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# Smart Digital School Bell With Timetable Display And Sms Alert

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**Abstract***:* School time management is essential for maintaining discipline and ensuring smooth academic operations, yet delays and inaccuracies still occur with traditional manually operated bell systems. This paper examines the effectiveness of a Smart Timetable Display and Automated Bell System designed to improve scheduling accuracy and operational efficiency in educational institutions. The system integrates an ESP8266 microcontroller, a 128×64 OLED display, and a GSM SIM800C module to automatically update time and timetable data while triggering the bell precisely at scheduled intervals. Real-time information is presented on the local OLED display, and SMS alerts enable administrators to monitor schedule-related events remotely. Drawing on recent studies, the paper highlights how IoT-based school automation enhances punctuality, reduces manual workload, and strengthens communication across the institution. Challenges such as network dependency, installation cost, and power reliability are also discussed, along with strategies to make such solutions more feasible for small and medium-sized schools.
**Index Terms** — Smart timetable display, automated school bell, ESP8266, OLED 128×64 display, GSM SIM800C, IoT-based scheduling, real-time clock synchronization, smart notification system

## 1. INTRODUCTION

Efficient time management is essential for maintaining discipline, punctuality, and smooth academic operations in educational institutions. Traditional manual bell systems rely heavily on human involvement, making them vulnerable to delays, inconsistencies, and operational errors. Despite their long-standing use, these conventional methods fall short in delivering precise and reliable scheduling required in modern schools. Automation through embedded systems and IoT technologies provides a promising solution by enabling accurate, real-time schedule execution and centralized control of school bell operations.This paper presents a low-cost, practical Smart Timetable Display and Automated School Bell System built using the ESP8266 microcontroller. The system integrates a 128×64 OLED display for real-time timetable visualization, a GSM SIM800C module for remote notifications, and automated buzzer control for period transitions. Time synchronization through the internet ensures accuracy without manual adjustments, while remote updates allow administrators to modify schedules instantly. By reviewing existing school automation technologies and identifying gaps, the proposed system aims to enhance punctuality, reduce manual workload, and provide a scalable automation solution tailored specifically to the needs of schools and colleges.

## 2. LITERATURE REVIEW

Research on smart school automation has steadily expanded over the past few years, with a strong shift toward microcontroller-based bell systems, IoT-enabled scheduling, and digital timetable displays. These studies highlight improvements in timing accuracy, remote accessibility, and operational efficiency, while also documenting challenges in network reliability, hardware durability, and long-term maintenance.

### 2.1 Advances in Automated Bell System

Al-Saadi and Mohsen [1] designed an Arduino-based bell automation setup aimed at reducing the manual effort involved in operating school bells. Their system successfully improved time accuracy and reduced staff dependency, though occasional issues such as electrical noise and time drifts were observed during extended use. Similarly, Tulshidas et al. [2] developed an automatic class bell with real-time control features that ensured timely ringing even during frequent timetable modifications. Their work demonstrated the potential for fully automated scheduling, but also pointed out the need for periodic updating of internal parameters.

### 2.2 IoT-Based Scheduling and Remote Control

Several studies highlight the benefits of IoT integration in school bell systems. Prayoga et al. [5] implemented a smartphone-controlled bell using a NodeMCU module, offering users the ability to modify bell timings remotely. While the system improved flexibility, it also relied heavily on stable internet connectivity.Sharma and Singh [8] proposed a broader IoT automation framework built around ESP8266, enabling remote monitoring, cloud logging, and schedule adjustments. Their research showed strong scalability but emphasized the challenges associated with network lag and setup complexity.

### 2.3 Digital Timetable Display and Visual Scheduling

Ahire and colleagues [4] combined automated bell ringing with a digital timetable display to improve classroom transitions and minimize confusion among students. Their findings suggest that visual reinforcement of schedules helps maintain discipline and reduces delays between periods .Pavani et al. [18] created a smart timetable display that automatically updates subject allocations for each classroom. Although effective, the display required stable power and network conditions for uninterrupted operation, indicating the importance of system resilience.

### 2.4 Communication-Based Notification Systems

Gupta and Soni [9] introduced a GSM-powered school bell notification model capable of sending updates to staff and administrators. The system increased transparency and oversight but depended heavily on telecom signal quality and incurred ongoing messaging charges.

### 2.5 Low-Cost and Resource-Efficient Designs

Research also highlights the development of affordable solutions for schools with limited resources. Wohiduzzaman et al. [7] created a low-cost smart bell system that prioritized simplicity and ease of installation. Their design proved effective, but environmental exposure and hardware aging were identified as long-term concerns .Dinda et al. [13] developed a high-accuracy bell controller using Arduino Uno and a DS1307 RTC module. Their system delivered consistent timing performance, though real-world factors such as temperature variations occasionally affected clock precision.

### 2.6 Practical Deployment Challenges

Studies by Setiawan et al. [10] and Amin et al. [11] shed light on practical obstacles encountered during field deployment, including dust accumulation, moisture exposure, wiring instability, and unexpected voltage variations. These findings underscore the need for protective casings, reliable power management, and routine maintenance protocols .Ayson [17] reported installation-related failures in microcontroller-based systems, highlighting the importance of proper wiring, grounding, and hardware protection for long-term functionality.

### 2.7 Multi-Technology Integration and Advanced Features

Sanodiya et al. [15] explored a combined Node MCU and matrix display architecture, integrating bell control with live announcements and schedule visuals. Their system demonstrated the advantages of merging multiple communication functions into a single platform.

Saini and Kumar [14] proposed a comprehensive IoT-driven school automation ecosystem that links bell systems, timetable displays, and cloud dashboards. Their work reflects a growing trend toward centralized and smart academic infrastructure.

## 3. SYSTEM DESIGN AND IMPLEMENTATION

The Smart Digital Timetable and Automatic Bell System is designed using the ESP8266/ESP32 microcontroller as the primary control unit due to its built-in Wi-Fi, low power consumption, accurate timing capability, and flexible GPIO support. The system integrates time-keeping hardware, display modules, and audio alert mechanisms to automate timetable updates and bell ringing within educational institutions. The design ensures high accuracy, minimal manual intervention, and ease of use for administrators.

### 3.1 Block Diagram:

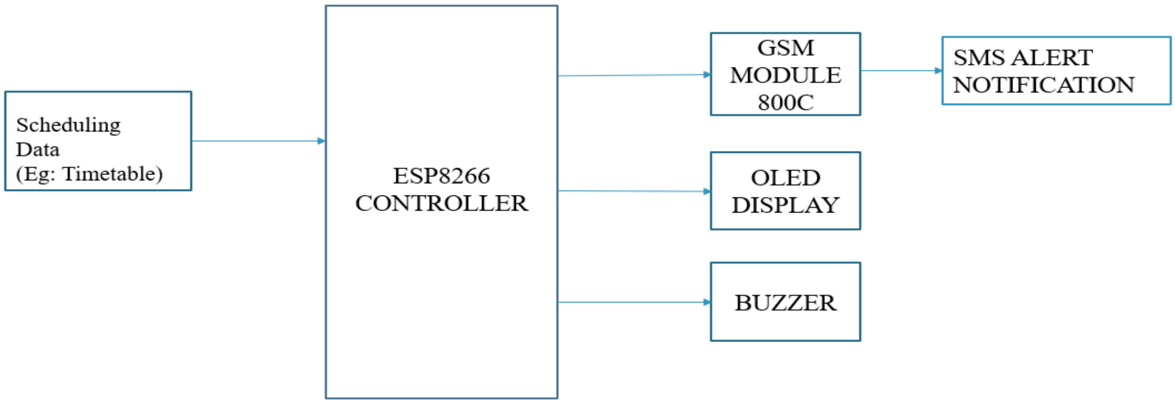


Figure 1. Block Diagram of Smart Digital Timetable and Automatic Bell System

### 3.2 Hardware Components

1. The ESP8266 microcontroller interfaces with the OLED display and GSM SIM800C module to manage real-time timetable updates and automatic bell control.
2. A 128×64 OLED display is connected through the I2C pins of the ESP8266 to show the current time, running period, next class, and break status.
3. The GSM SIM800C module communicates with the ESP8266 via UART to send SMS alerts and receive remote scheduling commands.
4. A buzzer or relay-driven bell is connected to the ESP8266 GPIO pins to provide automatic ringing during period changes.
5. The system is powered by a regulated 5V DC supply that provides stable voltage to the ESP8266, OLED display, GSM module, and buzzer, ensuring reliable and uninterrupted operation.

### 3.3 Connections:

1. The OLED display (SDA and SCL) is connected to the ESP8266 I²C pins (GPIO4 and GPIO5), while its VCC and GND connect to the 3.3V and GND pins of the microcontroller.
2. The GSM SIM800C module TX and RX pins are connected to ESP8266 UART pins (GPIO1 and GPIO3) for two-way communication, with its VCC supplied from a stable 5V line.
3. The buzzer or relay module receives power from the 5V supply, and its input control pin is connected to an ESP8266 digital GPIO pin to activate the bell automatically during period changes.

### 3.4. Software Components:

1. The ESP8266 is programmed using the Arduino IDE, employing libraries for OLED display handling, GSM SIM800C communication, scheduling algorithms, and Wi-Fi connectivity when enabled.
2. The system uses time-based logic: when the current clock value matches the stored timetable entry, the buzzer or relay activates automatically to ring the bell; during non-scheduled periods, the system remains idle.
3. Real-time class information, including ongoing period and upcoming period details, is displayed continuously on the OLED screen, providing immediate visual feedback.
4. The SIM800C GSM module is integrated to send automated SMS notifications and receive remote timetable update commands from authorized users, enabling external monitoring and control without physical access to the system.
5.To send automated SMS alerts to teachers, the system uses a Wi-Fi–based communication method supported by the ESP8266 module. The ESP8266 connects to the internet and sends messages through the CircuitDigest Cloud SMS API service. This software component securely sends JSON-formatted data containing the teacher's mobile number and message template. Whenever a reminder or notification is needed, the system automatically triggers this function, ensuring teachers receive timely updates without manual intervention.

- The ESP8266 first powers on and connects to the configured Wi-Fi network using the saved SSID and password.
- After the Wi-Fi connection is established, the system prepares an SMS message that includes the teacher's mobile number and the required notification text.
- The ESP8266 then creates a secure HTTPS communication link with the CircuitDigest Cloud SMS API server.
- The device formats the SMS information in JSON form, which includes the template ID, mobile number, and message variables.
- This JSON data is sent to the server through an HTTP POST request.
- The API processes the request and delivers the SMS to the teacher's phone number.
- Finally, the ESP8266 checks the server's response. If the message is successfully delivered, a confirmation is shown on the serial monitor; if not, an error message is displayed.

**3.5. Operational Flow:**

1. The system initializes the ESP8266 controller, OLED display, GSM SIM800C module, and buzzer/relay, loading the stored timetable values for the day.
2. The microcontroller continuously checks the current time and compares it with the timetable entries to determine whether a scheduled bell time is approaching.
3. If the day is marked as a holiday, the system displays a holiday message on the OLED screen and automatically sends a holiday notification to parents through the GSM module.
4. During regular school days, if the current time matches a bell time, the controller activates the relay or buzzer for a fixed duration, plays a preset alert, and then turns it off automatically.
5. If the current time does not match any bell event, the system displays the next upcoming timetable entry on the OLED screen and keeps monitoring the clock in the background.
6. Before each bell event, the system checks whether an alert must be sent to teachers, ensuring they receive advance notifications for upcoming sessions when configured.
7. After completing each bell action or message routine, the controller enters a wait-and-repeat cycle, monitoring the next time slot until the end of the school day.
8. Once all scheduled events for the day are completed, the system enters low-power mode and remains inactive until the next morning's initialization cycle.

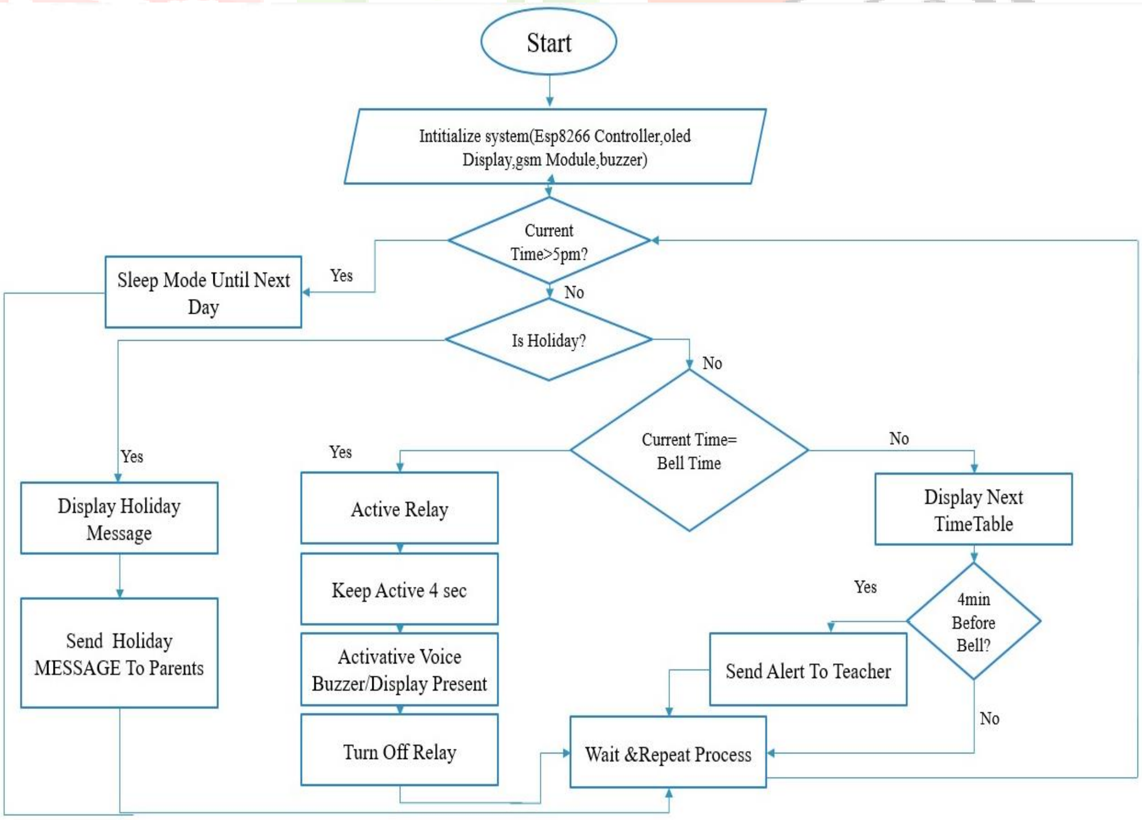


Figure 2.OperationalFlow Chart for Smart Timetable and Automated School Bell System

# 4. RESULTS

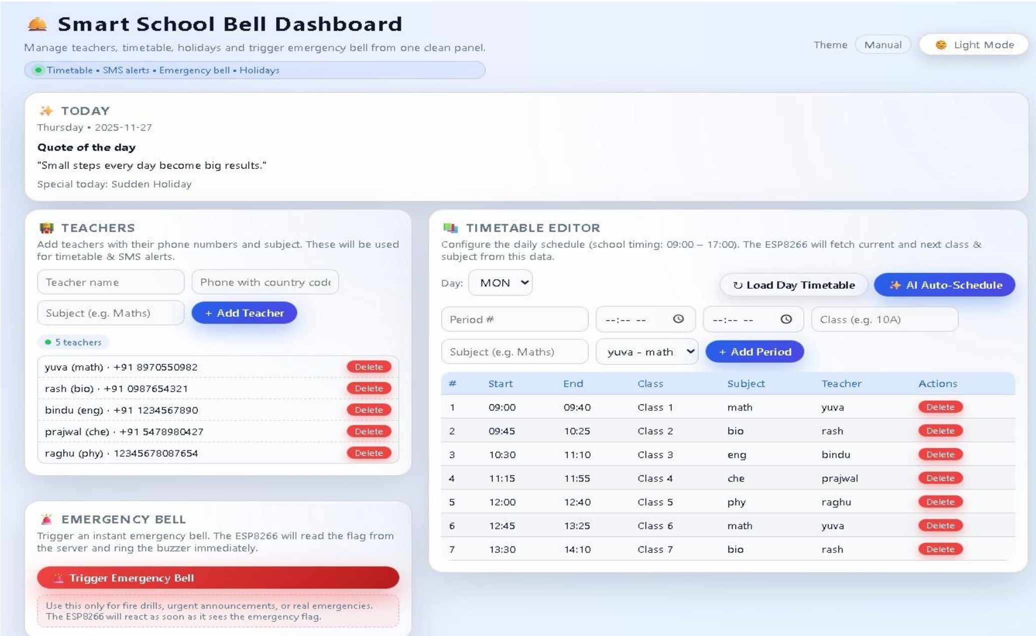


Figure 3. Smart School Bell Dashboard with real-time timetable, teacher data, holiday management, and emergency controls

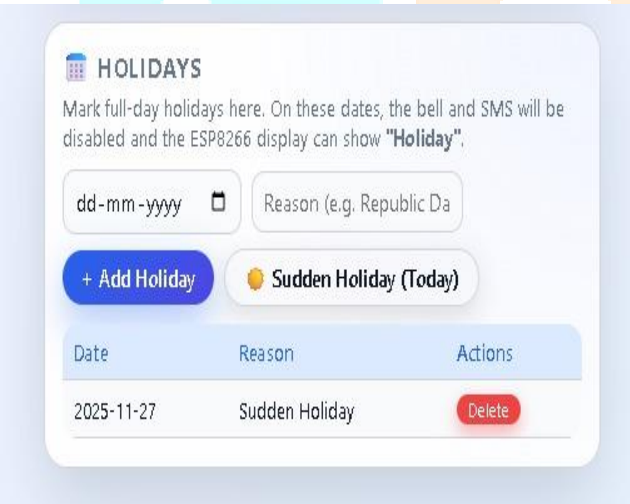


Figure.4.Holiday management interface showing a sudden holiday entry created in real time

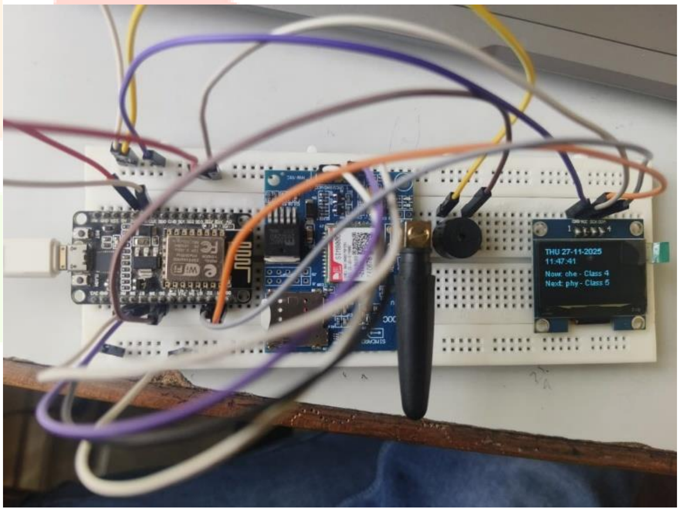

Figure 5. Hardware prototype using ESP8266, SIM800C GSM module, buzzer, and OLED display showing current and next class

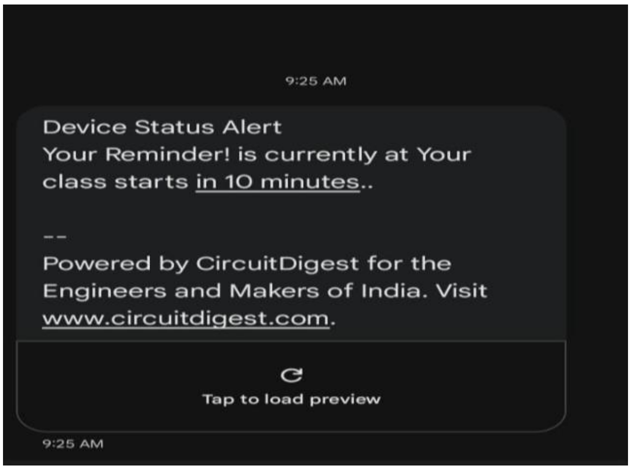


Figure 6. Automated SMS alert received by teacher showing class reminder message

The Smart School Timetable Display and Automated Bell System successfully demonstrated reliable real-time scheduling and alert automation using the ESP8266, SIM800C module, buzzer, and OLED display. The device accurately showed the current class and the next class on the 128×64 OLED screen, confirming proper synchronization with the cloud-based timetable. The buzzer activated precisely at scheduled bell times, while emergency alerts triggered from the dashboard were instantly executed on the device. The dashboard allowed easy addition of teachers, editing of timetables, and marking of holidays, all of which were correctly reflected on the hardware. The SIM800C module also delivered SMS notifications, ensuring timely communication. Overall, the system operated smoothly, reduced manual effort, and proved to be an efficient and dependable solution for school bell and timetable automation.
The overall system performed reliably under continuous operation, with stable power usage and consistent Wi-Fi/GSM connectivity. The interface responded quickly to user inputs, and no errors were observed in subject display or bell triggering. These results confirm that the smart timetable and bell system can significantly reduce manual workload, improve punctuality, and enhance overall school management efficiency.

## 5. CONCLUSION AND FUTURE SCOPE

Smart timetable display and automated bell systems have significant potential to modernize and streamline school operations. By integrating the ESP8266 microcontroller, OLED displays, and GSM communication modules, institutions can manage daily schedules with precision and reliability. This not only saves time and reduces manual effort but also ensures that bells ring exactly when they should, improving punctuality and overall discipline within the campus. The inclusion of real-time time synchronization and schedule updates ensures that teachers and students receive accurate information throughout the day.

However, several challenges remain before such systems can be widely adopted. The initial cost of hardware may be a limitation for smaller schools with restricted budgets. Network dependency is another concern, as Wi-Fi or GSM fluctuations can disrupt message delivery or timetable updates. Power availability also plays a key role, especially in regions where voltage instability or outages are common. Finally, usability remains essential; interfaces must be simple, intuitive, and multilingual to ensure accessibility for administrators with varying technical backgrounds.
Looking ahead, there are numerous promising directions for further improvement. Integrating AI-based timetable generation can help schools automatically create schedules based on teacher availability and classroom load. Adding solar-powered backup modules will enhance reliability during power cuts, especially in rural institutions. Designing plug-and-play hardware kits can simplify installation and make the system more approachable for schools without technical staff. Collaborations with educational boards and training centers can help administrators learn the system more easily, ensuring effective long-term usage. Expanding cloud dashboards with historical logs, attendance linking, and automated reminders will further enhance decision-making and operational efficiency.

With the right tools, partnerships, and continuous development, smart automation technologies can become accessible to every school, particularly those aiming to improve punctuality and reduce manual workload. This vision of affordable, scalable, and user-friendly school automation has the potential to transform academic environments for the better.

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