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IoT-Enabled Smart Notice Board for College – Dynamic Updates via Cloud

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Abstract:
This paper presents the design, development, and implementation of an IoT-based smart notice board system tailored for educational institutions. Traditional notice boards in colleges and universities rely heavily on manual updates, which is time-consuming, error-prone, and resource-intensive due to the extensive use of paper. To address these limitations, the proposed system leverages the capabilities of the Internet of Things (IoT) and cloud computing to enable dynamic, real-time updates of notices and announcements. The core of the system is a microcontroller, which interfaces seamlessly with an electronic display unit. This setup allows administrators, faculty members, or designated staff to remotely manage content through a cloud platform, ensuring that information reaches students and staff promptly and accurately. The system supports a variety of content formats, including text, images, and notifications, making communication more interactive and visually engaging. The smart notice board contributes to sustainability efforts within educational campuses by reducing dependency on printed notices. Furthermore, the solution improves operational efficiency by minimizing manual intervention, reducing update delays, and enabling centralized management of multiple boards across different campus locations. The integration of cloud technology ensures scalability, accessibility, and secure data management, making the system adaptable for institutions of varying sizes. Thus, this IoT-based smart notice board represents a significant advancement in campus communication infrastructure, enhancing the dissemination of information, promoting eco-friendly practices, and fostering a more connected and responsive educational environment.

Keywords:
IoT, Smart Notice Board, Cloud Computing, Remote Updates, Educational Institutions, Digital Communication, Sustainability etc.

Introduction:

Traditional notice boards in educational institutions have long served as the primary medium for sharing announcements, event schedules, and important notifications. However, these conventional systems rely heavily on manual updates, which often require staff to physically post notices, replace outdated information, or manage multiple boards across different locations. This manual process led to delays in communication, inconsistencies in information, and increased chances of miscommunication. Moreover, the reliance on printed notices contributes to paper wastage, adding to operational costs and environmental impact. In the era of digital transformation, these limitations underscore the need for more efficient, reliable, and sustainable communication methods within educational campuses.

The emergence of the Internet of Things (IoT) and cloud computing provides a promising solution to modernize traditional notice boards. IoT-enabled smart notice boards integrate microcontrollers, display units, and cloud connectivity to create a dynamic and interactive communication platform. Through this system, administrators and staff updates notices remotely in real-time, ensuring that students, faculty, and other stakeholders receive accurate information without delay. This capability is particularly valuable for time-sensitive

announcements, such as class schedule changes, exam notifications, event reminders, or emergency alerts.

In addition to enhancing communication efficiency, IoT-based smart notice boards offer significant benefits in terms of content management and scalability. The cloud-based infrastructure allows centralized control of multiple boards across different departments or campus locations, reducing the need for physical intervention. The system supports diverse content formats, including text, images, and multimedia notifications, making information more engaging and easier to comprehend. Furthermore, by minimizing the dependence on printed notices, the smart notice board promotes eco-friendly practices and aligns with institutional sustainability goals. Beyond operational efficiency and environmental advantages, this technological solution enhances campus safety and responsiveness. Instant notifications for urgent situations, such as campus closures or safety alerts are disseminated immediately, ensuring that all stakeholders are informed without delay. IoT-enabled smart notice boards represent a significant advancement in educational communication infrastructure. These systems streamline information dissemination, improve engagement, and foster a more connected, efficient, and sustainable campus environment by combining real-time updates, remote accessibility, and cloud-based management.

Methodology:

The operation of the IoT-based smart notice board system follows a systematic and streamlined process to ensure timely and accurate dissemination of information within educational institutions. The process begins with **message creation**, where authorized users such as faculty members, administrative staff, or designated personnel compose notices, announcements, or event information using the dedicated mobile application. The application provides an intuitive interface that allows users to format text, add symbols, or schedule messages for future display. Once the message is composed, the **data transmission** phase begins. The mobile application securely sends the message to the cloud platform, such as Firebase, using internet connectivity. The cloud serves as a centralized repository, storing the message and making it readily accessible to connected devices while maintaining data integrity and security.

In the **data retrieval** stage, the ESP32 microcontroller, integrated with the LED matrix display, periodically checks the cloud platform for new messages. Using the custom firmware, the microcontroller fetches the latest content, ensuring real-time updates without manual intervention. Finally, during the **display update** phase, the microcontroller processes the retrieved data and updates the P10 LED matrix display accordingly. This allows students and staff to view the information clearly and promptly. The entire methodology ensures a seamless, efficient, and automated communication process, minimizing delays, reducing paper usage, and enhancing the overall effectiveness of campus information dissemination.

System Design:

A. Hardware Components:

The proposed IoT-based smart notice board system relies on a carefully selected set of hardware components to ensure reliable performance, efficient communication, and clear display of information. Each component has been chosen based on its compatibility, functionality, and suitability for deployment in educational institutions.

Microcontroller: The core of the system is an ESP32 microcontroller, which serves as the primary processing unit. The ESP32 is highly favoured for IoT applications due to its built-in Wi-Fi and Bluetooth capabilities, allowing seamless connectivity with cloud platforms. Its dual-core processor ensures that the system handles multiple tasks simultaneously, such as fetching data from the cloud, processing updates, and controlling the display output

without delays. The ESP32 provides a wide range of input/output pins, enabling easy interfacing with other sensors or peripheral devices if required in future expansions. Its low power consumption and robust performance make it ideal for continuous operation in campus environments.

Display Unit: To present messages in a visually clear and impactful manner, a P10 LED matrix display is employed. The P10 module consists of multiple light-emitting diodes arranged in a grid, capable of displaying text, symbols, and simple graphics. Its brightness and visibility ensure that information is easily read from a distance, even in well-lit environments. The modular nature of the P10 display allows for scalability; multiple panels are combined to create larger notice boards to accommodate longer messages or multimedia content. The LED display is energy-efficient compared to traditional lighting systems, contributing to the sustainability of the installation.

Power Supply: A stable and reliable power source is crucial for continuous operation. The system utilizes a 5V regulated power supply to ensure consistent voltage delivery to the microcontroller and display unit. This prevents voltage fluctuations that could lead to component malfunction or data loss. The power supply is selected to handle the combined load of all hardware components, including the ESP32 and LED display, while maintaining efficiency and safety. In addition, proper regulation protects sensitive electronic components from damage due to overvoltage or short circuits, ensuring long-term durability and minimal maintenance.

Collectively, these hardware components form the backbone of the IoT-enabled smart notice board system. The integration of the ESP32 microcontroller, P10 LED display, and stable power supply provides a robust, scalable, and energy-efficient solution capable of supporting real-time, cloud-based communication within educational institutions.

B. Software Components:

The functionality and efficiency of the IoT-based smart notice board system heavily rely on its software components. These components work in tandem with the hardware to enable real-time updates, remote management, and seamless communication between users and the display unit.

Firmware: At the core of the system's operation is custom-developed firmware installed on the ESP32 microcontroller. This firmware is responsible for managing Wi-Fi connectivity, ensuring that the device remains continuously linked to the internet and access the cloud platform. It also handles data reception from the cloud, processes the incoming messages, and formats them for display on the P10 LED matrix. The firmware is designed to operate efficiently, minimizing latency while maintaining a stable connection, even in environments with variable network conditions. It includes error-handling routines to manage failed data transmissions or connectivity interruptions, ensuring that the notice board remains reliable and functional at all times.

Cloud Platform: To facilitate centralized data management and remote updates, a cloud platform such as Firebase is employed. The cloud service acts as a repository for all messages, announcements, and multimedia content intended for display. Authorized users upload, modify, or delete messages from any location with internet access, eliminating the need for physical intervention at the notice board. The cloud platform also provides real-time synchronization, ensuring that any updates made by users are instantly reflected on the display unit. Its secure architecture protects sensitive data and prevents unauthorized access, thereby maintaining the integrity and confidentiality of institutional communication. The platform supports scalability, allowing the system to manage multiple notice boards across different campus locations simultaneously.

Mobile Application: To simplify user interaction, an Android mobile application has been developed. This application allows authorized personnel, such as faculty members or

administrative staff, to send updates directly to the cloud, which are then displayed on the notice board. The app provides a user-friendly interface where messages created, scheduled, and formatted with ease. Push notifications and confirmation messages ensure that users are aware of successful uploads. The mobile application enhances convenience and accessibility, allowing administrators to manage the notice board from virtually anywhere, at any time.

Together, the firmware, cloud platform, and mobile application form a cohesive software ecosystem that enables the smart notice board to operate efficiently, reliably, and securely. This integration ensures real-time information dissemination, reduces manual effort, and creates a modern, interactive communication solution for educational institutions.

Findings of the Study:

The implemented IoT-based smart notice board system was tested in a real college environment to evaluate its performance, efficiency, and usability. The results demonstrate that the system effectively addresses the limitations of traditional notice boards and offers significant improvements in communication and operational efficiency.

One of the most notable outcomes was the real-time update capability. Messages uploaded via the mobile application were displayed on the P10 LED matrix within seconds, ensuring that students and staff received the latest information promptly. This rapid dissemination of information proved particularly useful for time-sensitive announcements, such as class rescheduling, exam notifications, and emergency alerts, significantly reducing delays and potential miscommunication.

The system also excelled in user accessibility and convenience. Authorized users were able to remotely update the notice board from anywhere with internet access. This feature eliminated the need for physical presence at the board, saving time and labour. The mobile application's user-friendly interface enabled easy composition, formatting, and scheduling of messages, enhancing overall user experience and ensuring that the system could be used effectively by individuals with minimal technical expertise.

Another key result was the reduction in paper usage. By minimizing reliance on printed notices, the smart notice board contributed to the institution's environmental sustainability initiatives. The digital system not only lowered paper consumption but also reduced the operational costs associated with printing and manually updating notices, thereby demonstrating both ecological and economic benefits.

There are many challenges were observed during testing. Ensuring reliable Wi-Fi connectivity was critical for maintaining real-time updates, as intermittent network disruptions occasionally delayed message display. User authentication and access control required careful management to prevent unauthorized individuals from modifying or posting messages, highlighting the importance of secure login protocols and administrative oversight.

Thus, the results indicate that the IoT-enabled smart notice board system provides a robust, efficient, and eco-friendly solution for campus communication. It enhances information dissemination, improves operational convenience, and supports sustainable practices while addressing common challenges through careful network management and secure user authentication. The study demonstrates that such systems have strong potential for adoption across educational institutions, contributing to smarter and more connected campuses.

Conclusion:

The IoT-enabled smart notice board system represents a significant advancement in the modernization of traditional notice dissemination processes within educational institutions. Traditional notice boards often suffer from delays, inconsistent updates, and dependency on manual intervention, which lead to miscommunication and inefficient information sharing. The proposed system addresses these challenges, enabling **real-time updates** and remote

management of information. Authorized users compose and upload messages from anywhere using a mobile application, which are then instantly displayed on the LED matrix, ensuring timely and accurate communication to students, faculty, and staff.

The system improves operational efficiency and promotes **environmental sustainability** by reducing reliance on printed notices. This reduction in paper usage aligns with institutional goals for eco-friendly practices while simultaneously lowering costs associated with printing and manual updates. The modular design of the hardware and the scalable cloud infrastructure ensure that the system is easily expanded to multiple notice boards across different departments or campus locations, supporting broader institutional communication needs. Looking ahead, several **future enhancements** could further increase the system's utility and impact. The integration of multimedia content, such as images, videos, or event banners, could make announcements more engaging and visually informative. Additional features, such as scheduled automated updates, priority alerts for emergency notifications, and multi-user access management, could further streamline operations. Expanding the deployment across all departments or integrating the system with other campus services, such as event management platforms or student portals, could create a fully interconnected communication network, enhancing campus-wide engagement and responsiveness.

Thus, the IoT-enabled smart notice board demonstrates the transformative potential of combining IoT and cloud technologies in educational environments. The system provides a practical and forward-looking solution for modern educational institutions, paving the way for smarter, more connected campuses by enhancing communication efficiency, promoting sustainability, and offering scalability,

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