

## ARDUINO UNO R3 MICROCONTROLLER-BASED DESIBEL (dB) METER DEVELOPMENT ALERT(CASE STUDY SDN 04 TAPAKTUAN)

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### ABSTRACT

Noise is an environmental problem that arises due to the rapid growth of communication, industrialization, transportation, space, musical instruments and population. The purpose of this research is to detect the frequency value of sound intensity that can cause deafness and sound frequency that is safe for human hearing. The sound intensity value detected by the sensor is displayed in Real Time through Lcd. This tool research uses three parts, namely control, input and output, where Arduino nano functions as a tool controller, sound sensor as an input that functions as a sound detector around, dfplayer and Lcd as an output that functions to display sensor readings in the form of numbers and emit sound. Sound sensor reading data uses 4 categories, namely 0-30 dB "very safe", 30-60 "safe", 60-90 "dangerous" and 90-100 "very dangerous", and the sound will sound according to the value displayed on the sound sensor to Arduino to facilitate the monitoring process. After the whole tool is assembled the tool is tested in two different places, namely Taman Pala and SDN 9 Tapaktuan South Aceh. The results of testing the tool in the nutmeg garden show a sound frequency number of 53.26 dB in the "safe" category, while the test results at SDN 9 show a frequency number of 98.93 dB in the "Very dangerous" category when the room is noisy.

### INTRODUCTION

The world of electronics is currently experiencing rapid development. Various components are evolving in terms of efficiency, function, benefits, and physical characteristics. The application of electronics can create tools that simplify and streamline work processes and protect hearing health. Noise is an environmental problem caused by the rapid growth of communication, industrialization, transportation, buildings, musical instruments, and population. Currently, the need for measurement tools is highly significant in every aspect of the electronics industry [1].

The presence of measurement tools is also highly beneficial in events, music concerts, mechanical machinery, recording studios, and electronics-related work in both industrial and mechanical sectors, as well as for hearing health. Noise measurement devices measure the intensity of sound produced by a sound source. The ear, seemingly like magic, converts incoming sound energy into eardrum oscillations, then into movements of the middle ear bones, creates waves on the basilar membrane, and finally transmits nerve impulses to the brain. The brain processes this information, interprets it, and psychologically determines the meaning and value of the sound. The human hearing frequency range is generally considered to be 20–20,000 Hz. The upper range varies significantly between individuals and decreases with age and exposure to noise. The amplitude of the hearing threshold (~0 dB) to the discomfort and pain threshold (above 140 dB) [2].

Development of the Design System Design of a decibel (dB) meter based on an Arduino Uno R3 microcontroller using a sound sensor to detect sound intensity, so that the sound intensity read by the sensor is sent to the Arduino as the controller, and the data read by the sensor is displayed on the LCD. If the sound sensor detects sound intensity exceeding 100 to 500 dB, an alarm will sound.

The development of a decibel (dB) meter using the Arduino Uno R3 microcontroller represents a significant advancement in sound measurement technology. This device captures sound levels effectively, providing valuable data for various applications, including environmental monitoring and audio performance optimization. The following sections outline the key components and functionalities of this dB meter. Microcontroller: The Arduino Uno R3 serves as the central processing unit, managing data from the sound sensor and controlling output displays (Tuwaidan et al., 2015). Sound



Sensor: Utilizing a MAX4466 sound sensor, the device measures sound intensity, converting acoustic signals into electrical signals for processing (Lapono & Pingak, 2018). Display Interface: The results are displayed on a computer interface, allowing for real-time monitoring and data visualization, enhancing user interaction (Lapono & Pingak, 2018). Measurement Accuracy The dB meter demonstrates high accuracy, with measurement results closely aligning with standard sound level meters. For instance, a test showed an average difference of only 0.41 dB between the Arduino-based meter and a commercial device (Lapono & Pingak, 2018). The system is designed to function effectively in various environments, such as open spaces during the day and enclosed areas at night, ensuring versatility in sound measurement (Tuwaidan et al., 2015). This dB meter can be utilized in concert settings to monitor sound levels, ensuring compliance with safety regulations and minimizing noise pollution (Tuwaidan et al., 2015). Additionally, it can serve educational purposes, helping students and researchers understand sound dynamics and measurement techniques (Noori et al., 2013). While the Arduino-based dB meter offers numerous advantages, including cost-effectiveness and ease of use, it is essential to consider potential limitations, such as the need for calibration against professional equipment to ensure precision in critical applications.

### LITERATURE REVIEW

The development of a decibel (dB) meter using an Arduino Uno R3 microcontroller, as explored in the case study of SDN 04 Tapaktuan, involves leveraging the capabilities of modern electronics to measure sound pressure levels effectively. This project utilizes a microphone to capture sound, which is then processed by a pre-amplifier and the Arduino microcontroller to provide real-time dB readings. The system is designed to be efficient and functional, offering a practical solution for monitoring sound levels in various environments, such as concerts or urban settings. The integration of LEDs provides a visual indication of sound intensity, enhancing user interaction and awareness. Key Components and Functionality Microcontroller: The Arduino Uno R3 serves as the central processing unit, handling data from the microphone and controlling the output display (Tuwaidan et al., 2015). Microphone and Pre-Amplifier: These components capture and amplify sound signals, which are then converted into electrical signals for processing (Tuwaidan et al., 2015). LED Indicators: LEDs provide a visual representation of sound levels, flashing in response to changes in dB levels (Tuwaidan et al., 2015). Comparison with Other Arduino Applications Radiation Survey Meter: Similar to the dB meter, the radiation survey meter uses the Arduino platform for real-time data processing and display, showcasing the versatility of Arduino in different measurement applications (Rahman et al., 2016). Water Flow Meter: Another application of Arduino in measurement devices, highlighting its cost effectiveness and adaptability in various fields (Febriansyah, 2023). Broader Implications and Considerations While the Arduino-based dB meter offers a cost-effective and efficient solution for sound measurement, it is essential to consider the calibration and accuracy of such devices compared to commercial options. The flexibility of Arduino allows for customization and adaptation, but it may require additional validation to ensure reliability in professional settings. This highlights the balance between innovation and precision in developing microcontroller-based measurement tools.

### METHOD

The tools and materials required in the development of the design system for a decibel (dB) meter measuring tool based on the Arduino Uno R3 microcontroller consist of hardware and software, including: The hardware used in the development of the design system for a decibel (dB) meter based on the Arduino Uno R3 microcontroller includes:

1. Arduino Uno  
As the main controller of components in the Development of the Design System for a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller.
2. Sound Sensor  
As an input to detect sound frequency in the Development of the Design System for a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller.
3. I2C LCD  
As an output to display the frequency results detected by the sound sensor in the Design System for a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller.
4. Dfplayer  
A sound player for frequency warnings detected by the sound sensor. The software used in the design of the design system for the development of the design of a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller. is:
  1. Fritzing.0.9.0b.32.pc

- Used to simulate the system circuit of the Design Development Design of a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller.
2. Arduino 10 windows  
Used to upload programs in the system Design Development Design of a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller.

This block diagram is made to simplify the design process of the system tool Design of a decibel (dB) meter measuring tool based on the Arduino uno R3 microcontroller. The system circuit of this tool consists of 3 circuits, namely the input section, the control section, and the output section.

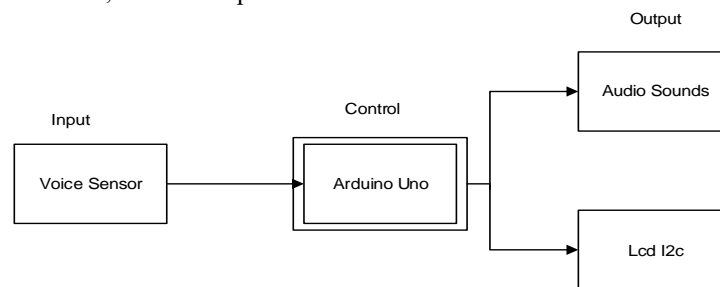


Figure 1. System Design Diagram

1. Input Section  
The input section consists of a sound sensor that functions as a sensor to detect sound intensity.
2. Control Section  
The control section consists of an Arduino Uno that functions as a controller for the entire circuit so that the circuit can work optimally.
3. Output Section  
The output section consists of an I2c LCD and Audio that function to display the results detected by the sensor.

Design and construction system for a decibel (dB) meter measuring instrument based on the Arduino Uno R3 microcontroller.

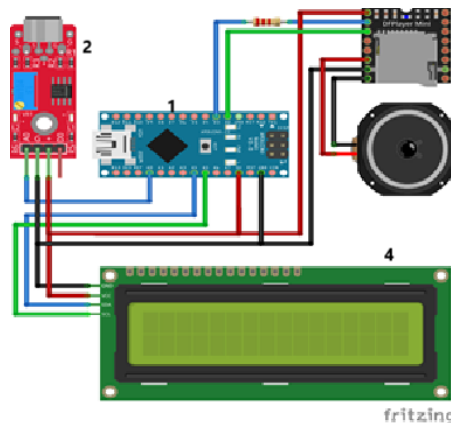


Figure 2. Tool Design

The LCD GND pin and vibration sensor pin are connected to the Arduino GND pin, the VCC pin of the vibration sensor and LCD are connected to the Arduino 5V pin A0, the vibration sensor is connected to the Arduino A0 pin, the LCD SDA pin is connected to the Arduino A1 pin, the LCD SCL pin is connected to the Arduino A2 pin. Working Principle of System Design System Design of decibel (dB) meter measuring tool based on Arduino uno R3 microcontroller, when Arduino starts analyzing all connected sensors, the sound sensor starts detecting audio sound around the sensor, if the sensor detects sound 0 - 30 dB (very safe), 30 - 50 (safe), 50-90 (dangerous), 90 - 100 (very dangerous) And the sensor reading results will be displayed on the LCD and will emit a human warning sound.

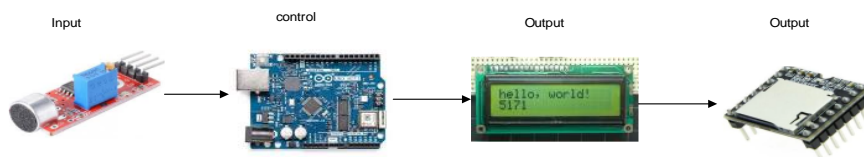


Figure 3. Tool Working Principle

Flowchart is a chart or image that shows the process flow and relationships of a program. Flowchart is needed to explain the program flow that is made in graphic form so that others can understand the flow that has been made. The following is a flowchart to detect the design of a decibel (dB) meter measuring instrument based on the Arduino uno R3 microcontroller.

The flowchart above explains the flow of how the program on Nodemcu has 2 processes, namely:

1. Arduino is tasked with controlling the analysis of the connected sensor components and ensuring that all sensors are working according to the command so that Arduino can send data.
2. The sound sensor will work automatically if the sensor detects the sound intensity on the Audio exceeding 81 - etc. dB, then the data sent from the sensor is displayed on the LCD in the form of sound frequencies that have been converted by the sensor in the form of numbers and display text and warning sounds.

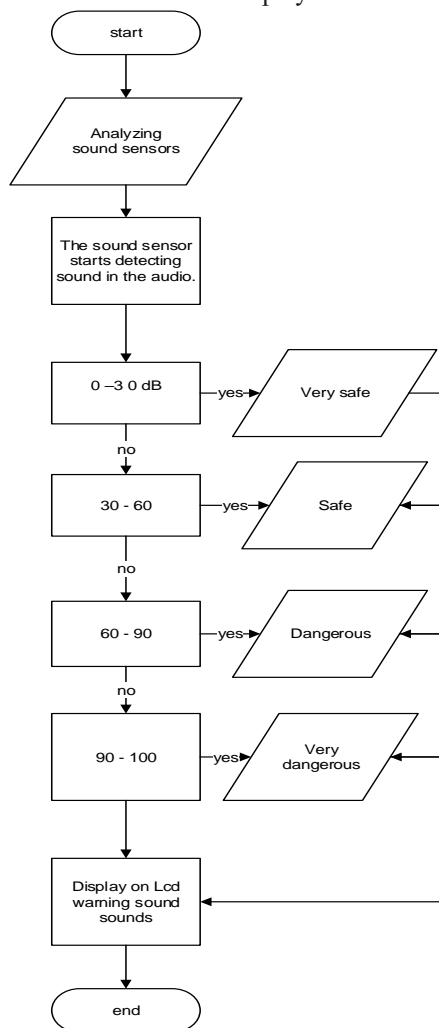


Figure 4. Programme of Flowchart

### RESULT

The design of a decibel (dB) meter based on the Arduino Uno R3 microcontroller is designed to measure noise levels that can damage hearing if done repeatedly. With this tool, it can minimize noise levels that can damage hearing. All components of the tool are interconnected with each other, the Arduino which functions as a controller will control all sensor components that have been connected according to the commands that have been programmed in the Arduino IDE application. Then the sound sensor will detect the noise level around the sensor so that the data will be sent to the Arduino so that the Arduino will process the data detected by the sound sensor and sent to the LCD converted in the form of numbers and sounds with 4 categories, namely 0 - 30 dB "very safe", 30 - 60 "safe", 60 - 90 "dangerous" and 90 - 100 "very dangerous", and the sound will sound according to the value displayed on the sound sensor to the Arduino to facilitate the monitoring process.

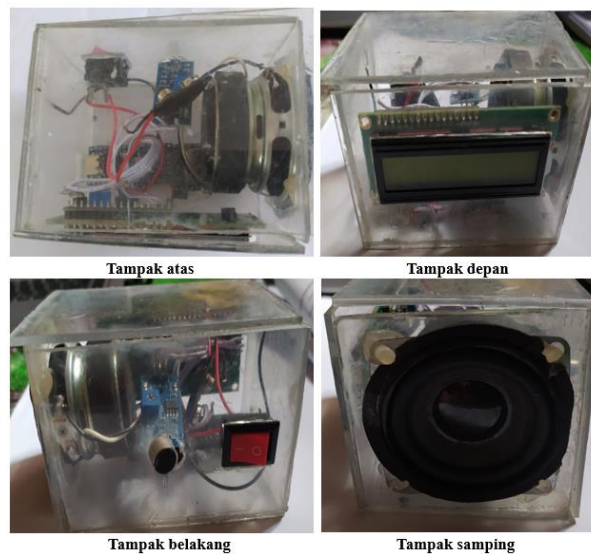


Figure 5. Alert System Electronic Circuit

Based on the image above where all sensors are connected to each other, the tool can be used according to the commands that have been programmed in the Arduino Idea application. So that the tool can be used according to needs. After the system is designed, it is necessary to carry out a testing phase on the tool to determine whether the sensor works according to the commands that have been programmed in the Arduino Ide application. When the tool is run, the sound sensor will detect the noise level around the sensor and will send data from the reading to the Arduino, so that the Arduino will process the data and then send it to the LCD and convert it into numbers and sounds to facilitate the monitoring process. In this case, the researcher conducted 10 tests to determine the level of accuracy of the sensor reading, which was carried out in two different places, namely Taman Pala Indah and SDN 9 Tapaktuan.



Figure 6. The process of testing the tool in the beautiful nutmeg park



Figure 7. The process of testing the equipment at SDN 9 Tapaktuan

From the two testing processes above, the steps taken in running the tool are that all component cables are ensured to be connected to the tool, the current used is 5 Volts, the USB that meets the 5 Volt adapter current is connected to the tool. After being turned on, wait 20 seconds for the sensor reading loading process, and the tool is ready to run. Based on the results of the tool test, when the tool starts running, the Arduino which functions as a controller will control all sensor components. The sound sensor detects the sound around the sensor and will send the sensor reading data to the Arduino to be processed so that the Arduino sends the data to the LCD and produces a sound in the form of audio, making it easier to find out the value of the sound through the LCD.

Table 1. Sensor test results at Pala Indah Park

No	Testing	Sound Sensor Reading	LCD Output	Audio sound	
1	First	40.83 dB	Very safe	On	Off
2	Second	30.22 dB	Very safe	√	
3	Third	10.11 dB	Very safe	√	
4	Fourth	13.58 dB	Very safe	√	
5	Fifth	16.83 dB	Very safe	√	
6	Sixth	6.32 dB	Very safe	√	
7	Seventh	60.93 dB	Very safe	√	
8	Eighth	26.73 dB	safe	√	
9	Ninth	50.83 dB	Very safe	√	
10	Tenth	61.13 dB	safe	√	

The table data above the first study was conducted in a room by taking samples 10 times using a sound sensor to determine the level of sensor accuracy in capturing sounds around the room. If the sound sensor detects a sound around the sensor, the data will be sent to the Arduino module for processing. After being processed, the Arduino sends the data to the LCD in 4 categories, namely, very safe, safe, dangerous and very dangerous, it will emit audio in the form of an alarm in the form of sound.

Table 1. Results of tool testing at SDN 9 Tapaktuan

No	Testing	Sound Sensor	LCD Output	Audio sound	
		Reading		On	Off
1	First	40.83 dB	Sangat aman	On	Off
2	Second	30.22 dB	Sangat aman	√	
3	Third	64.11 dB	Aman	√	
4	Fourth	68.58 dB	Aman	√	
5	Fifth	70.83 dB	Aman	√	
6	Sixth	99.00 dB	Berbahaya	√	
7	Seventh	98.93 dB	Berbahaya	√	
8	Eighth	90.73 dB	Sangat berbahaya	√	
9	Ninth	100.83 dB	Sangat berbahaya	√	
10	Tenth	111.13 dB	Sangat berbahaya	√	

Based on the data in the table above, the second study was conducted at SDN 9 Tapaktuan located on Jl. Tapaktuan-Subussalam no 6, kp hulu Kec. Tapaktuan, South Aceh Regency. The study was conducted in room VI A where the number of students was 41 students. When the device is running, the sound sensor begins to detect the sound in the classroom. When the atmosphere in the classroom is quiet, the data detected by the sound sensor will be sent to the Arduino module so that the Arduino processes the data and then sends it to the LCD and converts it into numbers and sounds, namely with the category "very safe". And vice versa when the position in the classroom is noisy, the numbers and sounds displayed are in the category "very dangerous".

## DISCUSSION

From the title of the design of a decibel (dB) meter based on the Arduino Uno R3 microcontroller, the following suggestions can be made:

1. The design of a decibel (dB) meter based on the Arduino Uno R3 microcontroller should be further developed using an Internet of Things-based smartphone.
2. The design of a decibel (dB) meter based on an Arduino Uno R3 microcontroller can be applied in the community to determine the risk of hearing loss from continuously listening to sounds above 90 dB.

## CONCLUSION

After designing and assembling a decibel (dB) meter based on an Arduino Uno R3 microcontroller and then testing the device, both individually and as a whole, the following conclusions can be drawn:

1. The sound sensor captures all sounds around the sensor and displays them on the LCD screen and through audio output.
2. The LCD screen displays the sound levels around us.
3. If the sound level exceeds 90 dB, the device emits a warning sound indicating extreme danger, thereby minimizing the risk of hearing loss.

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