MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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DEPARTMENT OF MECHATRONICS

SONIC AWARE: REAL TIME WARNINGS OF SOUND LEVEL

MTE 3262-IIoT LAB

Submitted by

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ABSTRACT

Sound pollution is a growing concern in our cities and workplaces, and it can have serious health implications for individuals. To address this issue, I have tried developing a sound monitoring system that utilizes the power of the Industrial Internet of Things (IIoT). The IIoT is a network of connected devices, sensors, and machines that collect and share data in real-time. By combining an ESP8266 microcontroller with a sound sensor and a Telegram bot, we create a system that can detect sound levels and notify users via a messaging app. This project not only provides a solution for noise pollution but also demonstrates the potential of the IIoT in improving workplace safety and health.

The healthy level of exposure to sound is generally considered to be below 85 decibels for an extended period. However, according to the World Health Organization (WHO), more than 1 billion young people are at risk of hearing loss due to exposure to loud sounds. This is particularly concerning because loud noise exposure is a preventable cause of hearing loss. With the implementation of a sound monitoring system like the one described in this project, it becomes easier to identify and mitigate potential sources of noise pollution. The integration of this system into an IIoT environment also enables real-time monitoring and management of sound levels, making it a valuable tool in ensuring a healthy and safe work environment.

IIoT allows for the continuous monitoring of sound levels, enabling users to take immediate action if noise levels exceed safe limits. This functionality has applications in various industries, including manufacturing, construction, and transport. It can detect machinery malfunctions and prevent accidents in manufacturing plants and prevent hearing loss in workers exposed to high noise levels in construction sites. Furthermore, this system can be used to monitor noise levels in public places such as airports, train stations, and concert halls to ensure public safety.

By implementing this sound monitoring system, we aim to raise awareness about the importance of sound control in the workplace and demonstrate the potential of IIoT in improving safety and health. With further development, refinement and usage of sensors and board of better specifications and calibration, this project could have widespread applications in industries where noise pollution is a concern.

1. INTRODUCTION

In today's fast-paced world, noise pollution is becoming an increasingly pressing issue, affecting both our physical and mental health. Excessive noise levels can lead to hearing loss, sleep disturbance, and even cardiovascular disease. Therefore, there is a need for effective noise monitoring systems that can detect and control noise levels in real-time.

In the field of Industrial Internet of Things (IIoT), there have been various developments in sound level monitoring systems. These systems are designed to provide real-time monitoring of sound levels in industrial and public settings. They can help detect potential malfunctions in machinery, prevent accidents, and ensure compliance with safety regulations.

One of the challenges in this field is to develop systems that are both accurate and cost-effective. While there are many commercially available sound level meters, they can be expensive and often require trained personnel to operate them. Therefore, there is a need for low-cost and user-friendly systems that can be easily implemented in various settings.

The proposed project aims to address this challenge by developing an IIoT-based sound level monitoring system that is both accurate and cost-effective. The system will use low-cost sensors and wireless communication modules to transmit data to a central monitoring station. The data will be processed using advanced signal processing techniques to filter out noise and provide accurate sound level measurements.

Therefore, to make a point, even if we cannot deploy the current project at industrial level without further additions and improvements, this can very well find it’s application at home, offices, recreational spots where user will be notified via notifications on telegram since everyone is at phone and available to check their social media notifications and necessary actions could be taken.

2. PROBLEM STATEMENT

Noise pollution is nevertheless a concern in a variety of settings, including industrial workplaces, construction sites, and public areas, despite the established consequences. Conventional sound monitoring devices frequently have a limited range of functions and demand manual data collection and analysis. This makes it challenging to identify possible noise dangers in real-time and can be time-consuming and error prone.

Thus, there is a need for a system that can monitor noise levels in varied settings and send warning signals to avoid being exposed to such levels of noise in a more effective and efficient manner and furthermore to maintain compliance with noise rules and to create a healthier and safer environment for workers and the public.

3. OBJECTIVE

The main objective of this project is to create an IoT-based system for real-time sound level monitoring to increase workplace safety and prevent hearing impairment. The risk of hearing loss and other related health issues will be reduced because the system will continuously monitor the sound levels and send out real-time alerts when the levels go above acceptable limits. The system's ability to track noise levels over time as well as providing insights concerning noise pollution in various locations will also be useful in assisting enterprises in identifying and resolving noise-related problems. With the help of this project, a low-cost, scalable solution that is adaptable to a variety of sectors as well as in our own homes and daily lives, will be made available. It will also be simple to integrate into current infrastructure.

4. COMPONENTS USED

1. ESP8266 Node MCU Wi-Fi Module

Technical Specifications:

Operating Voltage	3.3V
Input Voltage	4.5-10V
Clock Speed	80MHz
Flash Memory	4MB (64KB)
Digital I/O Pins	11
Analog I/O Pins	1
ADC Range	0-3.3 V
Temperature Range	-40C – 125C

2. Sound Detection Sensor

Sound is detected via microphone and fed into an LM393 op amp. The sound level set point is adjusted via an on-board potentiometer. When the sound level exceeds the set point, an LED on the module is illuminated and the output is sent low.

Technical Specifications

Operating Voltage	3.3-5 V
Operating Current	4-8 Ma
Frequency Response	20Hz-20kHz
Size	32mm x 17mm x 12mm

5. METHODOLOGY

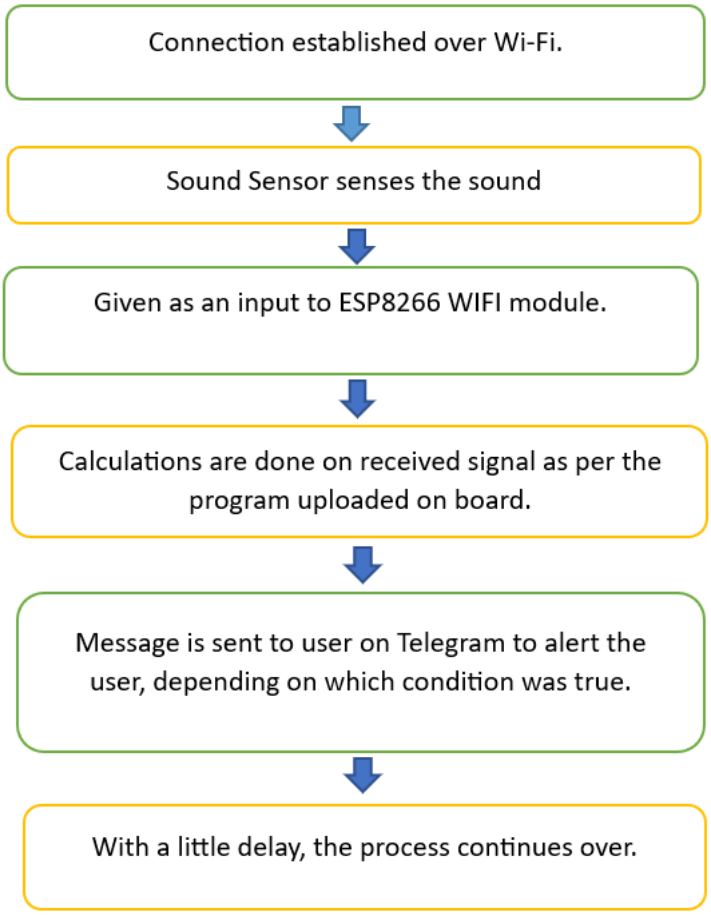
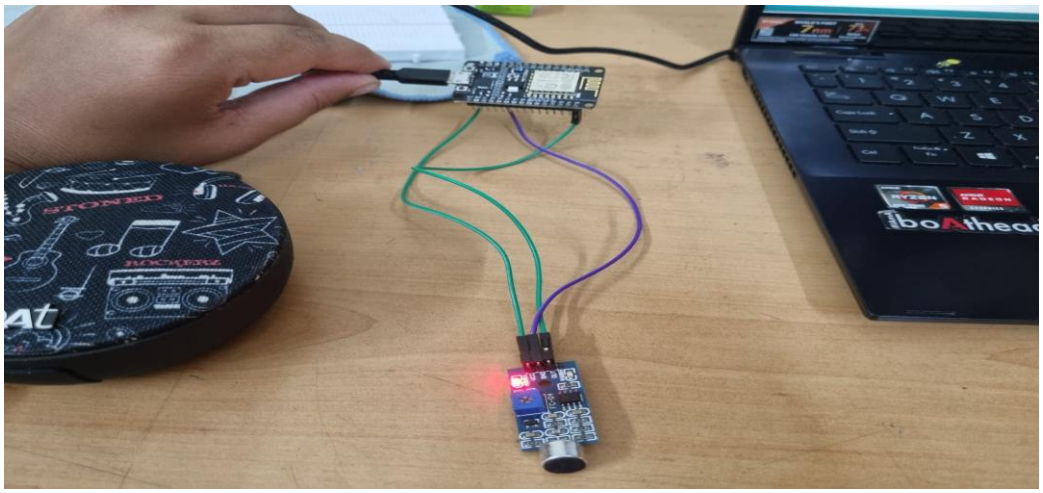


Figure 1: Flowchart for Real time data collection and warning alerts

5.1 CONNECTIONS BETWEEN HARDWARES

Connect the sound sensor module to the ESP8266 board using following pin configuration:

- Sound sensor module VCC to ESP8266 3.3V/Vin
- Sound sensor module GND to ESP8266 GND
- Sound sensor module D0 to ESP8266 GPIO16



5.2 Flow of Code:

- Install the necessary software: Install the Arduino IDE software and the required libraries including ESP8266WiFi, Wire, WiFiClientSecure, UniversalTelegramBot, and ArduinoJson.
- Obtain the required credentials: Obtain the credentials required for this project including the Wi-Fi network SSID and password, Telegram bot token, and chat ID.
- Set up the Telegram bot: Set up a Telegram bot using the BotFather and obtain a bot token.
- Obtain the chat ID: Get the chat ID for the Telegram account or group that you want to receive the sound level alerts. Use the @myidbot to get the chat ID.
    - The ESP8266 connects to the Wi-Fi network and gets an IP address.
    - Then, set up the Telegram bot with the provided bot token and the client with the root certificate for api.telegram.org.
    - The program retrieves the current time via NTP.
    - The ESP8266 starts looping through the main loop function.
    - Sound sensor value is read and starts a sample window for 50 milliseconds.
    - Peak-to-peak amplitude of the sound signal is calculated and calibrates it for decibels.
    - After that as and how the volume is increased or

decreased and recorded by sensor and is being calculated, an image along with the message meeting the condition is sent to the user on their Telegram.

- If the volume is at a higher level than it should be, a warning is also displayed to the user.
- The program waits for 1.5 seconds before sending a new message to avoid spamming the Telegram bot.

- Upload the code: Connect the ESP8266 module to the computer and upload the code to the ESP8266 module using the Arduino IDE.
- Test the system: Turn on the sound sensor and monitor the serial output of the ESP8266 module to ensure that the sound sensor readings are being accurately received by the module. Carefully, observe the alerts being sent to the Telegram when the sound level reaches a certain threshold. The use of Telegram Bot provided a convenient and user-friendly interface for receiving the sound level notifications.

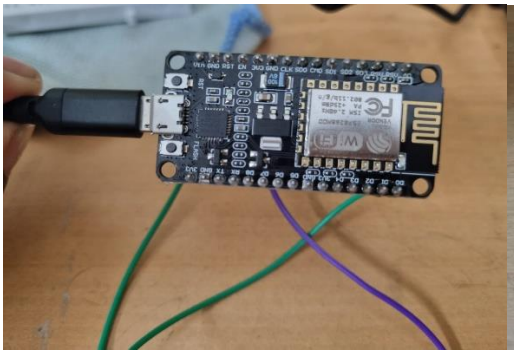
6. RESULTS AND CONCLUSION

This project intended to create a Telegram Bot-based sound sensor system utilizing the ESP8266. The project was successfully executed, and the system was able to detect the sound level and send corresponding messages to the user on Telegram. Based on a calibrated decibel range, the device was able to distinguish between quiet, medium, and loud sound levels. The use of Telegram Bot provided a convenient and user-friendly interface for receiving the sound level notifications.

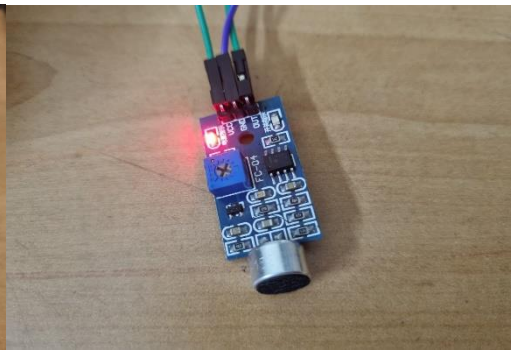
The project succeeded in its goal of developing a sound sensing system that can be utilized for a variety of purposes, including noise monitoring in public spaces, and sound level monitoring in households or office environment. The technology is easily adaptable to diverse sound level monitoring needs.

The system can be easily customized to suit different sound level monitoring needs. With the integration of Telegram Bot, the system provides a convenient and efficient means of receiving sound level notifications in real-time.

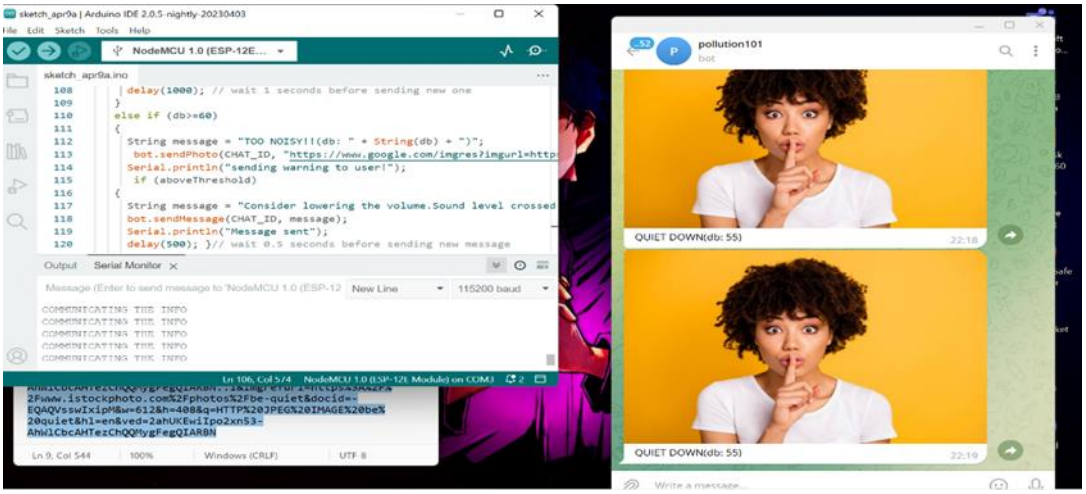
In conclusion, the study has shown the viability of combining ESP8266 and Telegram Bot for sound sensing applications. Future work may focus on increasing the precision of sound level readings and investigating additional potential uses for the system.



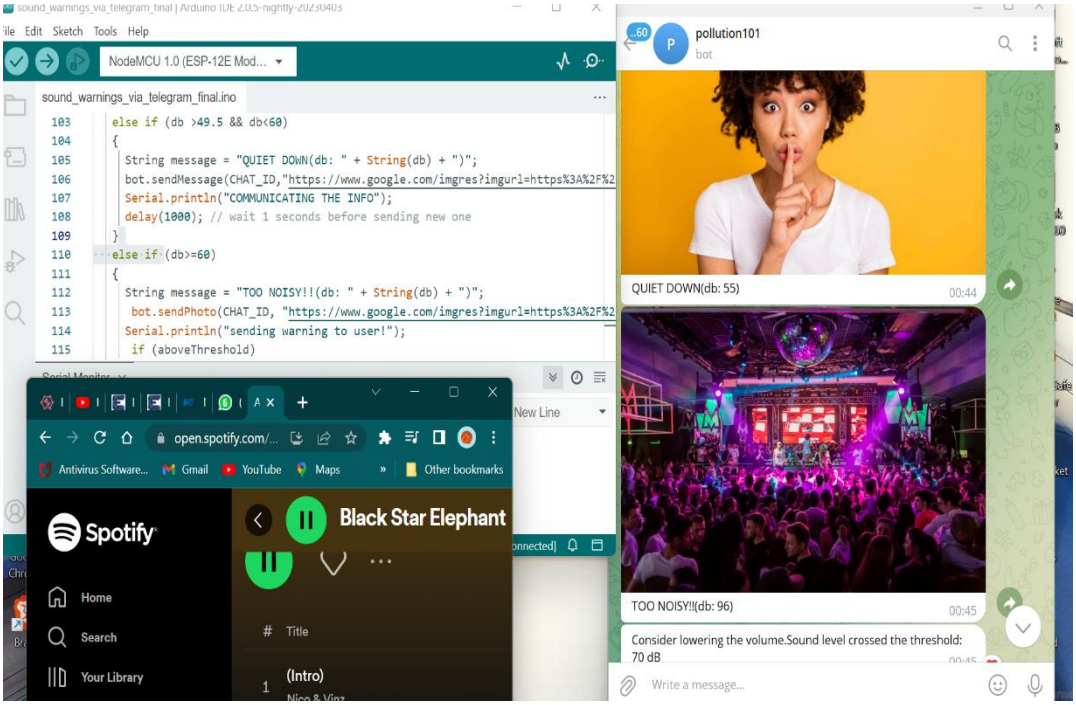
ESP8266 NODE-MCU



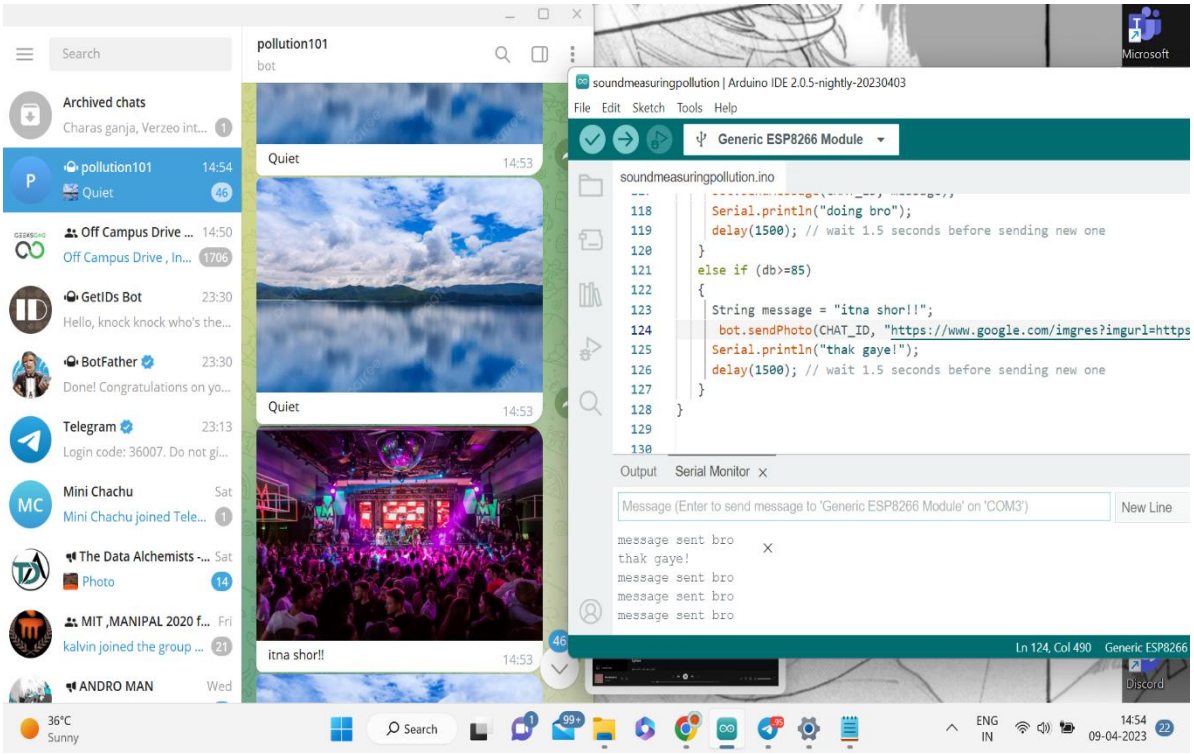
FC-04 Sound Module



Message displayed on serial monitor for 55 dB and user receives warning on Telegram to quiet down.



As the volume increases from 55 dB to 96, user receives warning to lower the volume.



When the sound is low or at a hearable level, user receives ‘Quiet’ as message.

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