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Library Visitor Noise Monitoring System Design With Warning Using LED and Telegram

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Abstract. *The library supports education and is a place to learn and gain knowledge. To maximize its use, visitors need comfort by not making noise or upheaval that can disturb other visitors. According to the decision of the Ministry of Environment in 1996, the maximum standard for noise levels in libraries is 55 dB. This research was conducted to design a tool that can monitor the noise that occurs in the library by providing information on room conditions using LED (Light Emitting Diode), LCD (Liquid Crystal Display), and giving notifications to librarians in the form of messages on the Telegram application if the noise exceeds the limit maximum. The tool is designed using ESP32 as a control, a GY-MAX4466 sensor to detect sound, and the output system uses red, yellow, and green LED (Light Emitting Diode), LCD (Liquid Crystal Display) 16x2, and the Telegram application. The results of this study concluded that the noise monitoring system was running well, with a GY-MAX4466 sensor error rate of 0.4%, and the best R Square value was obtained at a distance of 1 meter from the sound source with an R Square value of 0,7202.*

Keywords: *ESP32, GY-MAX4466, LCD, LED, Library, Noise, Telegram.*
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INTRODUCTION

The library functions as a medium for education, research, preservation, information, and entertainment and acts as a promoter of literacy culture with the hope of creating conditions for cultural literacy to become a basic need in the daily lives of Indonesian people. If literacy culture is practiced as a way of life, then the Indonesian nation will become an educated society, thirsty for knowledge and ready to become a developed country [1]. Libraries have several types, namely national libraries, academic libraries, public libraries, community libraries, school libraries, and other libraries[2][3].

In every library, there is always a librarian who plays an important role in the management, service, and organization of library activities, and he is responsible for improving services, implementing program promotions, assisting customers in finding information, replacing damaged books, and sending them to the bookbinding department, monitoring the use of collections, verifying the correct arrangement of collections on shelves, making statistical

reports on activities, maintaining order and cleanliness of the room[4]. To maintain order, librarians give guests the freedom to carry out any activity as long as they don't disturb other guests. A warning is needed to remind the state of the room caused by visitor activity. Of course, the warning given shouldn't add to the noise in the room. In addition to warning visitors, it is also important to notify the librarian if room conditions exceed the noise limit values in the library. The minimum number of employees in a large room can cause the room to go unnoticed, requiring notification to provide reports even if the distance between staff and visitors is far.

As for several previous noise detection studies, Nurwati's first research was in 2018 regarding noise detection using a microcontroller similar to Arduino Uno, the LM393D sound sensor as a noise detector and a speaker as an alarm if noise is detected [5]. Then, in the same year, research was also carried out by Theodorus and his friends regarding a noise detection device using an Arduino Uno-type microcontroller, a condenser mic sound sensor as a sound detector, and a speaker as an alarm if noise is detected [6]. Using the Arduino Nano 33 BLE microcontroller and ESP32-WROOM32U using the DFROBOT Analog Sound Level sensor. The system was built by classifying machine training using the Convolutional Neural Network algorithm by utilizing a Feature Extraction [7].

In this study, the telegram application. This telegram application has been widely used in monitoring systems, such as monitoring electricity users, accessing smart agricultural data, monitoring traffic violations, monitoring automatic home keys, and Home automation[8][9][10][11][12]. Telegram is a cloud-based application in the form of instant messaging that focuses on speed and security. The use of Telegram is designed to be able to send text, audio, video, images, and stickers messages to each other safely. Its use is designed to be quite easy. [13].

For the problems above, the author intends to design a noise detector for library visitors based on sound pressure parameters using an amplified sound sensor so that it is able to detect not only loud sounds but also the GY-MAX4466 sensor. This sensor has been widely used to detect sound noise [14][15][16]. Research on monitoring noise in the library has been carried out using the ESP32 microcontroller with the WhatsApp application [17]. In other studies, noise measurement has also been carried out with the NODEMCU ESP8266 sensor [18]. The difference between this study and previous research is the application used is different. In this study, the telegram application. In this study, the ESP 32 microcontroller was used. To warn visitors, of course, warning signs were used so as not to cause additional noise, so 3 LEDs (light emitting diodes) with different colors were used to clearly indicate when one of them was on.

And for librarians, a system has also been created to notify when conditions exceed the limit. For this reason, the messaging application Telegram is used because it can be accessed on many devices so that many librarians can access it.

RESEARCH METHODS

This research was conducted at the Physics Laboratory Center, the Integrated Laboratory Center at UIN Syarif Hidayatullah Jakarta, and the Siliwangi University Library, Tasikmalaya City, West Java. The tools and materials used include an esp32 microcontroller, GY-MAX4466 sensor, LED (Light Emitting Diode), LCD (Liquid Crystal Display), laptops, Arduino IDE applications, telegram applications, etc. The research phase consists of the preparation stage, analyzing the tools and materials needed, designing hardware (hardware) and software (software), then calibrating and testing the accuracy of the sensor, testing the tool as a whole, analyzing data, and making conclusions.

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RESULTS AND DISCUSSION

Hardware Design Results

The hardware design for the library visitor noise monitoring system is designed by making the esp32 microcontroller the brain or control center for all components, including the GY-MAX4466 sensor, LED (Light Emitting Diode), and LCD (Liquid Crystal Display). The results of the hardware design can be seen in Figure 1 and Figure 2.

Figure 1. Hardware Design Results

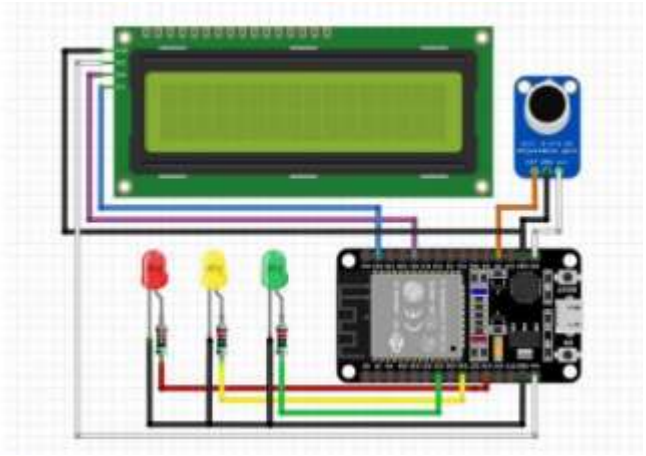

Figure 2. Series of noise monitoring systems

In Figure 1, you can see from the outside that a black circle, the GY-MAX4466 sound sensor, receives sound waves from the surrounding environment. Then, an LCD screen displays the results of the esp32 microcontroller process, which processes sound wave value data received by the sound sensor so that room conditions and sound intensity can be displayed. Finally, a red, yellow, and green LED (Emitting Diode) functions as a warning sign. The red LED will light up when the surrounding sound intensity is above 55 dB. The yellow LED will light up when the surrounding sound intensity is between 50 and 55 dB, and the green LED will light up when the surrounding sound intensity is below 50 dB.

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Software Design Results

The library visitor noise monitoring system software is designed by making the esp32 microcontroller, which is a microcontroller with a wifi module as the control center so that it can send noise alerts via the Telegram application. The design uses the Arduino IDE application as a programming medium and the Telegram application to receive warnings regarding room conditions. Here is a picture. 3 is a display of the design results for the Telegram application.

Figure 3. The results of the Telegram Messenger Application Software Design

Figure 3 shows that at the beginning of the message, type "/start" to start a chat on the Telegram bot so that the smartphone can receive a warning message when it is noisy with the sentence "WARNING!!! NOISY ROOM".

Tool Testing Results

test the noise monitoring tool for library visitors, and several stages were carried out, namely by testing the sensor's accuracy, then conducting a linear regression test, and finally testing the entire system, including LCD, LED, and the Telegram application.

GY-MAX4466 Sensor Accuracy Test Results

The GY-MAX4466 sensor is a sound sensor that identifies the sound intensity values around it. Testing the accuracy of the GY-MAX4466 sensor is carried out by taking sound intensity data in a library room measuring approximately 150 m2 and accommodating a maximum of 30 visitors. Retrieval is done by placing the GY-MAX4466 sensor in the middle of the room when the number of people in it is one person, ten people, 20 people, and 30 people, with data retrieval intervals every second. At the same time, data is also collected using a factory-made sound level meter, then the results from the GY-MAX4466 sensor are compared with the results of the factory-made device to determine the accuracy value of the GY-MAX4466 sensor.

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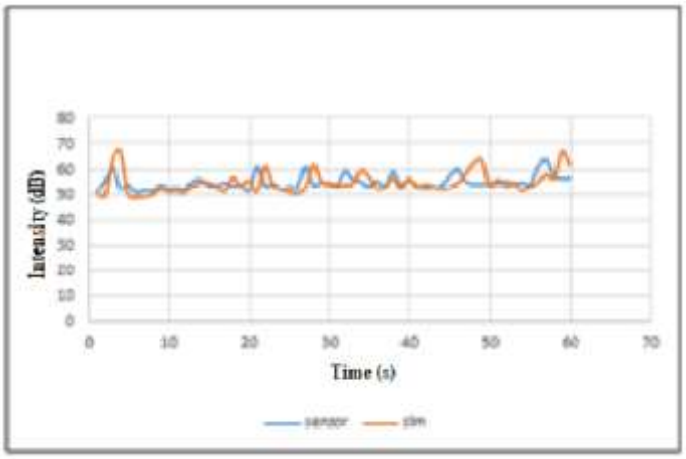

Figure 4. Graph of Comparison of Measurement Results of the GYMAX4466 Sensor with factory sound level meters in the library (20 people)

Figure 4 shows a graph of the results of sound intensity measurements carried out in the library room with one visitor. The blue line shows the measurement results using the GY-MAX4466 sensor, and the orange line shows the results using a factory-made sound level meter. The graph shows that the blue and orange lines have almost the exact shape of peaks and valleys, but there are gaps or differences between the two. Some lines intersect, which means that the measurement results with both tools have the same results, so the error rate is 0.1%. This system has an accuracy value of 99.9%. This value is higher than the monitoring system with the Blink application, with an accuracy of 97.58% [14].

Linearity Test Results

Another static characteristic test is a linearity test. In this test, the sound measurement is carried out using a higher audio sound source sensor. The measured level is 10% to 100% at 10% intervals. This test is also carried out for variations in the distance between the sound source and the GY-MAX4466 sensor. The distances tested were 1 meter, 2 meters, and 3 meters in a room with an area of about 30 m^2.

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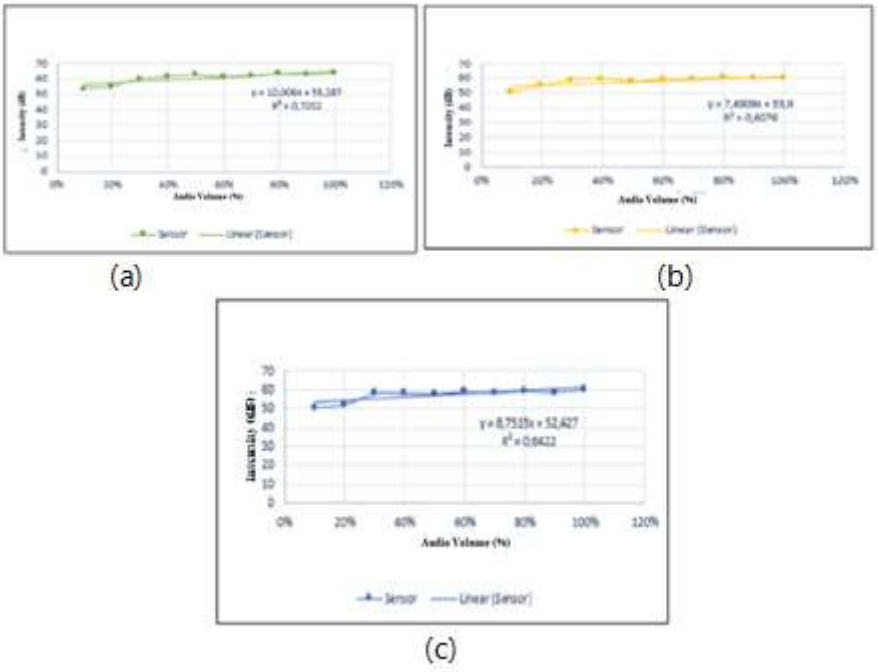

Figure 5. Graph of the Relationship Between Audio Volume and Sound Intensity at a Distance of (a) 1 Meter, (b) 2 Meters and (c) 3 Meters

Figure 5 shows a graph of the relationship between audio volume and sound intensity. It is then known that the higher the audio volume, the higher the measured intensity value. At a distance of 1 meter, an R-Square value of 0.7202 is obtained, which means that it is above the value of 0.67, so the results are categorized as vital. At a distance of 2 meters, an R-Square value of 0.6076 is also obtained, which means that between 0.33 and 0.67, the results are categorized as moderate. At a distance of 3 meters, an R-Square value of 0.6422 is also obtained, which means that between 0.33 and 0.67, the results are categorized as moderate [19].

It can be concluded that the data obtained at a distance of 1 meter is better than at a distance of 2 meters and 3 meters, with the R-Square value closest to number 1, namely at 0.7202. This value is much different from other studies conducted with variations of distances above 10m, 20m, 30m, 40m, and 50m. This study detects traffic noise using a sound level meter with a linearity of 0.98 for a distance of 10 m[20]. However, the trend obtained in this study has something in common with this study, namely experiencing a decrease in linearity with increasing distance.

Overall System Test Results

The final test is testing the entire system, which consists of the output LCD, LED, and warning messages that enter the Telegram application. When the sensor detects sound intensity below 50 dB, the LCD screen will display a notification "Quiet" with a green LED that lights up. When the sensor detects the sound intensity between 50 dB and 55 dB, the LCD screen will display the word "Caution" with a yellow LED that lights up, which means visitors are expected to be careful because the sound generated is close to the noise level. When the sensor detects the sound intensity is above 55 dB, the LCD screen will display a warning with

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the sentence "No noise" and a red LED that lights up as a warning to visitors to stop causing noise, and there will also be an incoming message via the Telegram application to notify the librarian that noisy room conditions. The test was carried out in an empty room 6 times with different sound sources, namely, without any sound interference, human voices talking, music from smartphones, the sound of clapping hands, the sound of turning book pages, and the sound of whistling with the distance of the sound source and the instrument. 1 meter away.

Table 1. Test Results for the Whole System

NO	Voice Description	Intensity (dB)	Telegram warning	LCD Detection Results	LED			Delay Telegram (s)	Information
					Red	Yellow	Green		
1	No sound disturbance	44,2 dB	-	Quite	-	-	✓	-	Succeed
2	Human Voice Talking	50,6 dB	-	Attention	-	✓	-	-	Succeed
3	Smartphone Music Sound	55,5 dB	✓	Do not be noisy	✓	-	-	3 s	Succeed
4	Applause	70 dB	✓	Do not be noisy	✓	-	-	3 s	Succeed
5	Turning Book Pages	54,5 dB	-	Attention	-	✓	-	-	Succeed
6	Whistling	52,5 dB	-	Attention	-	✓	-	-	Succeed

Table 1 shows the results of the first test without any additional sound disturbance; the measured sound intensity value is 44.2 dB, and the word "Quiet" is displayed on the LCD screen with a green LED that lights up, indicating that the room conditions are calm or conducive. The second test, with a human voice speaking, measured a sound intensity value of 50.6 dB, so the word "Caution" is displayed on the LCD screen with a yellow LED that lights up, indicating that the room conditions are at a moderate level. The third test was with a music sound source from a smartphone; the measured sound intensity value was 55.5 dB, so the word "Noise Prohibited" is displayed on the LCD screen with a red LED that lights up. The message has successfully entered the Telegram application with the interval between the color change of the LED light and the entry of the message. For 3 seconds, it indicates that the room condition is noisy. The fourth test is with the sound source of clapping. The measured sound intensity value is 70 dB. The word "No noise" is displayed on the LCD screen with a red LED that lights up well as the message successfully entering the Telegram application with the time interval between the color change of the LED light and the entry of the message for 3 seconds indicates that the condition of the room is noisy. The fifth test, with the book sound source, turned upside down, measured a sound intensity value of 54.5 dB; the word "Caution" is displayed on the LCD screen with a yellow LED that lights up, indicating that the room condition is at a moderate level. The sixth test, with a whistling sound source, measured a sound intensity value of 52.5 dB, so the word "Caution" is displayed on the LCD screen with a yellow LED that lights up, indicating that the room conditions are at a moderate level.

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Figure 6. Display of Telegram Overall System Test Results

Table 1 shows the first test's results without any additional sound disturbance; the measured sound intensity value is 44.2 dB, and the word "Quiet" is displayed on the LCD screen with a green LED that lights up, indicating that the room conditions are calm or conducive. The second test, with a human voice speaking, measured a sound intensity value of 50.6 dB, so the word "Caution" is displayed on the LCD screen with a yellow LED that lights up, indicating that the room conditions are at a moderate level. The third test was with a music sound source from a smartphone; the measured sound intensity value was 55.5 dB, so the word "Noise Prohibited" is displayed on the LCD screen with a red LED. Figure 6 displays the message that entered the telegram in the
sentence "WARNING!!!!" NOISE ROOM" when the sensor detects the sound source of smartphone music and hand clapping. From all the test results, it can be concluded that the design of the library visitor noise monitoring tool using LED (Light Emitting Diode) as a warning to visitors and messages sent via the Telegram application as notifications to guards can run well as planned.

CONCLUSION

The design of a tool for monitoring the noise of library visitors has been successfully carried out using LED (Light Emitting Diode) as a warning to visitors and messages via the Telegram application as notifications to guards. From the results of the characterization carried out on the GY-MAX4466 sensor, an average error value of 0.4% is obtained. The linear regression test obtains the R square value when the distance between the sound source and the GY-MAX4466 sensor is 1 meter. .6076 and 0.6422.
All components and systems in this noise monitoring tool are going well as planned. The sensor can identify the environment well so the warning LED can function correctly. Also, notification messages for the Telegram application can be received correctly with an average delay time of receiving messages of 3 seconds.

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