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Digital Lab Notice Board: An IOT-Enabled Smart Digital Display System for Real-Time Information Sharing and Campus Communication

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Abstract— **The Digital Lab Notice Board is a modern electronic notice display system designed to display important information and announcements in laboratories, colleges, and educational institutions. The main aim of this project is to replace traditional paper-based notice boards with a digital system that saves time, reduces paper usage, and makes information easily available to students and staff. In the traditional notice board system, notices are printed on paper and manually displayed on a board. This process takes time and requires regular maintenance. Sometimes, students may miss important information because they are not present when the notice is displayed. To overcome these problems, the Digital Lab Notice Board provides an easy and efficient method of displaying information electronically. The proposed system uses electronic components such as a microcontroller, display unit, and power supply to show notices digitally. Depending on the design, a Wi-Fi-enabled controller can be used to update notices through a computer or mobile device. The displayed information may include laboratory schedules, practical examination dates, class timings, student instructions, event announcements, and other important updates. The system can display text and other supported information clearly on an electronic screen. The Digital Lab Notice Board helps teachers and laboratory staff update information quickly without printing new notices every time. It reduces paper wastage, saves time, and improves communication between students and staff. It can also make laboratory management more organized and effectiveThe main objective of this project is to develop a reliable, cost-effective, and user-friendly digital notice display system for laboratories. It demonstrates the practical application of electronics, microcontrollers, display technology, and communication systems in real-life situations. In conclusion, the Digital Lab Notice Board is a useful step toward smart laboratories and digital education. It provides a modern alternative to traditional notice boards and supports faster, clearer, and more efficient information sharing within educational institutions.**

Keywords: Digital Lab Notice Board, Microcontroller,

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I. Introduction

Nowadays, technology is used in almost every field, especially in education. Schools, colleges, and laboratories use different technologies to make their work easier and faster. The Digital Lab Notice Board is one such project that helps display important information on an electronic screen. The main purpose of this project is to replace the traditional paper notice board with a digital system. In the traditional notice board system, notices are printed on paper and placed on a board. Whenever new information needs to be shared, the old notice must be removed and a new notice must be displayed. This process takes time and requires paper and printing materials. Sometimes, students may not see important notices because they do not visit the notice board regularly. To solve these problems, we can use a Digital Lab Notice Board. The Digital Lab Notice Board is an electronic system that displays important information on a screen. It can be used in computer laboratories, electronics laboratories, colleges, schools, and other educational places. The system can display different types of information, such as practical schedules, examination dates, laboratory timings, instructions, and important announcements. This project uses electronic components such as a microcontroller, display unit, and power supply. The microcontroller controls the system and sends information to the display. Depending on the project design, an LCD or LED display can be used to show the notices. If a Wi-Fi-enabled controller is used, notices can also be updated wirelessly using a computer or mobile device. The main advantage of this project is that it saves time and reduces the use of paper. Teachers and laboratory staff can display important information without printing notices every time. Students can easily read the information displayed on the screen. It also helps keep laboratory information organized and makes communication easier between students and teachers.

II. Proposed System and Architecture

The proposed system is a Digital Lab Notice Board that displays important notices and announcements on an electronic screen. The main purpose of this system is to replace the traditional paper-based notice board with a simple and modern electronic system. In the traditional system, notices are printed on paper and displayed manually. Whenever new information is available, the notice must be changed by hand. This process takes time and requires paper and printing materials. The proposed system makes this process easier by displaying information electronically. The Digital Lab Notice Board uses a microcontroller, display unit, power supply, and suitable programming. The microcontroller controls the system and sends the required information to the display. The display shows the notice clearly so that students and teachers can read it easily. In a basic version, the messages can be programmed into the controller and displayed on the screen. In an advanced version, a Wi-Fi-enabled controller can be used to update notices through a computer or mobile phone. The exact method of updating information depends on the components used in the project. The proposed system can display different types of information, such as:

- Laboratory timings and practical schedules.
- Examination dates and important announcements.
- Laboratory rules and safety instructions.
- Student instructions and academic updates.
- Events and other college-related information.

The system helps reduce paper usage, saves time, and makes information sharing more convenient. It can be installed in computer laboratories, electronics laboratories, classrooms, and other educational areas.

III. Hardware Description

A. ESP32 Microcontroller

The ESP32 acts as the main controller of the NexusGuard AI smart pole (Fig. 2). It collects data from multiple sensors, performs local processing and control decisions, and operates connected output devices. It also provides Wi-Fi connectivity and communicates with the Raspberry Pi 4 through UART for exchanging sensor and AI-related information.

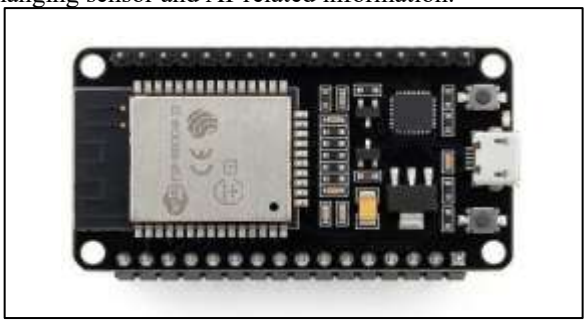


Fig. 2. ESP32 microcontroller.

B. Raspberry Pi 4

The Raspberry Pi 4 functions as the higher-level processing unit of NexusGuard AI (Fig. 3). It receives camera information and performs AI-based computer-vision processing, object detection, and event analysis. It works with the ESP32 through UART, allowing the system to combine sensor information with camera-based intelligence for improved campus

III

Hardware Components Required

Sr. No.	Component	Purpose
1	Arduino Uno	Controls the system
2	16×2 LCD display	Displays notices and messages
3	ESP8266 Wi-Fi module	Enables wireless communication
4	Power supply	Provides electrical power
5	Connecting wires	Connect the components
6	USB cable	Uploads the program to Arduino

IV

Working of the Hardware System

The hardware system works in the following steps:

1. Input: The notice is entered into the system or stored in the program.
2. Communication: If Wi-Fi is included, the ESP8266 receives notice data from an authorized device.
3. Processing: The Arduino processes the message according to the uploaded program.
4. Display: The LCD displays the message so that students and teachers can read it.
5. Power supply: The power supply provides the required power to the components.

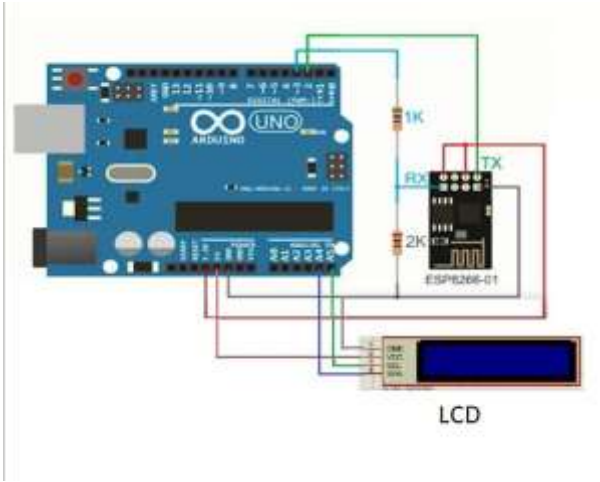
V

Advantages of the Hardware-Based System

- Reduces paper usage.
- Displays notices clearly.
- Saves time and manual effort.
- Supports wireless updates when configured.
- Can be used in laboratories, classrooms, and colleges.
- Can be improved by adding more advanced features.

VI.Conclusion

The hardware-based system is an important part of the Digital Lab Notice Board. It combines electronic components to display information in a simple and organized manner. The Arduino controls the system, the LCD displays the notices, and an optional Wi-Fi module allows wireless communication. This system provides a practical alternative to traditional notice boards and helps make laboratory communication easier and more efficient.



monitoring.



Fig. 3. Raspberry Pi 4.

C. AI Camera

The AI camera (Fig. 4) is used to capture images or video from the campus surroundings and provide visual information to the Raspberry Pi 4. Its primary purpose is to support AI-based object detection and event analysis. The camera helps the system identify relevant visual activities or unusual events as part of intelligent campus surveillance.

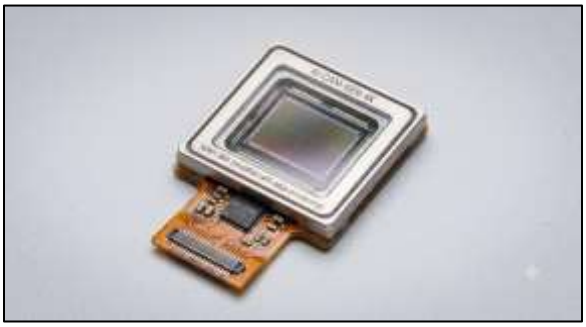


Fig. 4. AI camera.

D. PIR Motion Sensor

The Passive Infrared (PIR) motion sensor (Fig. 5) is used to detect movement or activity in the monitored area. It provides information about possible human movement and can support security monitoring. The PIR sensor can also assist the smartlighting system by helping determine when movement occurs and when lighting may be required.



Fig. 5. PIR motion sensor.

E. MQ-135 Gas/Air-Quality Sensor

The MQ-135 sensor (Fig. 6) is used to monitor gas-related and air-quality conditions around the smart pole. It provides environmental information to the controller and can help identify abnormal air conditions. The collected data can be processed locally and transmitted through the IoT communication system for monitoring and possible safety alerts.



Fig. 6. MQ-135 gas/air-quality sensor.

F. Flame Sensor

The flame sensor (Fig. 7) provides an additional safety mechanism for identifying fire-related conditions by detecting the presence of flame. It works alongside the smoke sensor to improve fire monitoring. When a possible flame event is detected, the information can be processed by the ESP32 and used to activate warning devices and generate a remote alert.



Fig. 7. Flame sensor.

G. DHT22 Sensor

The DHT22 sensor (Fig. 8) is used for environmental monitoring by measuring temperature and relative humidity. The sensor provides data to the ESP32, allowing the system to continuously observe surrounding environmental conditions. These measurements can be displayed and transmitted through the IoT platform, providing useful information for campus environmental monitoring and system analysis.

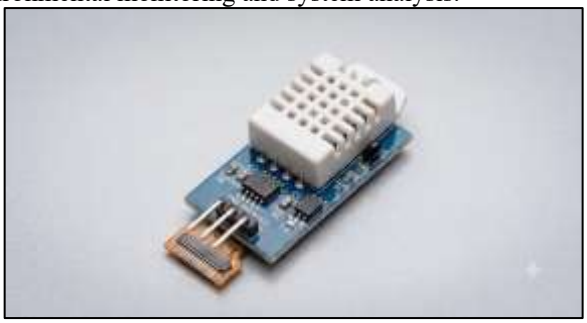


Fig. 8. DHT22 temperature and humidity sensor.

H. Light-Dependent Resistor (LDR)

The Light Dependent Resistor (LDR) (Fig. 9) is used to measure ambient light intensity in the surrounding environment. It helps the system determine whether conditions are sufficiently bright or dark and supports automatic LEDlighting control. By combining LDR information with movement detection, the system can operate lighting more intelligently and reduce unnecessary energy consumption.

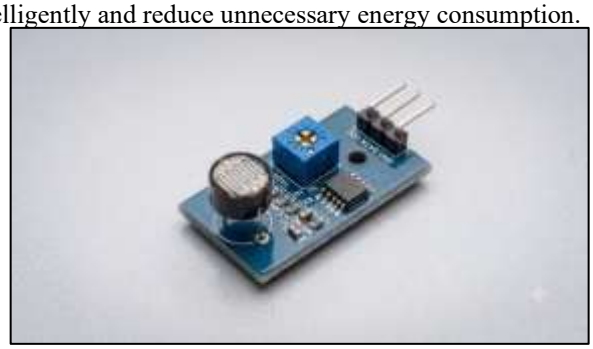


Fig. 9. Light-dependent resistor (LDR).

IV. Working of the System

The operation of NexusGuard AI begins with continuous data collection from the installed sensors and camera. The ESP32 receives information from sensors such as the PIR, MQ2, MQ-135, flame sensor, DHT22, sound sensor, and LDR. At the same time, the AI camera captures visual information and sends it to the Raspberry Pi 4. The Raspberry Pi processes camera data for object detection and event analysis, while the ESP32 handles sensor processing and device control. Information between the two controllers is exchanged through UART.

When an abnormal condition is detected, the system can generate a suitable local response. For example, smoke or flame detection can result in activation of the siren or buzzer, warning lights, speaker, and display. Similarly, an emergency event initiated through the SOS button can generate an immediate alert. Movement information obtained from the PIR sensor and camera can also be used for security monitoring and smartlighting decisions. Sensor information and alerts are transmitted through Wi-Fi and MQTT to the cloud platform, where the information can be monitored through Firebase and the dashboard or mobile application.

The smart lighting function uses the LDR and movement information to improve energy efficiency. During low-light conditions, the system can use movement information to determine whether lighting is required, reducing unnecessary operation. In this way, the system combines safety monitoring with energy management instead of treating lighting as an independent system. The solar panel and battery backup further support continuous operation of the smart infrastructure.

V. Conclusion

NexusGuard AI presents an integrated approach to campus safety and sustainability by combining artificial intelligence, Internet of Things technologies, embedded controllers, environmental sensors, camera-based surveillance, smart lighting, emergency response, cloud monitoring, and renewable power into a unified smart-pole architecture. The ESP32 functions as the main sensor and control controller, while the Raspberry Pi 4 performs AI-based camera processing. A collection of sensors provides information about movement, smoke, gases, flame, temperature, humidity, sound, and ambient light, while the actuator section enables local warning and control through LEDs, siren or buzzer, speaker, OLED display, and relay devices. Wi-Fi and MQTT provide network communication, Firebase provides real-time cloud management, and the dashboard or mobile application allows remote monitoring. Solar power, battery storage, and DC-DC conversion support autonomous operation. Overall, the proposed architecture aims to overcome the limitations of fragmented campus systems by providing a centralized, intelligent, scalable, and energy-conscious infrastructure for safety and sustainability.

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