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Design of noise detection and warning in library reading room using Wemos D1 R2 Based on IoT

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ABSTRACT

The library is one of the places needed by the community to improve academic knowledge, get information and become a means for students to learn. Library visitors certainly need a comfortable and quiet atmosphere so they can focus on reading books in the library. But not all visitors understand about the rules that apply to the library. Some visitors come just to chat, thus disturbing other visitors who are reading. Therefore, a system that can monitor the room is needed. The reading room noise detector aims to provide comfort and tranquility to visitors who come to read. the components used in this design are the Wemos D1 R2 microcontroller, DFRobot Analog Sound Sensor V2, DHT11, LCD, and Buzzer. This tool will work if the Sound Sensor detects Sound Intensity of more than 55dB then the Buzzer will be active and the LCD displays "PLEASE LET YOUR VOICE THANK YOU" and sends a notification to the Blynk application. Furthermore, DHT11 will function as realtime temperature monitoring in the room and display it on the LCD and Blynk Application.

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Introduction

In the current era of technological development, the Internet of Things (IoT) is very possible to be implemented in various aspects of life. This is due to the advantages of IoT which is able to integrate the physical real world into the virtual realm by means of internet network connectivity (O'Brien, 2018). Libraries as one of the public facilities in universities are also encouraged to implement various modern technologies including the Internet of Things to improve services and optimize the user experience (Rubin et al., 2010).

One of the potential implementations of IoT in libraries is noise detection and warning in library reading rooms. Research Taylor et al. (2019) explains that the high noise level in the library reading room is the factor that most disturbs the concentration of users while reading. In the long run, excessive noise can also affect cognitive function and academic performance (Klatte et al., 2013). However, previous research on the implementation of technology for monitoring and controlling noise levels in libraries is still limited. Meanwhile, IoT technology has enormous potential to be developed.

IoT technology has been used in various cases of environmental mitigation and monitoring, including noise warning cases. For example, Permana et al. (2020) has built a smart home to detect air pollution and noise in the home environment using NodeMCU ESP8266 and KY-037 Sound sensor.

Similar research has also been conducted by Roy et al. (2021) who designed a real-time noise detection system using a Wemos D1 mini microcontroller whose results can be displayed on an LCD screen and Android application. From these previous studies, it can be seen that IoT has great potential to be implemented in automatic noise detection solutions.

Noise detection and warning in the library through IoT technology will provide several benefits. First, it will increase the comfort of the users while doing activities in the library reading room. Second, it will help library managers monitor noise levels in real-time. Third, it will foster a more conducive culture of literacy and reading for the users. Fourth, the intensity of excessive noise in the library reading room can be reduced automatically, thereby reducing long-term health impacts for both users and librarians (Klatte et al., 2013).

Some previous studies on IoT applications in libraries have used several platforms such as NodeMCU ESP8266 Prabowo et al. (2020), Arduino UNO Subchan et al. (2021), Raspberry Pi Pardede et al. (2019), and other microcontrollers. However, in terms of functionality, sensor integration, and device price, Wemos D1 R2 has better and competitive specifications (Kusumo et al., 2021). In addition, another advantage of Wemos D1 R2 is that it has more optimal communication and power support, mini physical size, low power consumption, and ease of development and program coding using the Arduino IDE (Rahim & Rahman, 2018). This makes the Wemos D1 R2 worthy of being chosen as an IoT platform for similar case applications.

Several previous studies have discussed noise detection systems. However, not many have applied IoT technology to this system. Meanwhile, some researchers have utilized the Wemos D1 R2 microcontroller for other IoT applications (Badruddin et al., 2020). However, the utilization of these microcontrollers for IoT-based noise detection systems in libraries has not been widely studied. Therefore, this research will design and build a noise detection and warning system in the library reading room by utilizing the Wemos D1 R2 microcontroller and IoT technology.

The sound sensor or microphone that is suitable for detecting noise in the library, one of which is the KY-038 sound sensor. This sensor has been proven effective in noise monitoring applications in previous studies such as by (Permana et al., 2020). KY-038 has the advantages of high sensitivity in detecting sound frequency, fast response time, economical price, and an interface that is easily connected to microcontrollers such as Wemos D1 R2 (Lestari et al., 2021). This sensor uses the LM393 op-amp module which effectively converts the sound frequency in the form of analog waves into digital signals that are read by the microcontroller.

Based on the description and literature study, this research will design and build a noise detection and warning system in the library reading room by utilizing Internet of Things technology. The IoT platform used is Wemos D1 R2 microcontroller with KY-038 sound sensor. The sensor reading results will be processed by Wemos D1 R2 as the main controller of the system, then the system output in the form of noise warning indicators/alarms is displayed on LCD and LED. These results are expected to be accessed via wi-fi network by the library manager in order to monitor the reading room noise level in real-time.

Method

Tools and Materials

In building a noise detection tool, you need devices that will support the creation of the tool. This noise detector uses several main devices, namely sensors, microcontrollers and In building a noise detection device, devices are needed that will support the creation of the device. This noise detector uses several main devices, namely sensors, microcontrollers and actuators (Badruddin et al., 2020), (Wu et al., 2019). The devices used in this system are Wemos D1 R2, Analog Sound Sensor V2, DHT 11 Sensor, 16x2 LCD, Buzzer, Breadboard, Jumper Cables, Blynk Application, IOT, and Arduino IDE.

Analysis Method

The conceptual basis for this research is technically described in two ways, namely with a block diagram that describes the structure of the system to be built and a flow diagram that describes the system's work sequence.

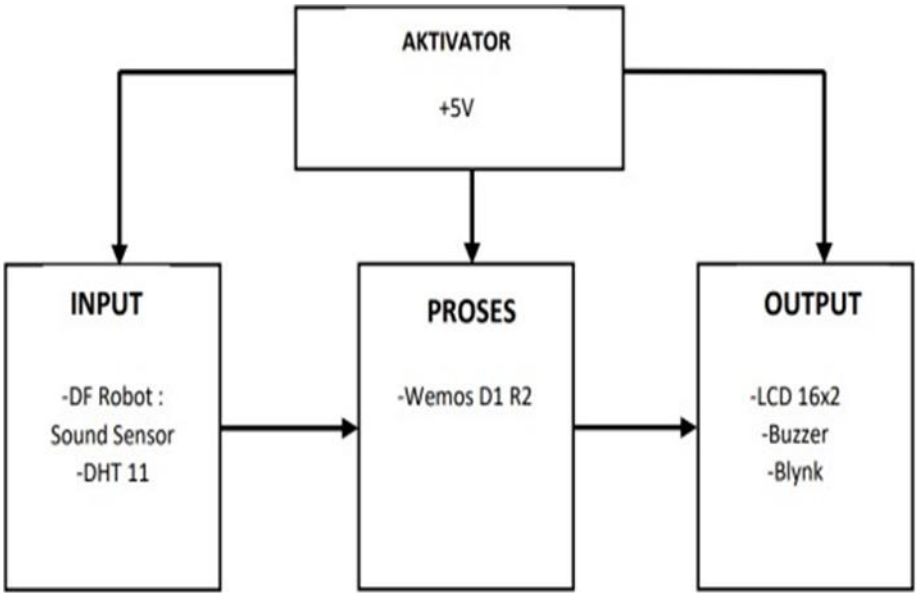

Figure 1. Block Diagram

In designing the noise detection and warning design in the library reading room using the IoT-based Wemos D1 R2, first make a block diagram design of the tool which has four design parts, namely: activator block, input block, process block, and output block. In this block activator block that provides electrical resources to all blocks, namely Input, Process, and Output. The voltage source supplied is 5 Volts, as recommended by the Wemos D1 R2 microcontroller to use a voltage of 5 - 12 Volts. Then, the Wemos D1 R2 can produce an output voltage of 5V and 3.3V DC to provide power for the Sound Sensor and DHT 11 in the input block, LCD and Buzzer in the output block.

In the input block circuit there is a Sound sensor and a Temperature sensor where the sound sensor functions to detect noise and the temperature sensor functions as a temperature detector in the room. Use of Robot DF Sensor: Sound Sensor & DHT 11 in the input block is an input signal that will be processed in the Wemos D1 R2 microcontroller. DF Robot Sensor: Sound Sensor as input is connected to analog pin A0 and DHT 11 is connected to pin D7 on the Wemos D1 R2 to send sensor data to the microcontroller. VCC pin on DF Robot: Sound Sensor is connected to the 5V pin and ground to the GND pin on the Wemos D1 R2 as well as the DHT 11 sensor (Sowah et al., 2014).

In this process block circuit is the process of receiving data from various input data generated in the input block. In this block also only consists of a Wemos D1 R2 microcontroller that has been uploaded to the Arduino IDE program whose function is to process input from the sound sensor and also the DHT11 sensor and the results of the process will be continued to the LCD screen which functions to display Sensor Value and also send data to the Blynk application (Deswar & Pradana, 2021).

The Output block is the result obtained from the input that has been processed from the process block. The output block which has 1 LCD screen measuring 16x2 whose function is only limited to displaying the sensor value of the Sound Sensor and DHT 11 and Buzzer, where the data is obtained from the input block and from the process block.

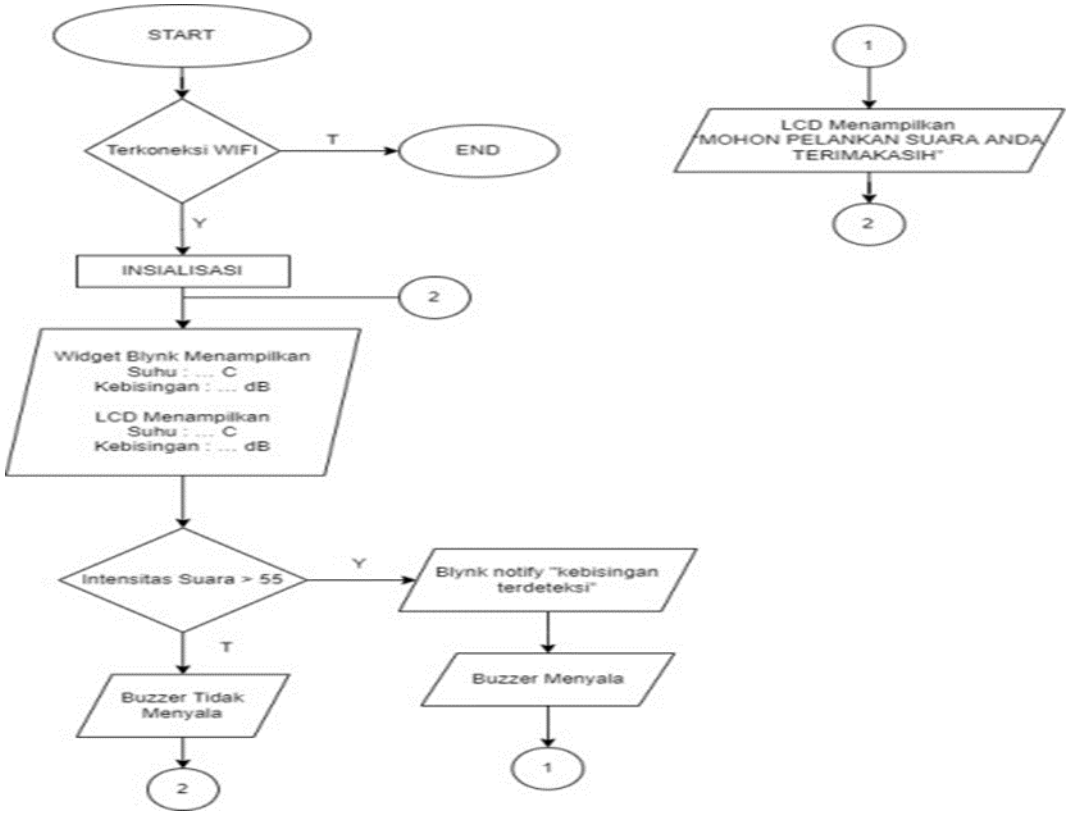

Figure 2. System Flowchart

Flowchart or can be called a flowchart, the creation of a flowchart of a tool design has a purpose as a detailed explanation and First, whether connected to wifi or not, if not connected to wifi on the tool then the condition is complete (end), but if yes then it will initialize the program and give an initial condition that is the display on the Blynk Widget & LCD. The next step is if the sensorValue detects a value of more than 55 db then the instruction will send a notification to the Blynk application in the form of "Noise Detected", the Buzzer turns on and the LCD will display "PLEASE LET YOUR VOICE THANK YOU" while if the sensor value is only below 55 db then the buzzer will not turn on.

Results and Discussions

System Design

The making of this noise detection and warning device begins with designing the overall system block diagram. The system block diagram consists of inputs in the form of sound sensors to detect noise levels and room temperature sensors. Processing is done by Wemos D1 R2 microcontroller by utilizing wifi network to transmit data in real-time. The output is a buzzer, LED, and noise level display on a smartphone. Next, the necessary components are prepared including the sound sensor, DHT11 sensor, Wemos D1 R2, LED, buzzer, resistor, and wifi module. The components are assembled on a PCB board and connected through the appropriate connecting lines and pins. The main system program is written using the C++ programming language in the Arduino IDE software. This main program functions to read sensor data, process data, output activation, and wifi communication.

After the program is successfully uploaded to the microcontroller, function testing of the prototype tool that has been made is carried out. Tests include sound sensors, DHT11 sensors, LEDs, buzzers, and displays on smartphones. If there are still errors, troubleshooting is carried out on the hardware and program so that the tool can function properly as designed.

Figure 3. Device System View

This section will be an explanation of the final result of the noise detector. The front view consists of a 16x2 LCD component that aims as an output viewer of Temperature and Noise data information if not using the Blynk application as an information display.

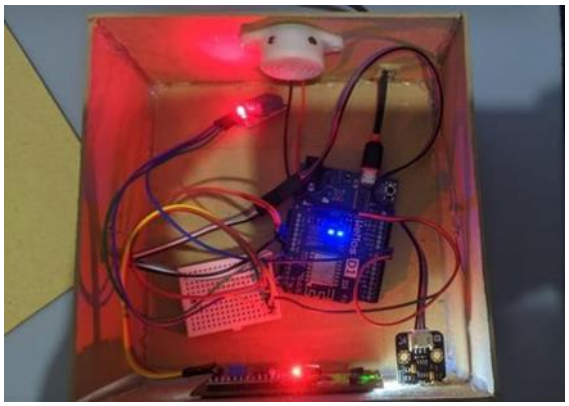

Figure 4. System Control Center

The inside of this tool contains components in the form of a Wemos D1 R2 microcontroller, breadboard tool components and input and output components such as Buzzer, 16x2 LCD as output and DF Robot: Sound Sensor, DHT 11 as input.

Tool Testing

Based on a series of designs that have been carried out, the author is testing / testing of the tool. the tool is tested based on the data needed to be taken and tested.

In this section will explain how the operation of the noise detection and warning tool in the library reading room using Wemos D1 R2 based on IOT, namely the tool is connected to a 5V voltage activator to activate all components in this tool such as the Wemos D1 R2 microcontroller, 16x2 LCD, DHT 11, DF Robot: Sound Sensor, and also Buzzer. After getting power the LCD layer will light up and the Wemos D1 R2 will run the uploaded program. After everything is active the sound sensor and temperature sensor will take data and be processed by the Wemos D1 R2 microcontroller. After the data is processed by Wemos D1 R2, information about noise and temperature will appear on the LCD screen and also the Blynk application widget. Furthermore, the buzzer will be active and the Blynk app will give notification when the sound intensity exceeds 55db.

Figure 4. Tool Testing

Results

Increased noise in the library reading room can disturb the concentration and comfort of readers. Therefore, a noise detection system is needed that can provide warnings so that the noise level is maintained. This research aims to design and build a noise detection device in the library reading room using Wemos D1 R2 connected to IoT (Purwanto et al., 2019). This tool works by detecting noise intensity using a sound sensor. The detection result data is sent via Wemos D1 R2 to the IoT cloud and then displayed on the web dashboard. If the noise level exceeds the threshold, a buzzer will sound as a warning for visitors to maintain the sound level. The system is also equipped with CCTV to monitor the condition of the reading room in real time. With the application of this noise detector, it is expected to help library managers in maintaining the level of comfort and order in the reading room. In addition, this system can also be developed by adding other supporting features (Ardiyanto et al., 14 C.E.).

Discussions

The designed noise detection and warning system demonstrates a holistic approach in addressing the issue of noise levels in library reading rooms. Through the use of sound and temperature sensors, it is able to provide relevant information to monitor environmental conditions in real-time. The decision to use a Wemos D1 R2 microcontroller connected to a WiFi network enables efficient data transmission to the IoT cloud, increasing the availability of information. As such, it not only provides alerts via a local buzzer, but also displays noise level information on the Blynk app, giving it an edge in remote monitoring.

The test results of the device show that the system has functioned as expected, and this success is supported by careful design and comprehensive testing. With the ability to effectively monitor and provide alerts, this device can make a positive contribution to the comfort and order in the library reading room. In addition, the potential for development by adding supporting features, such as surveillance through CCTV, provides the flexibility to enhance the functionality of the device according to future needs. Thus, this noise detector is not only a practical solution, but also provides a foundation for further improvements in monitoring and managing the reading room environment.

Conclusions

A prototype of noise detector in the library reading room has been successfully designed and built by utilizing Wemos D1 R2-based IoT platform. This tool implements a sound sensor to monitor the noise level in the library reading room. The data from the noise level monitoring is then sent in real time by the Wemos D1 R2 module to the cloud via the internet network, so that it can be monitored on a specially created web dashboard. The noise detection system in this library is also equipped with CCTV which functions to visually monitor the condition of the reading room. If the detected noise level exceeds the specified threshold, the system will activate a warning in the form of an alarm from a buzzer to remind library visitors to maintain their sound level. Thus, the noise in the reading room can always be maintained at a comfortable level to concentrate on reading. The implementation of the IoT-based noise detector in this library has successfully helped the manager in creating a conducive reading atmosphere for visitors. In the future, this system can still be improved by adding advanced features such as online

noise threshold level settings, mobile notifications, and integration of other supporting sensors for better automation. With further development, it is hoped that this tool can make a real contribution to improving the quality of service and satisfaction of library users. Future research development suggestions, to focus on improving the functionality and flexibility of noise detection devices in library reading rooms. Integration of additional sensors such as air quality sensors or motion sensors can provide more information about environmental conditions, providing a more holistic solution for patron comfort. Consider adding the feature of dynamically setting the noise threshold level based on specific times or activities within the library. The application of machine learning or artificial intelligence technology can also be explored to improve the system's ability to recognize more complex noise patterns and provide more targeted responses. Explore ways to integrate the system with smart building solutions or other supporting technologies. Utilization of the IoT platform could include connections with energy management systems or automated lighting to improve operational efficiency and user comfort. Consider aspects of data security and privacy, and develop methods to manage and analyze the collected data more effectively. By considering these aspects, future research can design solutions that are more integrated, responsive, and in line with technological developments to support the creation of optimized reading spaces in modern libraries.

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