



Noise Detection System in The Classroom Using Sound Sensors and NodeMCU ESP6288

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ABSTRACT

The educational environment is the process of educational activities, so the environment is expected to be comfortable and avoid noise. Noise can be disturbing, such as the ringing of mobile phones or sounds produced by humans. Sound noise in a room can cause loss of concentration, so that indoor activities can be disrupted. Based on these problems, it is necessary to have a tool used to detect the noise level of sound in the classroom. Therefore, a noise detection system in the learning room uses a sound sensor based on NodeMCU ESP8266, which can send email notifications and be monitored through the thingier.io application. The location of this research is in a classroom. This tool consists of hardware (hardware) including NodeMCU ESP8266, PIR Sensor, LCD 16x2 I2C, Sound Sensor, DF Player Mini Mp3, Speaker, and Android application software. The working principle is that if the decibel value exceeds the predetermined value, the room user will hear a warning sound and send an informational text in the form of an email notification. Based on tests on several parameters, testing using the sound of a drilling machine obtained an error value of 8.7%. In music sounds, an error value of 7.7%, and inhuman screaming sounds, an error value of 8.1%. The tool has been successful in the test results and can be implemented in the classroom.

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1. INTRODUCTION (10 PT)

The educational environment is where all educational activities occur, so the educational environment is expected to be comfortable and avoid excessive noise. Based on the Decree of the State Minister of Environment of the Republic of Indonesia Number 48 / MenLH / Year 1996, noise is unwanted noise from a business or activity in a certain level of time that can cause health problems and environmental comfort [1]. Voice plays an essential role in communicating. However, noise can be noise pollution or bothersome noise. All human life activities cause noise sources. Any noise can cause environmental discomfort that interferes with activities. Noise can result in disturbances in concentration, communication, and other psychological

disorders (stress, fatigue, emotions). Potential noise can also interfere with human health. Noise can result in increased blood pressure and pulse rate and impair hearing function ranging from temporary deafness to persistent deafness. Hearing damage depends on the degree and the length of noise exposure [2].

One place that is expected to avoid noise or noise in the educational environment is a learning/teaching room. A classroom is used to gain knowledge, so a comfortable place is needed from the disturbances in the room. Noise in the classroom is still common, especially from the users. Noise or noise in a room can cause loss of concentration so indoor activities can be disrupted. Noise is generated by sounds that can interfere with the room, such as the ringing of mobile phones or sounds produced by humans. In addition, it can reduce the effectiveness of classroom use. Existing officers have made efforts to overcome this, among others, by warning users who make noise (noise), but officers certainly do not always warn or control the situation at all times due to the limited workforce and others [3].

Based on these problems, it is necessary to have a practical tool that is easy to use, where the tool can measure the noise level in the classroom. Therefore, a noise detection system using a NodeMCU-based sound sensor ESP8266 was designed. This tool uses a sound sensor for noise detection and a PIR Sensor for motion detection. In processing sound, DF Player Mini is used as a sound file format, the PAM8403+Potentio Module as a sound amplifier, and a display appears on the LCD for output. At the same time, the warning system uses loudspeakers to make a sound when the noise occurs in the classroom. The working principle, if the decibel value exceeds the predetermined value, the user of the room will hear a warning sound. This tool can detect a movement and measure the decibel value by sending an email notification, and detection data from the sensor can be monitored through the web or thinger.io application on Android.

The journal of noise detection systems and voice alerts explains noise detection systems in hospitals where there should be no noise because as a medium of recovery from health problems, but some rooms in hospitals are very high in noise. One is in the inpatient room, starting from the voices of health workers and visitors. This noise interferes with the patient's healing stage, psychologically impacting discomfort, concentration, and irritability. A detection system and voice alert are needed as controls in the hospital. This system uses microcontrollers with ATmega 8585, ISD 2560, and Electric Condenser Microphone (ECM) equipment. The result will result in a system with a display on the LCD unit decibel (dB). The output is a voice message (Voice Alert) based on the maximum noise value limit. This system will provide patient comfort and make it easier for inpatient room staff to control the condition of the room and patients [4].

The journal of noise level indicators in the workshop room explained the creation of a tool to warn workers to the status of whether it is safe according to the regulations of the Minister of Manpower and Transmigration Number Per.13 / Men / X / 2011 Year 2011 concerning the Threshold Value of Physical Factors and Chemical Factors in the Workplace. This research was carried out by making an indicator tool to provide information on the status of noise intensity and dB values for workers. Thus it can prevent workers from hearing loss in a productive age. This indicator will detect noise in the workshop room. The sound sensor uses an analog sound sensor v2. This sensor will send data to the Arduino microcontroller. Then the Arduino microcontroller will process the data according to the program that has been created. Data that the Arduino microcontroller has processed will be displayed with the alerts on the LCD, LED, and buzzer, for the LCD will display the status of safe, alert, and danger. For notification, the LED light will light up according to the status displayed on the LCD. For green light indicates safe status, a yellow light indicates alert status, and a red light indicates dangerous status. The buzzer will sound if the noise status is alert and dangerous [5].

2. METHOD

2.1 Mechanical Design

Mechanical design using SketchUp software. The design of this tool shows a picture of a tool that will be worked on and tested. The table shaped is designed with a width of 40 cm and a height of 82 cm. Made from wood, acrylic, and iron. There is a box in the middle of the table to place the components. The mechanical design is seen in Figure 1, and the dimensions or sizes in the mechanical design can be seen in Figure 2.

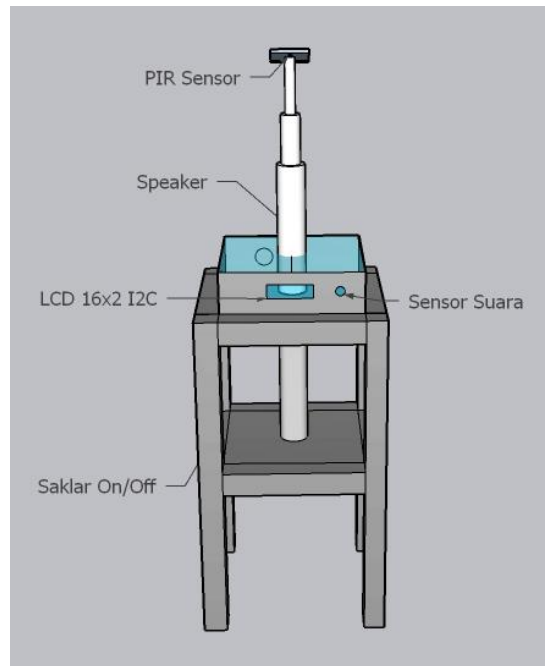


Figure 1. Mechanical design

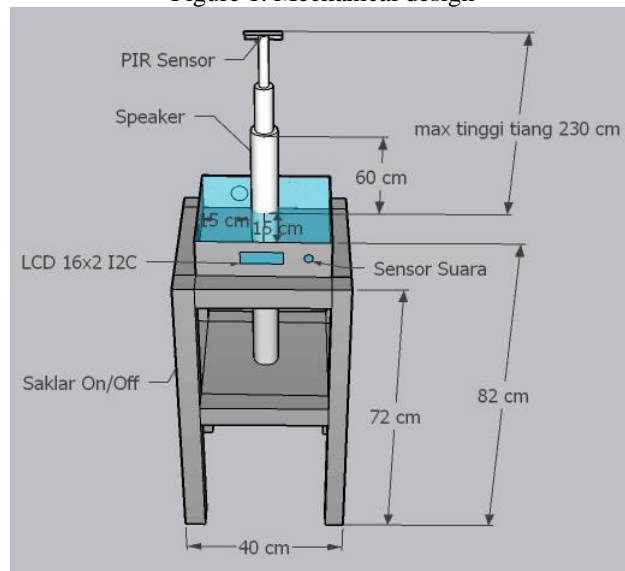


Figure 2. Dimension

2.2 Android App Design

This design displays the sensor measurement results in the noise detection system. It will be displayed as a column of numbers or letters for sensor results to be displayed and sent via email. The sensor's readings are displayed in real-time on each measurement result in the thinger.io system. The design display on the thinger.io application on Android can be seen in Figure 3.

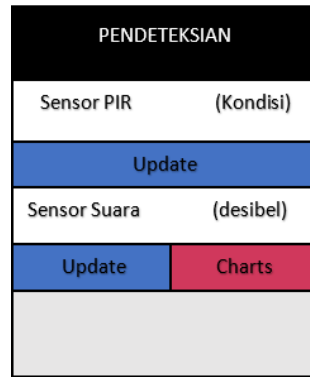


Figure 3. Example of thinger.io display on Android.

In general, thinger.io is one of the MQTT (Message Queuing Telemetry Transport) server service providers for IoT (Internet of Things). This service can monitor data from sensor measurement results through NodeMCU ESP8266, connected through a wifi network using subscribe and publish facilities.

2.3 Hardware Block Diagram

A block diagram is a process diagram for systems specializing in engineering activities. Its manufacture aims to show the working principle of the entire network and simplify the process of designing tool making. The hardware block diagram of this appliance system can be seen in Figure 4.

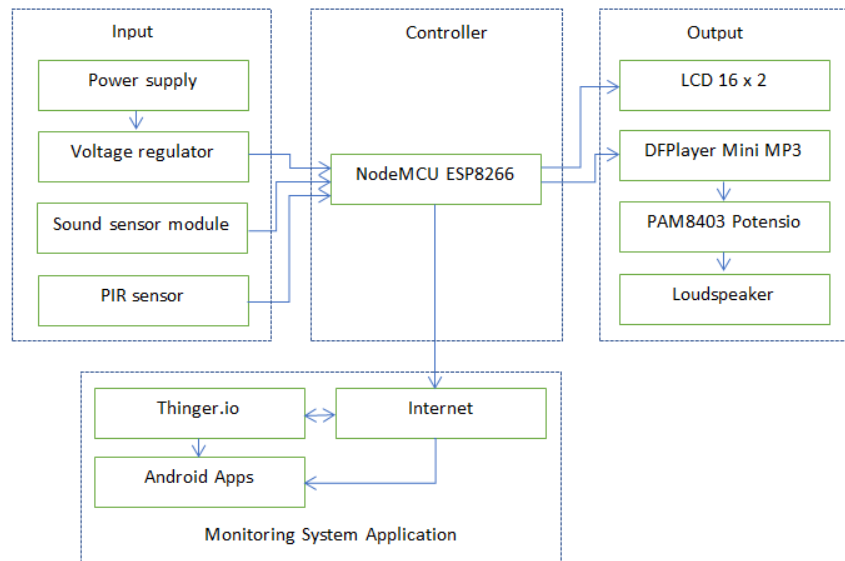


Figure 4. Hardware block diagram.

Based on the hardware block diagram above, the workings of the tool system made are when the device is turned on, the input current from the power supply voltage enters the stepdown to be lowered from 12V to 5V to supply to the circuit. Then make settings on the sensor by giving the desired program command. The NodeMCU ESP8266 microcontroller is an electronic circuit controller—the internet access to connect microcontrollers with thinger.io. The output in a 16 x 2 I2C character LCDs conditions (silent/noisy) and dB values on reading values from the sound sensor, followed by the speaker output turning on when the dB value exceeds a predetermined value. The thinger.io application monitors PIR and Sound sensor reading data and

can send email notifications. The existence of block diagrams can produce benefits for various parties. The benefits in question are such as, As a quick identification tool, a measuring tool or parameter of system success, and a tool for evaluating processes in the system.

2.4 Flowchart

The flowchart is a standard for describing processes. A flowchart illustrates the steps, sequences, and decisions to perform a process in a program. The flow diagram of this tool system can be seen in Figure 5.

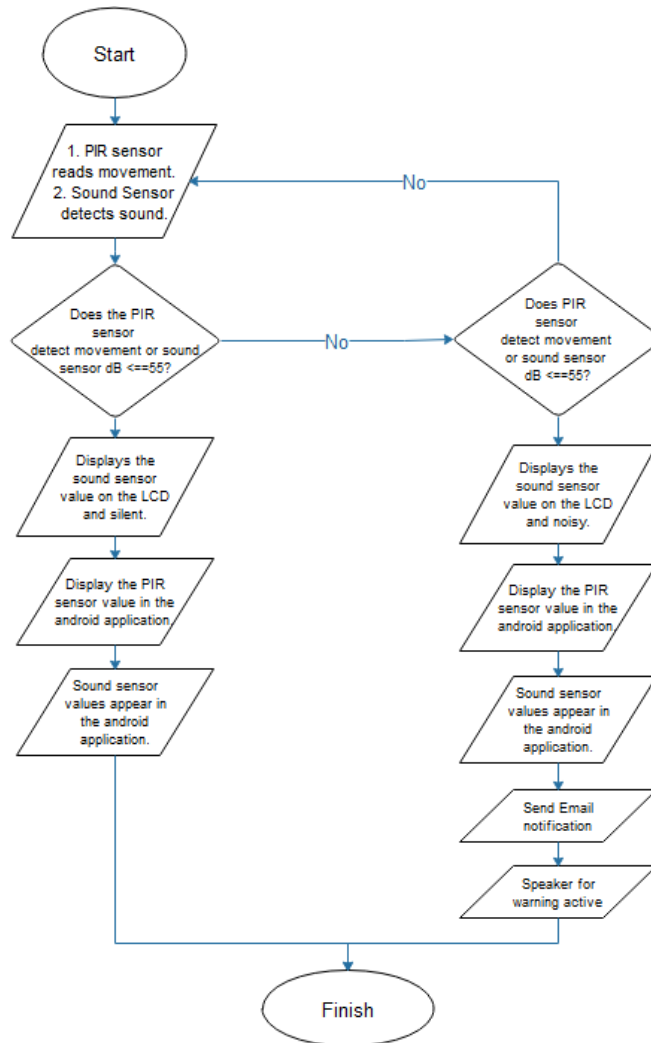


Figure 5. Flowchart.

Based on the flow diagram above, it is explained that the PIR sensor reads movement for initialization, and the sound sensor detects sound. Condition 1 if the PIR sensor reads movement or the sound sensor (db) ≤ 50 , then the output appears dB display with silent conditions on the LCD, PIR value, and dB value on the application on Android. Condition 2 1 If the PIR sensor reads movement or the sound sensor (db) ≥ 50 , then the output appears dB display with noisy conditions on the LCD, PIR value and dB value on the application on Android, and the speaker sounds with a "warning, do not speak too loudly" sound.

2.5 Wiring Design on Sound Sensor

The wiring design on the sound sensor is used to detect the signal output on the sensor to detect predefined sounds in the program, and the NodeMCU ESP8266 works as a microcontroller. The wiring on the sound sensor can be seen in Figure 6.

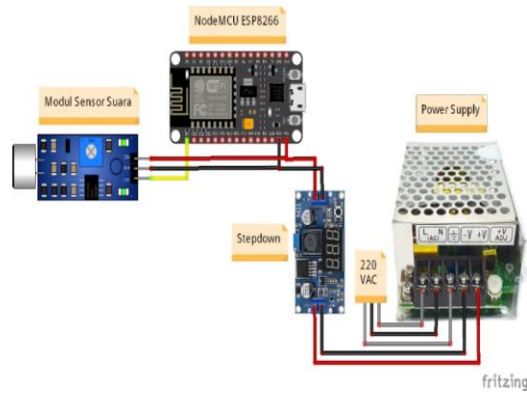


Figure 6. Wiring on the sound sensor

2.6 Wiring Design on 16x2 LCD

LCD is one of the most popular performers used as an interface between the microcontroller and its user. On this 16×2 LCD, users can see/monitor the state of the sensor or program. *Inter-Integrated Circuit*, or I2C, is a two-way serial communication standard using two specially designed channels to send and receive data. The I2C system consists of SCL (Serial *Clock*) and SDA (Serial *Data*) channels that carry data information between I2C and its controllers. The 16x2 I2C LCD wiring can be seen in Figure 7.

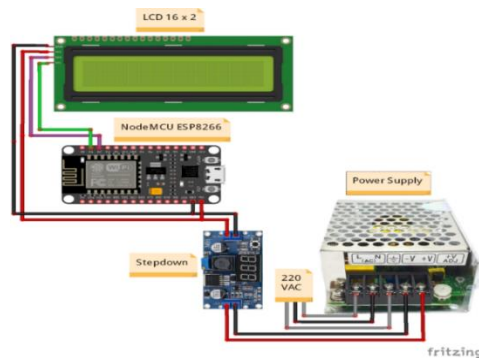


Figure 7. Wiring on 16x2 LCD

2.7 Wiring Design on PIR Sensor

PIR (Passive Infra Red) is a sensor used to detect the presence of infrared rays. PIR sensors are passive, meaning they do not emit infrared light but only receive infrared radiation from outside. The wiring on the PIR sensor can be seen in Figure 8.

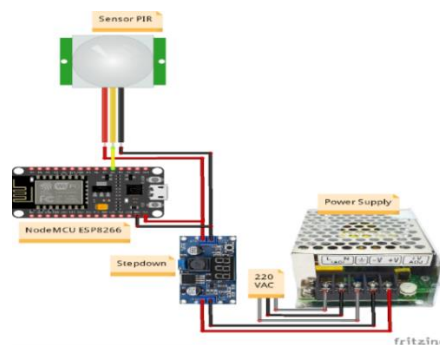


Figure 8. Wiring on the PIR sensor

2.8 Wiring Design on DF Player and Speakers

DFPlayer Mini Mp3 in electrical design on the system functions as an audio file player/music player module supporting formats such as mp3 files. This mini DFPlayer has a 16-pin interface, a standard DIP pin, and header pins on both sides. The mini DFPlayer can work alone, stand alone, or with a microcontroller via a serial connection. The speaker is output hardware that outputs the results of processing by the CPU in the form of audio/sound. Speakers can also be called auxiliary devices for the sound output of music devices such as MP3, DVD, and others. Wiring on DF Player speakers can be seen in Figure 9.

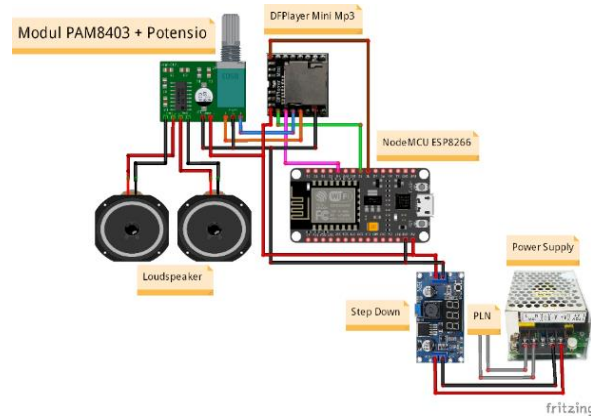


Figure 9. Wiring on DF Player and speakers.

2.9 System-wide Wiring Design

Wiring design of the entire noise detection system using a NodeMCU-based sound sensor ESP8266. The entire wiring system can be seen in Figure 10.

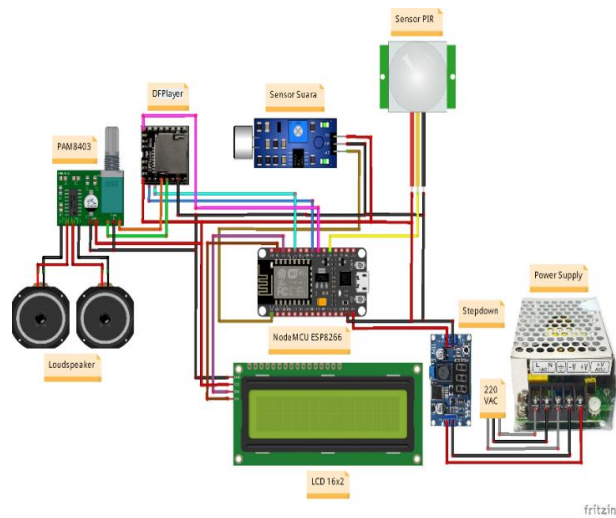


Figure 10. Whole system wiring

3. RESULTS AND DISCUSSIONS

3.1 ESP8266 NodeMCU Testing

Testing on the NodeMCU ESP8266 microcontroller aims to determine the response given to the NodeMCU ESP8266. This test measures how far is the wifi connection received by NodeMCU ESP8266 when it works. Table 1 Is the result of testing the connection distance on NodeMCU ESP8266 connected to the internet.

Table 1. ESP8266 NodeMCU connection test results

No	Distance	Hindrance	NodeMCU	Data
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			ESP8266	
1	5	Not	Connected	Sent
		Yes		
2	10	Not	Connected	Sent
		Yes		
3	15	Not	Connected	Sent
		Yes		
4	20	Not	Connected	Sent
		Yes		
5	25	Not	Not Connected	Disconnected
		Yes		

The test was carried out with a distance of every 5 meters wifi network with NodeMCU esp8266. Based on the test results above, NodeMCU ESP8266 can communicate up to 20 meters without any obstruction and with obstructions on wifi networks. When the wifi distance with NodeMCU ESP8266 exceeds 20 meters, the connection with NodeMCU esp8266 is lost, and the system cannot work. Response time testing on NodeMCU ESP8266 connected to the internet can be seen in Figure 1:1.

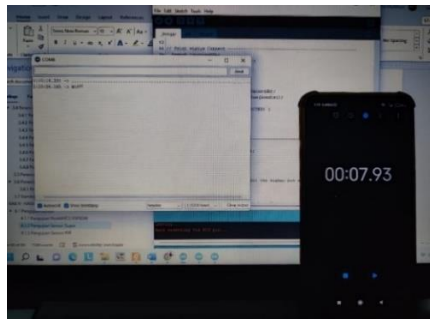


Figure 11. Time response test results

3.2 Sound Sensor Testing

Testing on the sound sensor aims to determine how accurately it identifies noise detection. The previous sensor calibration treatment also influences the sensitivity level of sound interference or *noise*. Tests on SLM, sensors, and speakers can be seen in Figure 12.



Figure 12. Tests on SLM and sensors

Furthermore, from the test results, values were obtained from the sound sensor input displayed on the LCD and SLM. The LCD and SLM tools will display the value when it detects noise. Test results on sound sensors for noise in drilling machines can be seen in Table 2.

Table 2. Noise test results on drilling machines

No	SLM (dB)	Analog Sound Sensor (dB)	Speakers	LCD
1	71,5	66,0	Active	Display noisy conditions and dB values
2	69,0	63,0	Active	Display noisy conditions and dB values
3	70,1	65,0	Active	Display noisy conditions and dB values
4	68,9	62,0	Active	Display noisy conditions and dB values
5	71	64,0	Active	Display noisy conditions and dB values
Average	70,12	64,0		

$$\text{Error} = \frac{70.12 - 64.0}{70.12} \times 100\% = 8.7 \%$$

3. The results of testing and data collection from sound sensors for noise in music sounds can be seen in Table 3.

Table 3. Noise test results on music sounds

No	SLM (dB)	Analog Sound Sensor (dB)	Speakers	LCD
1	72,3	67,0	Active	Display noisy conditions and dB values
2	68,3	62,0	Active	Display noisy conditions and dB values
3	70,5	64,0	Active	Display noisy conditions and dB values
4	70,5	66,0	Active	Display noisy conditions and dB values
5	67,8	63,0	Active	Display noisy conditions and dB values
Average	69,8	64,4		

$$\text{Error} = \frac{69.8 - 64.4}{69.8} \times 100\% = 7.7 \%$$

IV. The results of testing and data collection from sound sensors for noise in human shouts can be seen in Table IV.

Table IV. Results of noise testing on human screams

No	SLM (dB)	Analog Sound Sensor (dB)	Speakers	LCD
1	69,7	64,0	Active	Display noisy conditions and dB values
2	70,6	66,0	Active	Display noisy conditions and dB values
3	70,1	65,0	Active	Display noisy conditions and dB values
4	69,8	62,0	Active	Display noisy conditions and dB values
5	69,3	64,0	Active	Display noisy conditions and dB values
Average	69,9	64,2		

$$\begin{aligned} \text{Error} &= \frac{69.9 - 64.2}{69.9} \times 100\% \\ &= 8.1\% \end{aligned}$$

Based on the results of the sound sensor and SLM tests in the table above, it can be analyzed that the error results in each test are different. The test on drilling machine noise has an error value of 8.7%, music sound has an error value of 7.7%, and human shouting has an error value of 8.1 %.

3.3 PIR Sensor Testing

Sensor PIR testing aims to determine the motion detected by the sensor. The tilt angle of the PIR sensor is 45°, with a height of 230 cm. Testing is carried out by giving stimulants in the form of movement around the PIR sensor. Tests on the PIR sensor can be seen in Figure 1:3.



Figure 13. PIR sensor testing

The results of testing and data retrieval from the PIR sensor can be seen in Table V.

Table V. PIR sensor test results

PIR Testing Sensor	Distance (cm)	Condition (Nobody or No One)	Information
1	50	There are people	Detected
		No One	Detected
2	100	There are people	Detected
		No One	Detected
3	150	There are people	Detected
		No One	Detected
4	200	There are people	Detected
		No One	Detected

5	250	There are people	Detected
		No One	Detected
6	300	There are people	Undetectable
		No One	Undetectable

3.4 Monitoring Test Results

In testing for thinger.io applications on Android, the data read here is the result of sensor readings. The display values on the thinger.io application can be seen in Figure 14.



Figure 14. The results of displaying values in the application thinger.io

The results of testing and data collection monitored in the form of charts can be seen in Figure 15.



Figure 15. Results of display of values in chart form

Testing for display on the app thinger.io is successful and running well. The results show the value of the sensor reading, so to find out the latest sensor value, we must *update* the data first. Furthermore, the test results on the email notification can be seen in Figure 16.

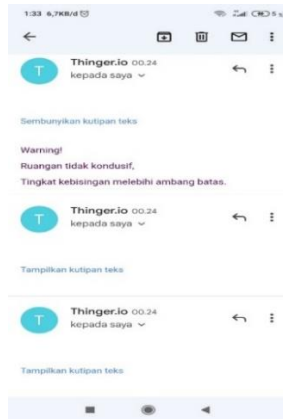




Figure 16. Email notification test results


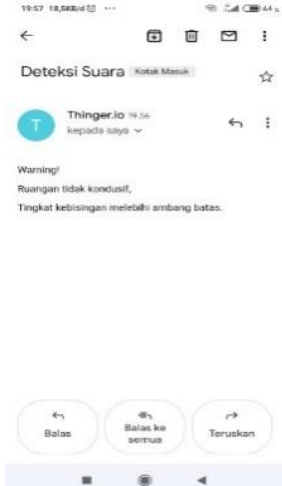
The test for email notifications was successful and went well. When the dB value exceeds the predetermined value in the sense of noise, it immediately sends an email notification in the form of information that the room is not conducive.

3.5 Overall Test Results

This test is carried out to test the tool's reliability from the beginning of the system operation to the end of the system test by obtaining test results. The test results obtained data that the system gets good connection results with the same *hotspot* connection with a maximum distance of 20 meters so that the tool can operate to detect noise. Furthermore, noise is made in the sound of drilling machines, the sound of music on mobile phones, and the sound of human screams. Different decibel (dB) values were obtained in the test, and the resulting output results are arranged in Table VI below.

Table VI. Overall test results.

No	Suara Noisy	SLM (dB)	Sensor (dB)	Output	Ket
1	Noise At drilling machine	71,5	66,0	Speakers Active speakers sound like "Warning, do not speak too loudly." 	succeed
				LCD The display on the 16x2 I2C LCD will display the conditions in the room and <i>the decibel</i> value (dB). 	

				<p>thinger.io The thinger.io application display on Android will display the values of the sound sensor and PIR sensor readings.</p> 	
				<p>Email notifications If the condition of the room is not conducive or noisy, then the tool will send a text email notification in the form of "Warning, the room is not conducive, the noise level."</p> 	

Based on Table VI explains that the tool can work or operate properly. In testing from the beginning of the sensor reading, the output value is successfully displayed in the LCD output and can be monitored through the thinger.io application on Android, and also successfully sent an email notification in the form of the text "Warning, the room is not conducive to noise levels exceeding the threshold." The tool has been successful in the test results and can be implemented in the classroom.

4. CONCLUSION

Based on the results of design, manufacture, testing, and analysis that have been carried out during this Final Project, the following conclusions are obtained:

1. Noise detection tools can detect noise levels in a classroom and send an email notification, and detection data from sensors can be adequately monitored via the web or application thinger.io on Android.
2. In the test results of the noise detection system, the noise detection value ranges from 62 – 67 dB.
3. The results of sound sensor and SLM testing show that the error results at each test are different. Noise testing on drilling machines has an error value of 8.7%, music sounds have an error value of 7.7%, and human shouts have an error value of 8.1 %.
4. In the speakers' output, the room user will hear a warning sound if the decibel value exceeds the predetermined value.
5. The tool has been successful in the test results and can be implemented in the classroom.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Author1: Conceptualization, Methodology, Software, Project administration. **Author2:** Software, Writing – original draft. **Author3:** Writing – review & editing.

DECLARATION OF COMPETING INTERESTS

There are no competing financial interests or personal relationships.

DATA AVAILABILITY

Data will be made available on request.

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