

Design and Build Noise and CO2 Control Devices in IOT (Internet of Things) Based Libraries

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ABSTRACT

Keywords: KY-037, Carbon Dioxide, MQ135, ESP32, PAM8403, DFPlayer Mini, Speaker, Internet of Things, Web Server.

The library is a source of knowledge, information, and support for learning. It is equipped with facilities to support comfort and maintain concentration while carrying out activities in the library. For human resources to progress further, libraries must be made as comfortable as possible to support learning. This study aims to design a noise and CO2 control device in an IOT (Internet of Things) based library by using 4 sound sensors KY-037 to detect noise and 1 MQ-135 sensor to detect CO2 gas. This research method uses a literature review study. The noise and CO2 control device in the IOT (Internet Of Things) based library has been completed and can work as planned, the accuracy obtained from the KY-037 sound sensor is quite high, which is 97.6%. However, the good thing is that if the sensor accuracy is improved again, the accuracy obtained from the MQ-135 sound sensor is also quite high, which is 99.16%. Conclusion If the accuracy of the sensor is improved again, the web server runs smoothly using AJAX (Asynchronous et al.) so that the resulting website does not need to load the entire page and the ESP32 as a microcontroller can control the entire system well.



Introduction

The library plays a very important role as a source of information and learning, equipped with facilities to support comfort and maintain concentration in carrying out activities in the library (Syaifah, Nugroho, & Aditya, 2023). Many activities can be done in the library, such as reading, studying, and group work. However, several factors, including noise and CO2 levels, can cause discomfort and reduced concentration in the library (Hartono & Hendrawan, 2020).

Noise is a distracting sound or sound from an activity that is not expected to be heard because it can impair comfort and concentration (Suardho, Ishak, & Yakub, 2021). Noise in the library can be caused by several activities, such as chatting too loudly and joking. By the Decree of the Minister of State for the Environment KEP-

48/MENLH/11/1996, regarding the recommended quality standard of the library noise level of 55 dB(A) (Amarta, Putrada, & Swastika, 2019).

Air is a very important natural resource to carry out life for living things on Earth (Azzahrah, 2022). Air quality, especially the amount of CO₂ (carbon dioxide) in the library, is very important for the health and comfort of library visitors. CO₂ is invisible and odorous; inhaling too much can cause weakness, dizziness, and difficulty breathing. A good indoor CO₂ level limit is 350 ppm (Sirait, Pakpahan, & Naibaho, 2023).

If many people gather in the library for a long time and do activities, then CO₂ will increase. The increase in CO₂ levels in the library results in discomfort for library visitors who carry out activities and can interfere with health (Sirait et al., 2023).

In this study, the aim is to design a noise and CO₂ control device in an IOT (Internet of Things) based library by using 4 KY-037 sound sensors to detect noise and 1 MQ-135 sensor to detect CO₂ gas (Rombang, Setyawan, & Dewantoro, 2022). 4 sound sensors will be placed at points in the library room that have the potential to generate noise. The readings of the five sensors are processed through the ESP32 (Auliq & Zamroni, 2021). The sensor readings are displayed on the web server. Inside the web server, there are sensor readings, a 3-level noise level indicator (normal, noisy, and too noisy), a 3-level CO₂ level indicator (good air quality, poor air quality, and poor air quality), and a manual warning button to output a noise warning sound from the speaker. If any sound sensor detects the presence of noise > 55db or the manual warning button is pressed, it will emit a noise warning sound from the speaker as a warning (Akbar, Zaenudin, Mutaqin, & Samsumar, 2022). There is an LCD near the library entrance to display CO₂ levels and limit people from entering if CO₂ levels exceed the limit. If the CO₂ level < 350 ppm, then the LCDs "PLEASE ENTER". If the CO₂ level is $\geq$ 350 ppm, then the LCDs "NO ENTRY" because the air in the room is not good. LCD limits people entering when CO₂ levels $\geq$ 350 ppm so that CO₂ levels can drop and air quality improves.

Method

This research has five stages: the first is a literature study, the second is design and manufacturing, the third is tool testing, the fourth is data collection and analysis, and the fifth is results and conclusions.

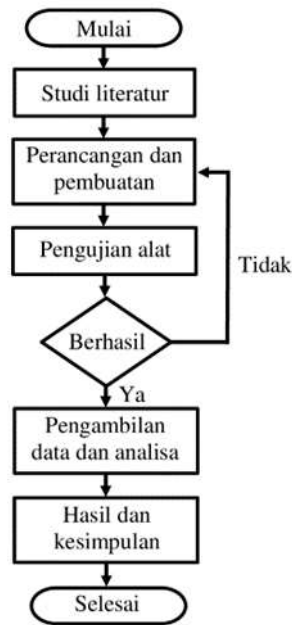


Figure 1. Flowchart of research methods

System Planning

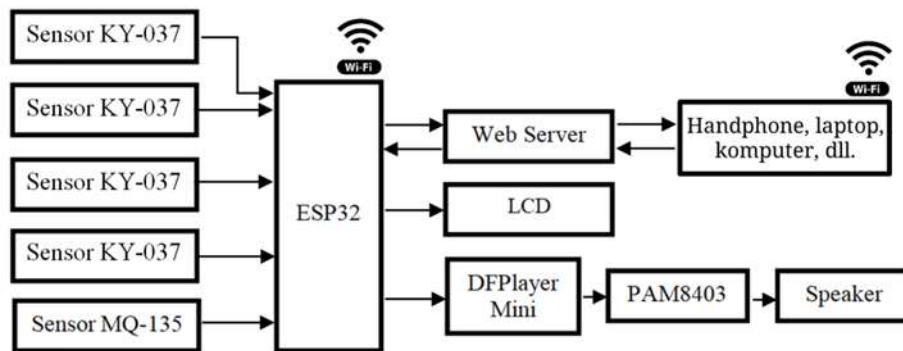


Figure 2. Diagram blocks

The ESP32 and the device used to access the website must be connected using the same wifi network because it uses a local network in this study. The sensors used are five pieces, namely 4 KY-037 sensors, which are used to detect sounds that will be installed at points in the library room that have the potential to cause noise, and also 1 MQ-135 sensor, which is used to detect carbon dioxide (CO₂) gas. Then, the data will be processed by ESP32. Then, it produces outputs like Web Server, LCD, and Speaker sound generated from DFPlayer Mini and amplified by PAM8403. The Web Server is used to display the data of each sensor with three levels of indicators. Inside the Web Server, a manual warning button is used to turn on the speaker's warning sound. An LCD will be placed near the entrance of the library. LCD to display CO₂ levels and descriptions can enter the library or not.

Hardware Design

The following is a wiring diagram used in this study.

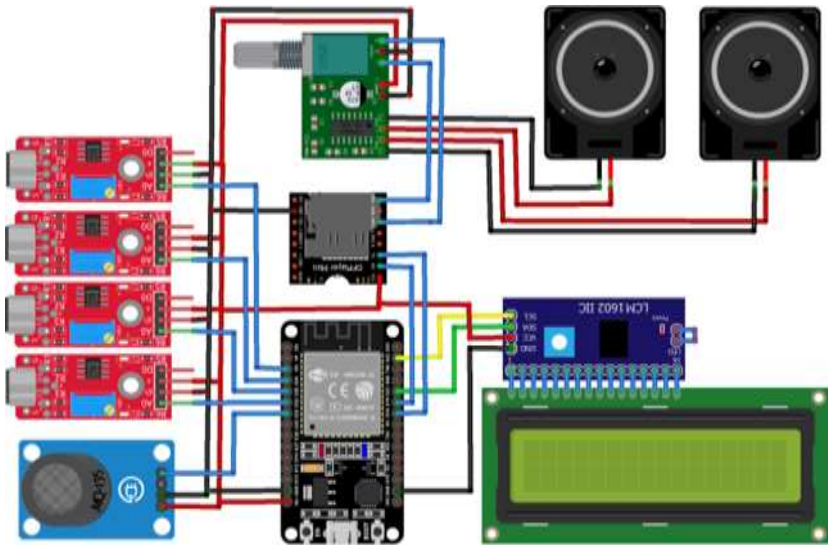


Figure 3 Wiring Diagram

System Workflow Design

The flowchart will explain the system's workflow.

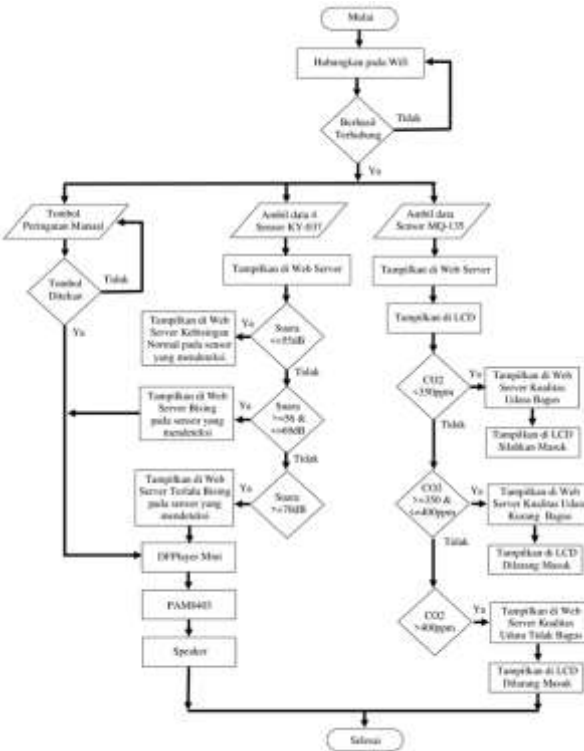


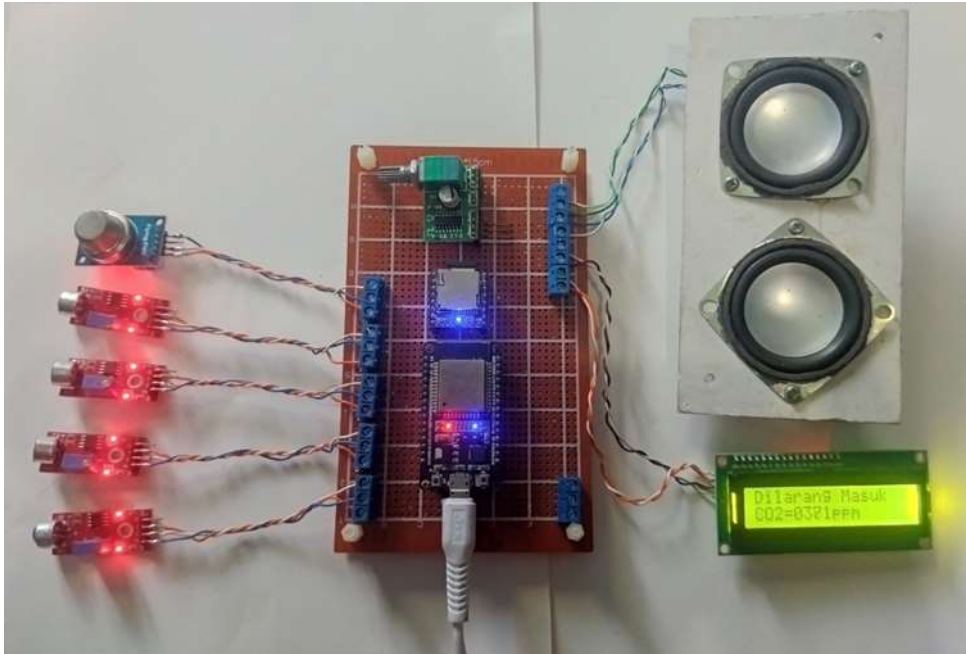
Figure 4. System workflow flowchart

- 1. Start the system.
- 2. Connecting to wifi

3. The process of monitoring four KY-037 sensors on the Web Server with three levels of each sensor (normal, noisy, and too noisy) and one MQ-135 sensor on the Web Server with three levels (good air quality, poor air quality, and poor air quality) and displaying CO2 levels on the LCD.
4. If the manual warning button is pressed, the ESP32 will process and command the DFPlayer Mini to play an amplified alert sound through the PAM8043 so that the speaker lights up, providing a warning sound to visitors to calm down and maintain comfort in the library.
5. If the KY-037 sensor is $\leq 55\text{dB}$, then the Web Server displays normal Noise on the detecting sensor.
6. If the KY-037 sensor is $\geq 56\text{dB}$ and $\leq 69\text{dB}$, then the Web Server displays Noise on the detected sensor. The ESP32 will process and command the DFPlayer Mini to play an amplified warning sound through the PAM8043 so that the speaker lights up to provide a warning sound to visitors to calm down and maintain comfort in the library.
7. If the KY-037 sensor is $\geq 70\text{dB}$, then the Web Server displays Too Noise on the detected sensor. The ESP32 will process and command the DFPlayer Mini to play an amplified warning sound through the PAM8043 so that the speaker lights up, providing a warning sound to visitors to calm down and maintain comfort in the library.
8. If the MQ-135 sensor is $< 350\text{ppm}$, then the Web Server displays Good air quality, and the LCD "PLEASE COME IN".
9. If the MQ-135 sensor is $\geq 350\text{ppm}$ and $\leq 400\text{ppm}$, then the Web Server displays that the air quality is not good, and the LCDs "DO NOT ENTER."
10. If the MQ-135 sensor is $> 400\text{ppm}$, the Web Server displays the poor air quality LCD displaying "PROHIBITED ENTRY".
11. Finish.

Results and Discussion

After the tool has been made, several tests and measurements are carried out to find out the capabilities of the system that has been made.



Web Server Testing

The Web Server test was successful on mobile devices, laptops, computers, etc. On the Web Server, the value of each sensor is displayed along with indicators or level descriptions (Husnira & Rivaldi, 2023). The levels on each sensor amount to 3 levels. On the web server, there is also a Manual Warning Button that functions to turn on the sound from the speaker. The Manual Alert button also works well.

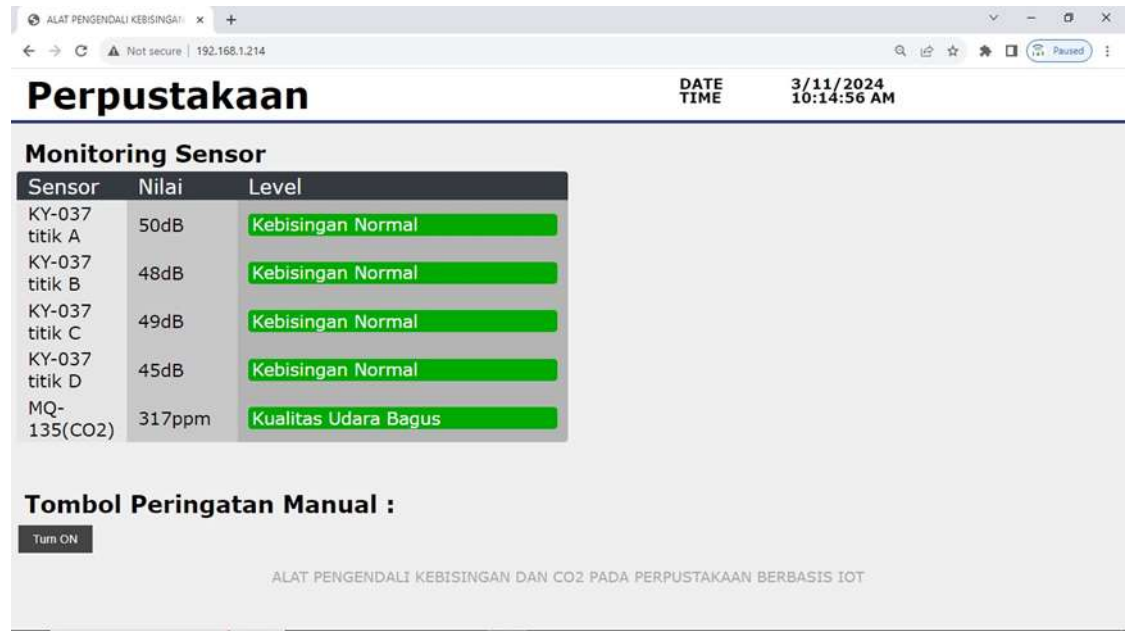


Figure 6. Web Server View

LCD Display Testing

The LCD placed near the library's entrance displays the CO2 level along with a description of whether the library can enter. This test is carried out by closing or opening the air circulation and turning off or turning on the air conditioner so that the CO2 level value and its description change. The tests performed on the LCD were successful.



Figure 7. LCD Testing 1



Figure 8 LCD Testing 2

Measurement of comparison of KY-037 sensor with Sound Level Meter

Before the KY-037 data collection, the KY-037 must be calibrated to obtain accurate measurement data results. The method used is linear regression, where this statistical method is useful for comparing sensor output with linear characteristics to standard values. After calibrating the KY-037 sensor, measurements and data collection were carried out to find the accuracy level value of the KY-037 sound sensor, it is done by comparing the measured values of the Sound Level Meter and KY-037, and then the percentage error value (%Error) is obtained with the formula:

$$\frac{\text{Nilai Sensor} - \text{Nilai Alat Ukur}}{\text{Nilai Alat Ukur}} \times 100$$

No	Sound Level Meter (dB)	KY-037 Sound Sensor (dB)	%Error
1	35.3	36	1.98
2	40.5	42	3.70
3	47.9	49	2.29
4	54.2	55	1.47
5	58.4	60	2.73
6	65.9	68	3.18
7	69.8	71	1.71

8	77.9	80	2.69
9	84.1	86	2.25
10	90.2	92	1.99

The average percentage error value of the KY-037 sensor from the ten measurements was 2.4%. So the accuracy value of the KY-037 sensor is 100% - 2.4% = 97.6%.

Measurement of the MQ-135 sensor compared to the CO2 Analyzer

Before MQ-135 data collection, MQ-135 calibration must be carried out to obtain accurate measurement data results. The method used is linear regression, where this statistical method is useful for comparing sensor output with linear characteristics to standard values. After calibrating the MQ-135 sensor, measurements and data collection were carried out to find the value of the accuracy level of the MQ-135 sensor, so it is done by comparing the measured values from the CO2 Analyzer and MQ-135, then the percentage error value (%Error) is obtained with the formula:

$$\frac{\text{Nilai Sensor} - \text{Nilai Alat Ukur}}{\text{Nilai Alat Ukur}} \times 100$$

No	CO2 Analyzer (ppm)	Sensor MQ-135 (ppm)	%Error
1	302	305	0.99
2	299	302	1.00
3	320	325	1.56
4	335	336	0.29
5	312	314	0.64
6	354	355	0.28
7	337	340	0.89
8	375	377	0.53
9	367	371	1.08
10	342	346	1.16

From the ten measurements taken, the average percentage error value of the MQ-135 sensor was 0.84%. So the accuracy value of the MQ-135 sensor is 100% - 0.84% = 99.16% (Nizam, Yuana, & Wulansari, 2022).

Overall testing

The overall testing of the tool was carried out by conducting experiments using ten conditions.

No	KY-037 A(dB)	KY-037 B(dB)	KY-037 C(dB)	KY-037 D(dB)	MQ-135 (ppm)	Manual Warning Button	Web Server	LCD	Speaker
1	45	47	50	49	317	Unpressed	Appropriate	Appropriate	Mati
2	48	50	59	53	346	Unpressed	Appropriate	Appropriate	Nyala
3	50	45	52	51	339	Unpressed	Appropriate	Appropriate	Mati
4	47	53	49	50	365	Unpressed	Appropriate	Appropriate	Mati
5	52	47	50	52	328	Unpressed	Appropriate	Appropriate	Mati
6	60	55	48	50	312	Unpressed	Appropriate	Appropriate	Nyala
7	53	48	51	52	320	Unpressed	Appropriate	Appropriate	Mati

8	49	52	54	48	370	dit kan	Appropriate	Appropriate	Nyala
9	52	50	46	47	345	Unpressed	Appropriate	Appropriate	Mati
10	48	46	50	52	336	dit kan	Appropriate	Appropriate	Nyala

Conclusion

From the results of the tests that have been carried out, several conclusions are obtained, namely: The noise and CO2 control device in the IOT (Internet Of Things) based library has been completed and can work as planned, the accuracy obtained from the KY-037 sound sensor is quite high, which is 97.6%. However, the good thing is that if the sensor accuracy is improved again, the accuracy obtained from the MQ-135 sound sensor is also quite high, at 99.16%. However, the good thing is that if the accuracy of the sensor is improved again, the web server runs smoothly using AJAX, so that the resulting website does not need to load the entire page, and ESP32 as a microcontroller can control the entire system well.

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