AUTOMATIC COOKER HOOD MONITORING SYSTEM BASED ON INTERNET OF THINGS

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ABSTRACT

Acute Respiratory Tract Infection (ARI) poses a significant health risk, particularly for housewives frequently exposed to kitchen smoke, which contains harmful pollutants like carbon monoxide, potentially leading to serious conditions such as cancer and pneumonia. To address this issue, the development of an effective smoke removal system is crucial. This research employs a Research and Development methodology to design and test an automatic cooker hood that utilizes the MQ-7 sensor for smoke detection, controlling a 12V DC fan through a relay to operate at three adjustable speeds: low, medium, and high, based on real-time smoke intensity. **The Aims** of this study are to create a monitoring tool that efficiently removes kitchen smoke and provides immediate feedback on air quality. **Results** indicate that the system functions optimally, with the fan speed successfully adjusting according to detected smoke levels and displaying data on a 16x2 I2C LCD as well as through the Blynk application, offering clear visualization of air quality metrics. This research introduces a **Novelty** in integrating IoT technology for real-time air quality monitoring in kitchens, enhancing user awareness and intervention capabilities. However, fluctuations in smoke readings from the MQ-7 sensor present a **Knowledge Gap,** highlighting inconsistencies that affect PPM accuracy. **The Implications** of this study suggest the potential for improved health outcomes through better indoor air quality management, while future research should explore sensor accuracy enhancements and optimal placement strategies to ensure more reliable measurements, thereby further advancing the effectiveness of the automatic cooker hood system.

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INTRODUCTION

The kitchen is an important part of a residential house that functions as a place to process food to be served. Without realizing it, smoke from kitchen activities can produce a variety of toxic gases, one of which is carbon monoxide (CO) gas which, if not given precautions, can affect the health condition of the respiratory organs of residents, especially mothers and toddlers [1].

Exposure to toxic gases produced from intensive kitchen smoke over a long period of time can increase the likelihood of residents developing Acute Respiratory Infections (COPD) [2]. The characteristics of individuals infected with ISPA include shortness of breath, sore throat, and headache [3]. To overcome this, residents can take advantage of ventilation ducts. Good kitchen smoke ventilation can increase a person's chances of not being exposed to ISPA by up to 56% [4]. But in some cases, a cooker hood can be the most effective solution to ensure that kitchen smoke can be removed perfectly when the intensity of the smoke produced by cooking activities is at a high level [5], [6]. A cooker hood is a device that functions specifically to suck up smoke from kitchen activities. The device is installed directly above the cooking location, so that the smoke can be immediately sucked up and removed [7]. In its current application, Cooker Hood still function at the same suction speed, regardless of the intensity of the smoke. Therefore, to save the energy expended, it is necessary to have a system where cooker hood can automatically adjust its speed based on smoke intensity.

Previous research on cooker hood automatic as research from Agus Waluyo (2019) where the cooker hood is used as an automatic smoke extractor in the kitchen controlled by an Arduino Nano microcontroller with a PID system using the rotation of the DC motor to regulate the speed of smoke suction detected by the MQ-7 sensor [8].

Then research from Muhammad Taufiq Tamam (2023) regarding Mini Nopia where the smoke from the cooking process interferes with the breathing conditions of the craftsmen. Therefore, the researcher utilized a smoke sensor to detect smoke levels which was then processed using the Arduino Uno. The output produced is a relay that functions to regulate the condition of the exhaust fan as a fume extractor from the cooking of the mini nopia. The rotation speed of the exhaust fan is divided into three, namely low, middle, and high [9].

Finally, research from Nursuwars (2023) where researchers created a system to monitor carbon monoxide gas detected by the MQ-7 sensor which is then processed by an ESP-32 microcontroller where the reading data can be viewed through a 16x2 I2C LCD and sent through technology Internet of Things integrated with the Wireless Sensor Network system [10].

The current research provides an update with the use of Internet of Things technology where the data from the reading of the device can be monitored in real-time using a smartphone [11]. This tool uses a NodeMCU microcontroller ESP8266 as a data processor where this microcontroller has the ability to connect to the internet network so that it is better than Arduino UNO in general [12]. The sensor used is the MQ-7 sensor because of its relatively small size and good sensitivity to detect carbon monoxide gas levels in the air, especially in the kitchen [13]. Then, a 4-channel relay is used as voltage switching based on the MQ-7 sensor reading value [14]. The data readings and relay conditions are displayed using a 16x2 I2C LCD and through the Blynk application installed on the user's smartphone so that real-time monitoring of the air condition in the kitchen can be carried out [15]. With this tool, it is hoped that kitchen air conditions can be maintained at the healthy limit of the ISPU (Air Pollution Standard Index) so as to minimize the possibility of residents contracting ISPA.

METHODS

The research utilizes research and development methods by testing the effectiveness of the tool through various kinds of experiments, improvements, and finalization of the tool in order to overcome the problems faced and achieve the final goal where the product functions in accordance with the research objectives [16]. The stages in the research and development method are problem identification (1); literature studies (2); planning (3); testing (4); repairs (5); and implementation (6).

A. Block diagram

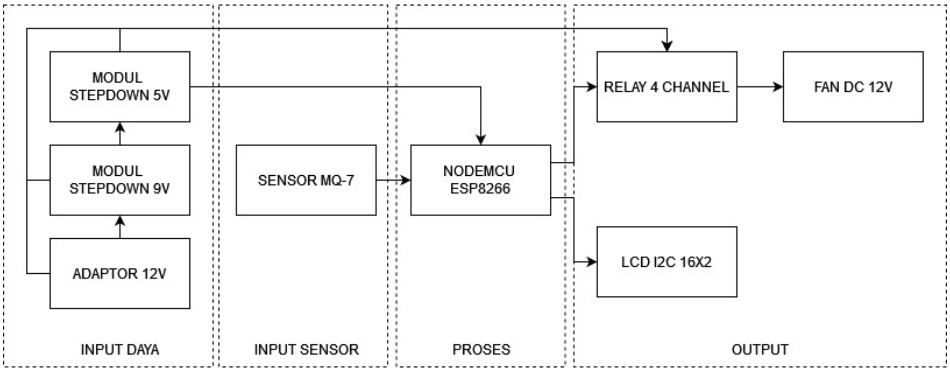

Figure 1. Block Diagram

This research uses an input, namely a 12v adapter as the main power source, which is then connected to two LM2596 step-down modules to divide the voltage into 9v and 5v. Then the sensor input is an MQ-7 sensor processed by NodeMCU ESP8266. The output component consists of three parts, namely a 4-channel relay connected to a 12v DC fan, and a 16x2 I2C LCD as a *display*.

B. Flowchart

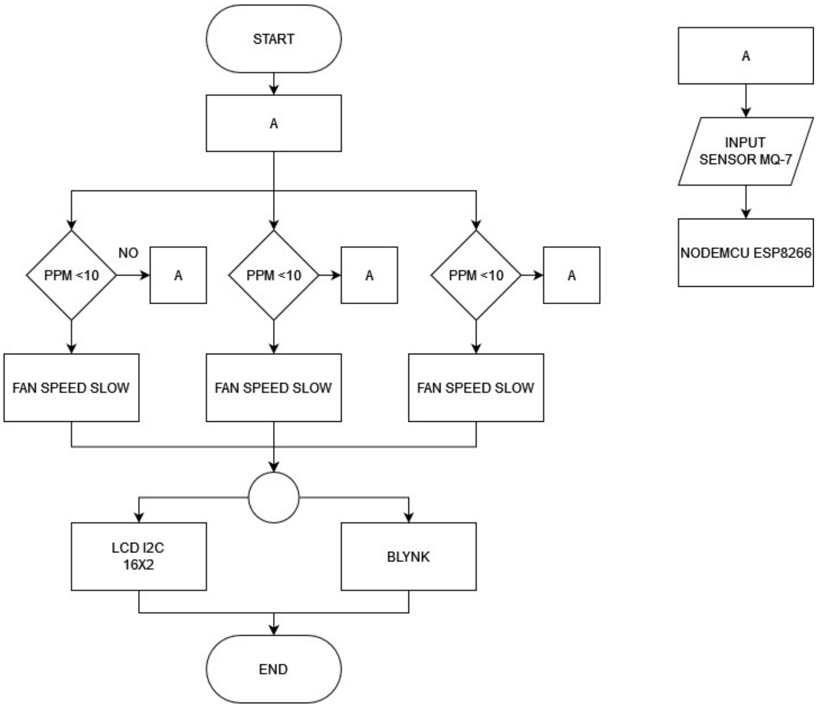

Figure 2. Flowchart

The flow starts with condition A where there is a process of input of the PPM value detected by the MQ-7 sensor, the input data is then processed by the NodeMCU microcontroller ESP8266. After that, there are three *different decisions*, namely when the PPM value detected by the sensor is below 10ppm, the *relay* will activate and give a voltage of 5V to the fan which means "*speed low*". When the PPM rises to 11ppm to 20ppm, the K2 on the *relay* will be activated and provide a voltage of 9V to the fan, which means "*speed medium*". Finally, when the PPM value exceeds 21ppm, the K3 on the *relay* will be activated and provide a voltage of 12V to the fan which means "*speed high*". Sensor reading data and fan speed conditions are displayed through a 16x2 I2C LCD and a Blynk app for *real-time* monitoring by the user.

C. Wiring diagram

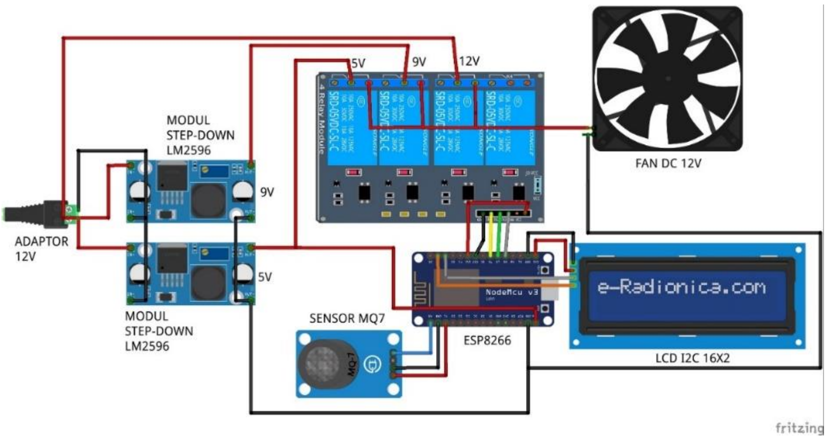

Figure 3. Wiring Diagram

The electrical circuit or wiring diagram from the research made begins with a power input from a 12V DV adapter connected to two LM2596 step-down modules that reduce the voltage to 5V and 9V so that the circuit has three different voltages, namely 5V, 9V, and 12V which are connected by a 4-channel relay, where the first channel is powered by a voltage of 5V, the second channel is with 9V, and a third channel with 12V.

The resulting *step-down* voltage to 5V is then connected with the VIN and GND pins of the NodeMCU ESP8266 as power inputs to the microcontroller. Then pin A0 of the MQ-7 sensor is connected with the A0 pin of the ESP8266 NodeMCU while pins D1 and D2 are connected with the SCL and SDA pins of the 16x2 I2C LCD. Finally, pins D5 to IN1, D6 to IN2, and D7 to IN3 from the 4-channel relay. The 12V DC fan is connected NO (Normaly Open) with a relay.

RESULT AND DISSCUSION

A. MQ-7 sensor test for low fan speed

The MQ-7 sensor test was carried out to determine the suitability of the program logic where when the PPM reading value is in accordance with the limit, which is <10ppm, the fan speed is in low condition. The object detected by the MQ-7 sensor is cigarette smoke, then to test the rotational speed *of the UT373 non-contact fan tachometer is used as a measuring device.*

Table 1. MQ-7 sensor test for low fan speed

Testing Wed-	PPM Value	Fan speed (rpm)
1	5.34	2102
2	5.98	2021
3	6.20	2215
4	6.07	2365
5	5.79	2415
6	5.72	2483
7	5.94	2138
8	6.10	2349
9	6.26	2125
10	6.16	2025
	Average RPM	2223

Table 1 shows that the program logic where when the PPM value is below 10ppm, the fan speed is in a low-speed condition. Ten tests also showed that with little or no smoke, the PPM reading value was consistently below 10ppm. The average RPM for low-speed fans is 2223RPM where the maximum speed of the fan used is 4000RPM.

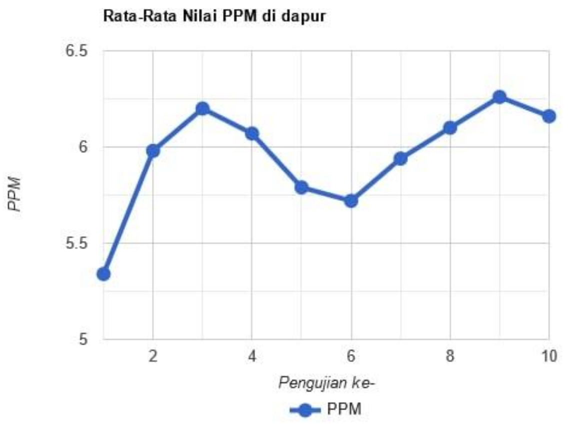

Figure 4. Graph PPM Value for low fan speed.

B. MQ-7 sensor test for medium fan speed

The MQ-7 sensor test was carried out to determine the suitability of the program logic where when the PPM reading value is in accordance with the limit, which is >11ppm to <20ppm, the fan speed is in medium or medium conditions.

Table 2. MQ-7 sensor test for medium fan speed

Testing Wed-	PPM Value	Fan speed (rpm)
1	12.14	3216
2	11.25	3321
3	13.24	3124
4	16.28	3257
5	14.81	3269
6	15.67	3157
7	14.53	3261
8	18.47	3367
9	15.64	3412
10	12.68	3258
	Average RPM	3264

Table 2 shows that the program logic where when the PPM value is between >11ppm to below 20ppm, the fan speed is in a medium or medium speed condition. Ten tests also showed that with moderate smoke intensity conditions, the PPM readings consistently ranged from >11ppm to below 20ppm. The average RPM for a medium speed fan is 3264RPM where the maximum speed of the fan used is 4000RPM

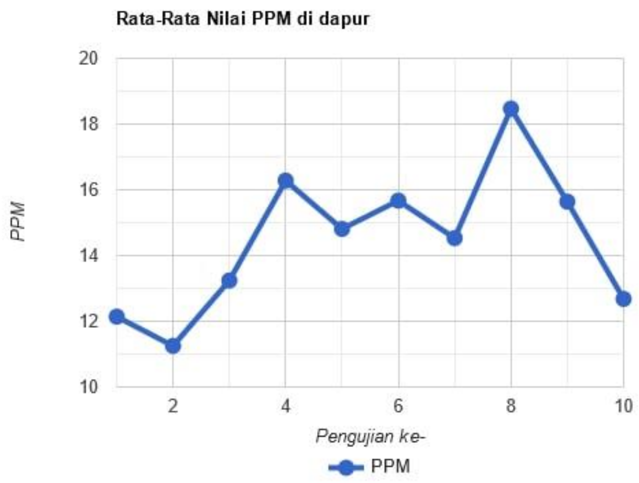

Figure 5. Graph of PPM Value for medium fan speed.

C. MQ-7 sensor test for high fan speed

The MQ-7 sensor test was carried out to determine the suitability of the program logic where when the PPM reading value is in accordance with the limit, which is >21ppm, the fan speed is in high conditions.

Table 3. MQ-7 sensor test for high fan speed

Testing Wed-	PPM Value	Fan speed (rpm)
1	21.05	3994
2	22.84	3945
3	21.56	4012
4	24.36	4008
5	25.65	3987
6	25.78	3968
7	29.85	3978
8	24.68	4010
9	30.01	4003
10	32.32	3998
	Average RPM	3990

Table 3 shows that the program logic where when the PPM value is above 21ppm, the fan speed is in a high-speed condition. Ten tests also showed that with thick or high smoke intensity conditions, the PPM reading value was consistently above 21ppm. The average RPM for a medium speed fan is 3990RPM where the maximum speed of the fan used is 4000RPM.

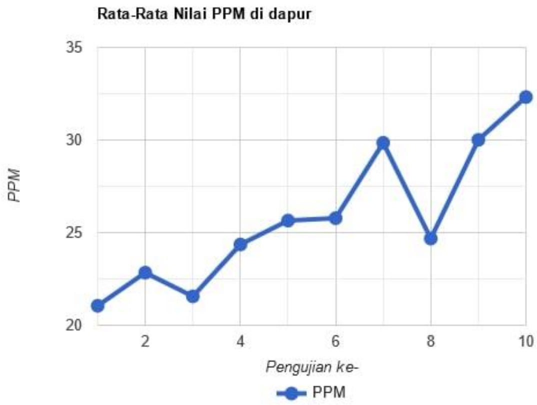

Figure 6. Graph of PPM Value for medium fan speed.

D. Testing data delivery to the Blynk app

The test of sending the data of the device's reading results to the Blynk application is intended to determine the *delay* between the reading time and the delivery.

Table 4. Testing sending data to Blynk

Testing Wed-	Data Condition	Standby Time(s)	Response Speed
1	Sent	2.1	KEEP
2	Sent	1.5	FAST
3	Sent	1.2	FAST
4	Sent	1.6	FAST
5	Sent	1.3	FAST
6	Sent	1.1	FAST
7	Sent	1.2	FAST
8	Sent	1.4	FAST
9	Sent	1.2	FAST
10	Sent	1.1	FAST
Average wait time		1.37	

Table 4 shows the average waiting time or delay between reading the device and sending data to the Blynk application, which is 1.37 seconds, which is relatively fast, making it easier for users to get *real-time* data quite accurately.

E. Bynk app testing

The creation of the Blynk application that can be downloaded for free on the user's smartphone is shown in the image below. There are four main *widgets*, namely a label containing the text "Cooker Hood IoT", then *a gauge* to display the reading value of the MQ-7 sensor, an LED on the right side of the *gauge* that will change color when the PPM value exceeds 21ppm, and finally *a superchart* that functions as a display of the sensor reading history in the form of *a line chart*.

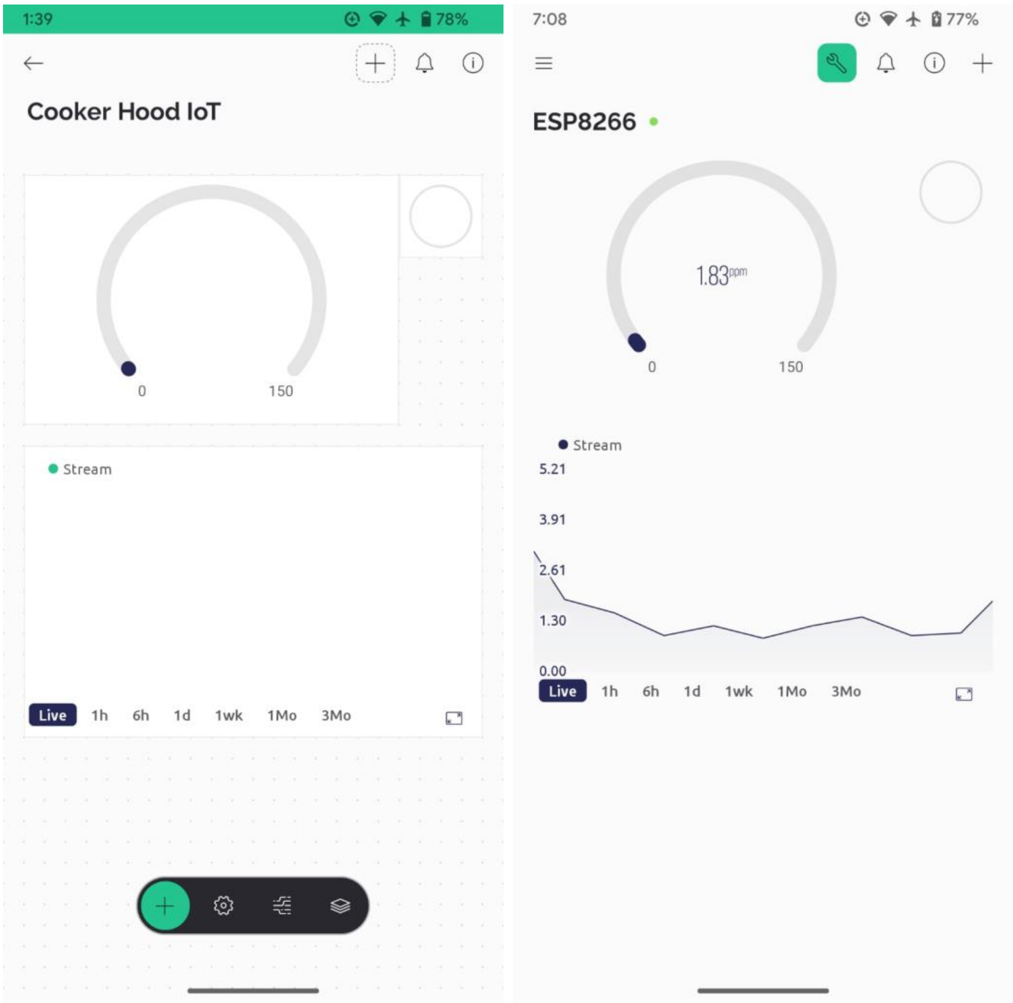

Figure 7. Blynk App Testing

The image on the left side shows the display of the application when it has not received data, while the image on the right side is the display when the application receives data from the carbon monoxide gas level reading from the device. It can be seen that the gauge in the application is filled according to the value read from the sensor with the maximum limit *of the gauge* being 150 ppm.

F. Overall testing

Overall testing is carried out to ensure that the system on the tool works according to the research objectives. The test was carried out 10 times and the test results can be seen in the following table:

Table 5. Overall System Test Results

No	PPM Value	Fan Speed	Data Submission to Blynk
1	25.52	HIGH	Sent
2	12.28	WITH	Sent
3	5.21	LOW	Sent
4	30.25	HIGH	Sent
5	6.55	LOW	Sent
6	11.27	WITH	Sent
7	24.95	HIGH	Sent
8	11.84	WITH	Sent
9	17.24	WITH	Sent
10	11.21	WITH	Sent

Table 5 presents the results of the testing of the tool system made in the study. The results indicate that the appliance functions according to the given logic where the fan speed on the *cooker hood* will switch on the *relay* based on the smoke intensity detected by the MQ-7 sensor. The real-time data transmission to the Blynk application shows that the process *of monitoring* kitchen air conditions can be done easily and can be monitored through *a smartphone*.

CONCLUSION

In conclusion, this study successfully developed an automatic cooker hood monitoring system that effectively addresses the risks associated with kitchen smoke exposure, particularly for housewives susceptible to Acute Respiratory Tract Infections (ARI). The **Fundamental** Finding reveals that the cooker hood can operate at three distinct fan speeds (SLOW, MED, HIGH) based on real-time smoke intensity detected by the MQ-7 sensor, providing a practical solution for improving indoor air quality. The **Implication** of this research highlights the potential for significant health benefits through enhanced smoke management, thereby reducing the risk of respiratory issues linked to prolonged exposure to kitchen pollutants. However, a notable **Limitation** is the inconsistency in smoke readings from the MQ-7 sensor, which affects the accuracy of PPM measurements and could lead to suboptimal performance of the system. **Further research** is recommended to explore alternative sensors and optimize their placement to enhance measurement reliability, as well as to assess the long-term effectiveness of the system in diverse kitchen environments, ensuring that the monitoring tool achieves its intended health protection goals.

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