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Smart Class Room Noise Detection

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Abstract: *This work presents a Smart Classroom Noise Detection and Alert System aimed at maintaining a controlled and distraction-free learning environment. Studies show that environmental noise significantly impacts concentration and academic performance in learning spaces. Existing monitoring systems rely on manual supervision, which is inefficient and lacks real-time response capability. To address this, the proposed system uses an ESP32-S3 microcontroller integrated with a digital microphone sensor to continuously monitor sound intensity in real time. Similar embedded monitoring approaches have been widely used in IoT and sensor-based systems for environmental data acquisition. When noise exceeds a predefined threshold, an alert mechanism is triggered, aligning with earlier smart alert-based monitoring systems. The system is compact, energy-efficient, and powered by rechargeable modules, making it suitable for embedded IoT applications. Overall, the proposed system supports smart classroom management and improves discipline using real-time monitoring techniques .*

Keywords: Arduino IDE, SMS service, noise detection, Real-Time Monitoring

I. INTRODUCTION

Smart classrooms are becoming a key component of modern educational systems, where maintaining a distraction-free environment is essential for effective learning [6], [12]. However, excessive noise generated inside classrooms often reduces student concentration and learning efficiency [7], [14].

Traditional monitoring methods depend on manual supervision, which is not sufficient for continuous noise control [7], [8]. Similar limitations have been observed in earlier environmental monitoring systems where manual intervention reduced system scalability and effectiveness [6], [9].

Recent advancements in IoT and embedded systems have enabled automated monitoring solutions capable of real-time data acquisition and processing [11], [12]. Wireless sensor networks and embedded devices have been widely used for environmental monitoring applications [9], [16].

The proposed system follows similar embedded design principles, integrating microcontrollers and sensors for real-time processing [11], [15]. Alert-based systems using buzzers and displays have also been successfully implemented in various monitoring applications to improve awareness and response time [14], [17][18-174].

II. LITERATURE REVIEW

Several researchers have developed noise monitoring systems for libraries, industries, classrooms, and other public environments. These systems primarily utilize sound sensors along with microcontroller platforms to measure environmental noise levels and enable basic monitoring and alert functions [6], [7], [9].
Existing studies indicate that excessive classroom noise significantly affects student concentration, learning efficiency, and academic performance [6], [12], [14]. Maintaining an appropriate acoustic environment is therefore essential for effective teaching and learning outcomes [6], [7].

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In addition, IoT-based monitoring systems have been widely explored for real-time data acquisition, sound analysis, and automated alert generation [11], [16]. These systems allow continuous monitoring and remote accessibility, thereby improving efficiency and responsiveness in environmental monitoring applications [11], [12].

Microcontroller-based systems using sound sensors have also been proven effective for low-cost and automated noise detection solutions in various embedded applications [9], [15]. Such systems rely on real-time processing and simple decision-making algorithms for threshold-based detection [9], [11].

Furthermore, smart alert systems using buzzers and display modules enhance user awareness and improve discipline in controlled environments such as classrooms and libraries [14], [17]. These alert mechanisms are widely adopted in embedded monitoring systems to provide immediate feedback to users [14], [17].

The proposed system improves existing approaches by integrating an ESP32-S3 microcontroller with an INMP441 digital microphone sensor, enabling more accurate real-time classroom noise detection and improved processing efficiency compared to traditional analog sensor-based systems [11], [15], [16].

II. CIRCUIT DIAGRAM

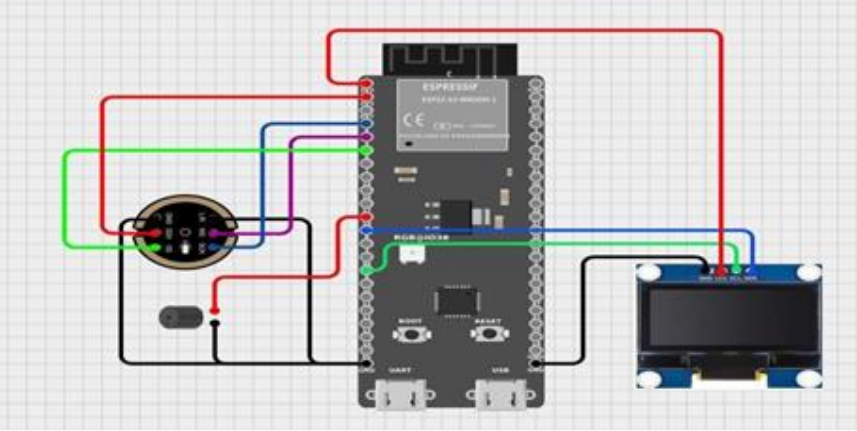

Figure : Circuit diagram

III. PROPOSED SYSTEM

The proposed system continuously monitors sound levels using a digital microphone sensor connected to an ESP32-S3 microcontroller. Similar embedded sensing approaches have been widely used in IoT-based monitoring systems [11], [12].

When sound intensity exceeds a threshold, the system activates a buzzer and displays a warning message, similar to earlier alert-based monitoring systems [14], [17].

IoT-based embedded architectures demonstrate that real-time processing and automated response improve system efficiency and usability [11], [15]. The design follows standard low-power embedded system principles widely used in wireless sensor applications [9], [16].

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IV. HARDWARE DETAILS

1) POWER SUPPLY

The power supply section provides electrical energy to the complete system. In this project, Li-ion batteries along with the TP4056 charging module are used to supply rechargeable power. The LM2596 voltage regulator is used to provide stable voltage to the ESP32-S3 and other components.

2) ESP32-S3 MICROCONTROLLER

The ESP32-S3 is the main controlling unit of the system. It processes the sound data received from the INMP441 microphone sensor and controls the OLED display and buzzer based on the programmed conditions. It also supports fast processing and low power consumption.

3) OLED DISPLAY

The OLED display is used to show the current classroom noise status and warning messages. It provides clear visual output with low power consumption and helps users monitor sound levels easily.

4) INMP441 MICROPHONE SENSOR

The INMP441 digital microphone sensor is used to detect classroom sound levels. It measures sound intensity and sends digital audio signals to the ESP32-S3 microcontroller for processing and noise analysis.

5) BUZZER

The buzzer is used to produce an alert sound whenever the classroom noise level exceeds the predefined threshold value. It helps students and teachers become aware of excessive noise immediately.

6) ZERO PCB

The Zero PCB is used for permanent component connections and circuit assembly. It provides mechanical support and proper arrangement of electronic components in the project.

7) SWITCH

The switch is used to turn the system ON and OFF manually whenever required.

8) HEADER PINS

Female header pins are used for secure and flexible connections between ESP32-S3 and other hardware components.

9) CONNECTING WIRES

Single stand multicolour wires are used to establish electrical connections between all components in the circuit.

10) TP4056 CHARGING MODULE

The TP4056 module is used for safe charging and protection of Li-ion batteries used in the system.

11) LM2596 VOLTAGE REGULATOR

The LM2596 voltage regulator is used to regulate and maintain stable output voltage for proper functioning of the electronic components.

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V. SOFTWARE DETAILS

Embedded System: An embedded system is a microprocessor-based computer hardware system with software that is designed to perform a dedicated function, either as an independent system or as a part of a large system. At the core is an integrated circuit designed to carry out computation for real-time operations.

VI. ADVANTAGES

1. Automatic classroom noise monitoring
2. Improves concentration and discipline
3. Portable and rechargeable system
4. Low power consumption
5. Real-time noise alert system
6. Easy to install and maintain

VII. CONCLUSION

The Smart Classroom Noise Detection and Alert System provides an effective solution for maintaining a peaceful educational environment. The system continuously monitors classroom sound levels and automatically alerts users whenever excessive noise is detected. The project is economical, portable, reliable, and easy to implement using ESP32-S3 and INMP441 microphone technology.

The proposed system improves classroom discipline and supports smart educational infrastructure. In the future, the system can be enhanced using IoT technology, cloud monitoring, mobile applications, and data analytics for advanced smart classroom management

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