobile application would allow for remote content creation, scheduling, and potentially user authentication for secure content management.

Advanced Display Capabilities: Integrating higher resolution LED displays or exploring alternative display technologies like e-Paper could provide more flexibility in information presentation.

Sensor Integration: The system could be expanded to incorporate various sensors (e.g., temperature, humidity) for real-time data visualization on the display alongside the notifications.

Cellular Connectivity: Incorporating a GSM module could enable communication through cellular networks, extending deployment possibilities beyond Wi-Fi coverage areas.

Scalability and Networking: The design could be adapted to support multiple interconnected smart notice boards, creating a network for broader information dissemination.

Power Management Strategies: Implementing features like automatic display dimming or low-power operation modes would be crucial for battery-powered deployments.

Security Measures: Advanced security protocols like data encryption and user authentication would be essential for protecting the system from unauthorized access and potential manipulation of displayed content. By exploring these advancements, the functionality and applicability of the smart notice board system can be significantly enhanced, making it a more robust and versatile solution for various information display and communication needs.

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