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Automated Zone based Horn Control

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***Abstract*— Urban environments are increasingly experiencing elevated levels of noise pollution due to excessive and unnecessary vehicular horn usage. Continuous noise in urban areas not only affects daily life and comfort but also leads to health issues like tension, anxiety, and hearing fatigue. To mitigate this growing concern, this study proposes an automated, zone-based horn regulation system designed to minimize unwanted honking within traffic-sensitive areas. The proposed framework employs acoustic sensors strategically positioned near the vehicle's horn assembly to continuously detect and evaluate the sound intensity. When the measured noise level exceeds a predefined threshold, a notification is triggered through an integrated mobile application, alerting the driver to discontinue honking. Repeated threshold violations are automatically recorded in the system database, facilitating penalty enforcement and behavioural monitoring by traffic authorities. This system offers a low-cost, modular, and scalable solution that can be effectively implemented across urban regions, particularly in silence zones such as hospitals, educational institutions, and residential sectors. By ensuring responsible horn usage and real- time compliance monitoring, the proposed model aims to significantly reduce ambient noise levels, thereby fostering a healthier, safer, and more sustainable urban driving environment.**

***Index Terms*— noise pollution, vehicle horn control, automated monitoring, zone-based control, sustainable mobility, Internet of Things (IOT).**

I. INTRODUCTION

In today's fast-growing cities, noise pollution has turned into one of the biggest and most ongoing environmental challenges. Due to the rapid increase in population, continuous urban development, and the rising number of vehicles, noise levels on city roads have gone up drastically. Among all the reasons, the unnecessary use of vehicle horns has become one of the main sources of this problem, especially in crowded areas. Unlike construction or industrial sounds that are limited to certain places, honking happens suddenly and often, spreading across large areas and disturbing people living in the city. Reports from the World Health Organization (WHO) and other environmental groups show that being exposed to loud sounds for many hours can cause various health issues like stress, high blood pressure (BP), partial or complete hearing loss, sleep problems, and even heart diseases. Beside affecting physical health, noise pollution causes disturbance in mental health and productivity. This reduces the quality of life. This problem becomes worse near hospitals and schools where silence is important. There are many traffic rules to control the unnecessary use of horns. Methods like no honking boards are not successful in maintaining the silence. In the last few years, many researchers have tried using IoT based systems to connect urbanized data. But majority of the studies do not try to control the noise.

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This paper proposes an IoT based automatic horn control system to overcome this issue and reduce need less honking in cities. The system will consist of sound sensors placed near the vehicle horn that regularly check and measure the sound level. The system would trigger an alert to the driver's mobile application, if the sound exceeds a limit to remind them to avoid or minimize honking. The details can be logged in a database after the driver performs that particular action many times, which then can be used to issue warnings and fines. The system can also use geo fencing to automatically shut off the use of horns in sensitive areas, such as hospitals. Schools and residential areas aim in minimizing or avoiding unnecessary disturbances. The proposed system will be low-cost, adaptive, and easy to install; hence, it will be suitable for used widely in busy cities. With its live monitoring, automatic alerts, and zone- based control, the system encourages responsible driving and supports the creation of a quieter and healthier environment for everyone.

II. Literature Survey

Baaki Hima Venkata Navya Bindu et al. [1] proposed a noise control mechanism tailored for campus environments, yet the evaluation of accuracy, privacy, and reliability remained incomplete. Similarly, Kala et al. [2] designed an Arduino and Flet-based setup for sound detection and alerting. Although the design worked efficiently for fixed locations, it did not support mobile applications or wide-area monitoring. Celin Clufudean and Corneliu Buzduga [3] proposed a compact and low-cost portable device for collecting noise data. Salna Joy et al. [4] developed an embedded IoT-based monitoring setup designed for indoor environments. The model performed effectively in enclosed spaces but was not suitable for outdoor mapping or large-scale deployment. Likewise, Ashok K. and Santhosh Krishna B.V. [5] proposed a combined air and noise tracking module using IoT components. Their system needed frequent sensor recalibration, and its long-term stability under real conditions was not well tested. Janeera et al. [6] introduced an IoT-based embedded framework using Arduino for monitoring both air and noise pollution in real time. The system successfully collected and analyzed environmental data, yet its lack of GPS mapping and visualization restricted its use to small areas. Dr. Tanuj Manglani et al. [7] created an IoT-enabled noise and air monitoring system aimed at smart city applications. The setup worked well under controlled laboratory settings but displayed inconsistent results when tested outdoors. Himanshu Nandamwar and Anamika Chauhan [8] presented an IoT-based environmental monitoring concept that depended heavily on stable internet connectivity, which limited its independence in remote or offline regions. Dolvara Gunatillaka [9] also developed an IoT-assisted acoustic sensing system for environmental noise monitoring. Though effective in measuring sound intensity, the design required improvements in power efficiency, hardware durability, and ease of maintenance during extended operation. Sayed Khushal Shah et al. [10] incorporated machine learning algorithms to monitor both air and noise pollution. While their model produced reliable results, it required significant processing power and memory, making it difficult to implement in low-cost IoT devices.

III. Simulation Analysis

A. Hardware Requirements

- ESP32: For Wi-Fi-based data transmission to the cloud (ThinkSpeak)and for detecting Bluetooth signal.
- Sound Sensor: Designed to detect the actuation of the horn.
- Power Supply (3.7V): Powers the microcontroller and sensors.
- Voltage Regulator: used to provide a constant voltage to the microcontroller.

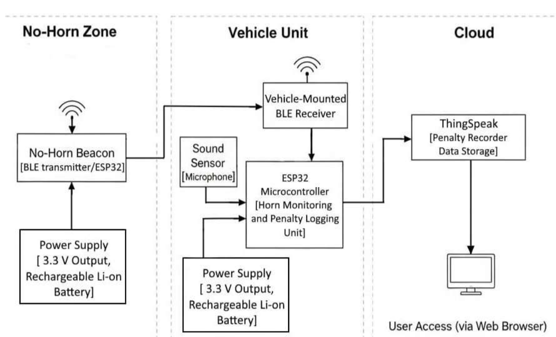

Fig.1. Block diagram of the Proposed System

B. Software Requirements

- Arduino IDE: For Programming and uploading to ESP32.
- ThinkSpeak: Cloud IoT Platform interacts with ESP32 records and stores the data.

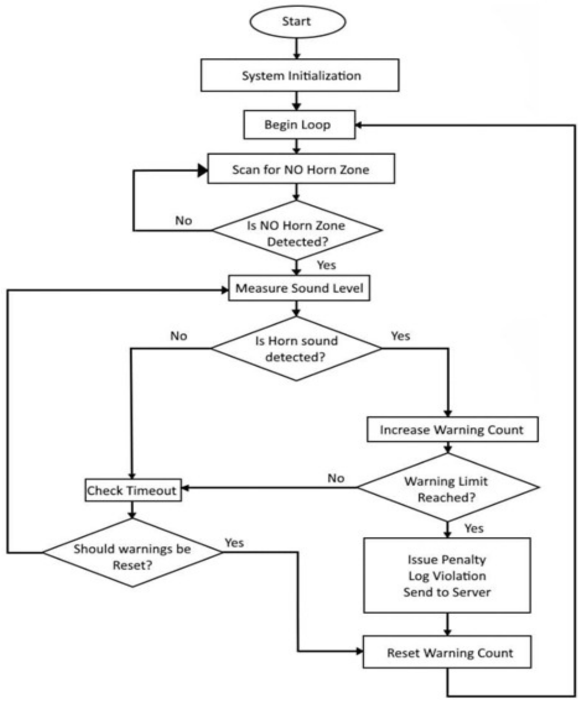

Fig.2. Flowchart of the Proposed System

IV. Methodology

This system consists of a Bluetooth Low Energy (BLE) transmitter designed to automatically regulate horn usage within designated "No-Horn Zones" with the help of a sound detection module. The methodology for the proposed IoT based system involves various steps that enable alerting and monitoring drivers in the No Horn Zone.

A. Problem statement

The present work addresses these shortcomings by introducing an IoT-driven automatic horn regulation model that integrates BLE technology for detecting restricted zones and sound sensors for identifying horn activity in real time. This setup enables vehicles to recognize No Horn Zones automatically and control horn usage accordingly. The approach not only promotes responsible driving habits but also supports smart city objectives aimed at reducing noise pollution in urban environments.

B. Objectives

- To create a system to detect the unnecessary usage of horns in restricted areas.
- Create a system that penalizes the driver for unnecessary use of horn.
- To store the violation in a cloud database

C. Limitations

- Relies on only sound to detect the horn usage.
- Requires the access to the internet to communicate with the cloud.
- Relies on battery for power.

D. Simulation Process

- BLE-Based Zone Recognition: BLE beacons are placed across restricted regions, transmitting signals continuously within a defined range. An ESP32 microcontroller installed in the vehicle which continuously scans its surroundings for these BLE signals. When the received signal strength exceeds the set threshold (−70 dBm in this implementation), the vehicle is considered to be in a restricted zone.

- Horn Activity Detection: Sound sensor connected to the ESP32 continuously measures the surrounding noise levels. If the sound intensity crosses the set limit (400 units in this prototype), the horn is considered to be activated. This threshold is adjustable and can be tuned accordingly.
- Warning and Violation Logging: Every horn activity detected within a restricted zone is registered as a violation. A warning is generated for the driver, and the offense counter is increased. To maintain fairness, a time-based reset mechanism clears previous warnings if no further violations occur within 30 minutes.
- Penalty Enforcement: Once the number of warnings reaches the set limit (three violations in this case), the system activates the penalty mechanism. Details such as vehicle's registration number and the timestamp are recorded. These records can later be shared with traffic authorities for regulatory action.

E. Design

The proposed Zone-Based Horn Control System is divided into two main parts: the Zone Recognition Unit and the Horn Monitoring and Control Unit. The two units work together to detect restricted zones and control horn activity. BLE transmitters placed in No Horn zones continuously transmit low power signal. These low power signals are detected by the ESP32 in the vehicle when the signal strength crosses a set limit the system considers that the vehicle has entered a restricted area. Now the sound sensor checks the horn noise level then the ESP32 compares the reading with the set limit and if it detects that the noise level is above the limit it records a violation. This system continuously scans for BLE signal, checks the sound level and records the violation which can be sent to a cloud server.

TABLE I: REPRESENTS FINAL OUTPUT THROUGHOUT THE STUDY

Test Case	Input	Expected Output	Actual Output	Status
T1	Horn Sound Detected	Warning 1	Warning 1	Passed
T2	Horn Sound Detected	Warning 2	Warning 2	Passed
T3	Horn Sound Detected	Warning 3	Warning 3	Passed
T4	Horn Sound Detected	Penalty	Penalty	Passed

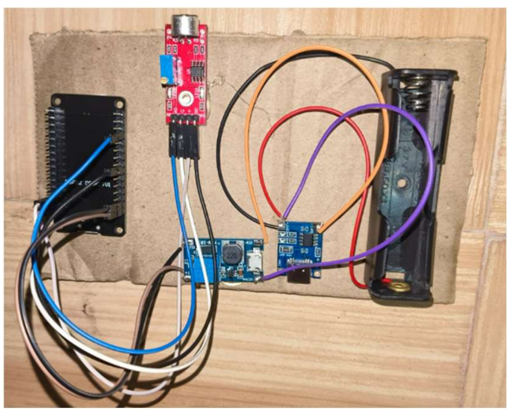

Fig. 3

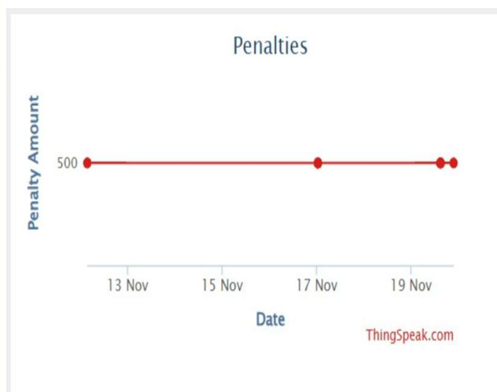

Fig. 4

Fig.4.1: Implementation system of the proposed idea where the sensor is connected to ESP32, sound sensor, voltage regulator and power supply (3.7V).
Fig.4.2: The graph shows the penalty amount over a period of time.

V. IMPLEMENTATION AND RESULTS ANALYSIS

Zone Based Horn Control System was designed and tested using an ESP32, sound sensor, voltage regulator and a power supply. BLE transmitters were setup. The range of the signals from this transmitter is about 10-20 meters depending on the surroundings. The ESP32 in the vehicle scanned for the signals and identified when the vehicle entered a No Horn Zone. Inside the No Horn Zone the sound sensor monitored the horn when the horn sound exceeded the set limit, the ESP32 gave a warning. Continued use of horn resulted in the system recording the violation and it penalize the driver. This entire process takes around 1-5seconds.

Whenever the system detects three violations, it automatically penalizes the driver and uploads this information to the server (in this case, ThingSpeak). The data stored on ThingSpeak can then be shared with the authorities, allowing them to take action and issue penalties to repeated offenders. Overall, the test results showed that the system was stable and dependable under different environmental conditions. The combination of BLE based zone recognition and sound level detection is affordable, scalable, and real time solution to address vehicular noise pollution.

VI. FUTURE SCOPE

There are several ways in which the system can be upgraded or improved in the future. The one major upgrade can be adding GPS. This would make the system more reliable and easier to maintain. Machine learning (ML) can be used to accurately detect more sounds. Solar panels can be used to make the system eco-friendlier. The hardware size can be reduced which would make it easier to be installing in vehicles. With these improvements the system could be more efficient reliable and sustainable.

VII. CONCLUSION

The Zone-Based Horn Control System uses BLE transmitter and a sound sensor to control the horn usage in a No Horn Zone. It is a low cost and efficient system which makes it suitable for schools and hospitals with some future improvements like GPS and ML, it can become a powerful tool for noise management.

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