Design and Development of Body Temperature Detection and Attendance Equipment in Covid-19 Era Based on the Internet of Things

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ABSTRACT
Every effort has been made to break the chain of the spread of the COVID-19 virus. Starting from maintaining distance, wearing masks, washing hands, uniting body temperature, to invitations to participate in vaccinations. However, apart from vaccination during the COVID-19 pandemic, the need for jobs that must come directly on the spot remains undeniable. Therefore, the researchers researched to produce a design for attendance and body temperature detection in the COVID-19 era based on the internet of things. Media for monitoring arrival times and body temperature to support workers or visitors who come to work but still comply with regulations. The method used is quantitative. Testing the design of the tool using a subject consisting of 10 students at the Telematics Laboratory of the Electrical Engineering building A8 Surabaya. The results showed that the internet-based attendance and body temperature detection tool in the COVID-19 era that was successfully made with the components of the MLX90614 body temperature which has a 100% Fahrenheit to Celsius temperature conversion calibration is the same as manual calculation conversion, MLX90614 has an ideal reading distance value with a distance of 1 cm to 5 cm from the human body. RFID reader that can compare card match codes. with the database, as well as DS1307 as an RTC module that provides time information. Attendance monitoring has been successfully carried out via the internet using the Blynk application, with one example being a user named Fajar who took attendance on Monday 28 June 2021 at 8:40:21 WIB and his temperature was 35,63°C.

Keywords: *COVID-19, Attendance, Internet of Things*

1. INTRODUCTION

The end of December 2019 was the beginning of a deadly epidemic that continued unabated even when this journal was written. The beginning of the spread of this deadly epidemic precisely originated from the city of Wuhan, Hubei province, China. From that city, a new virus was discovered which is currently commonly referred to as COVID-19. After the spread of the virus began to spread throughout the world, the World Health Organization (WHO) declared a Public Health Emergency of international concern on January 30, 2020, and the status of the pandemic was announced in March 2020 [1]. The first case of COVID-19 patients in Indonesia was identified on March 2, 2020, in the Depok area, West Java. Starting at the end of August 2020, the number of new positive cases in Indonesia reached more than two thousand per day, and the number of positive diagnosed cases reached more than 196,000 [2]. The Indonesian COVID-19 Handling Task Force created an official website sourced from WHO and intended to provide information on the number of cases that occurred. Data on COVID-19 cases with the latest data update on June 23, 2021, can be seen in table 1 [3]

Table 1 Data on Covid-19 cases in Indonesia.

No	Case	Number
1.	Positive	2.033.421
2.	Recover	1817.303
3.	Died	55.594

Every effort has been made to break the chain of the spread of the COVID-19 virus. Starting from keeping a distance, using masks, diligently washing hands, monitoring body temperature, to invitations to participate in vaccinations. The number of vaccination data in Indonesia can be monitored on the official website covid19.go.id which has been protected by the Committee for Handling COVID-19 and National Economic Recovery. Update on the number of vaccinations on June 23, 2021, can be seen in table 2.

Table 2 List of vaccination targets.

No.	Pieces of information	Number
1.	Vaccination Targets	181.154.465
2.	First Vaccination	24.358.856
3.	Second Vaccination	12.640.041
4.	Vaccination targets health human resources, public officials, and the elderly	40.349.049

Apart from vaccinations during the COVID-19 pandemic, the need for work that requires coming directly on the spot cannot be denied, therefore in every place has now been given a strong appeal to always provide a handwashing place or hand sanitizer and also equipped with detection devices body temperature at the entrance area to maintain health protocols. Many things are being sought by researchers in the current era to participate in breaking the chain of virus spread as was done by Rindi in 2020 who researched body temperature measuring devices displayed on a 16x2 LCD screen and the sensor used was DS18B20 [4]. A similar study was also conducted by Dainty in 2020 with the title of detecting body temperature using infrared, this study uses an OLED screen as a display of body temperature [5]. In the same year, Polly conducted a similar study involving temperature detection with a microcontroller and using an LCD to display temperature values [6].

From the background described above and the research that has been done previously, the researchers researched to produce a design for attendance and body temperature detection in the COVID-19 era based on the internet of things as a monitoring medium using smartphones in showing arrival times and temperatures. body to support workers, students, or visitors who require to come in place but also still comply with health protocols.

2. LITERATURE REVIEW

ESP32 is a development of the ESP8266 as internet of things-based microcontroller [7]. If the ESP8266 appeared in 2014, the ESP32 appeared in 2016. The ESP32 has 520 kilobytes of SRAM memory, 448 kilobytes of ROM, and has 34 programmable input-output pins. Espressif Systems released several modules that use the ESP32 IC and one of the popular options is the ESP-WROOM-32 Module.

MLX90614 is a temperature sensor that uses infrared to detect temperature changes. This sensor module has an I2C communication line that mandates the SDA and SCL pins as a communication line between the sensor module and the microcontroller [8].

RFID Reader with type RC522 is a product from NXP that uses fully integrated 13.56MHz non-contact communication between card chips to read and write code. Cards on RFID are widely used as identity cards or as identification [9]. DS1307 is a real-time clock component that is easily combined with a microcontroller to provide time information [10].

3. METHODS

This study uses quantitative methods. A quantitative research method is a research that uses data as analysis to test knowledge of something [12]. This research begins with a literature study of the related constituent components, followed by the design of the system flow diagram and the design of the wiring system. After the system diagram and wiring, the design has been successfully created, the next step is to test the tool. The tool testing in this study started from testing the performance of the body temperature sensor, RFID reader, RTC ds1307, and the last test was testing the final result in the form of monitoring from an internet-based smartphone. The final data collection used a subject consisting of 10 students at the Telematics Laboratory of the Electrical Engineering building A8 Surabaya.

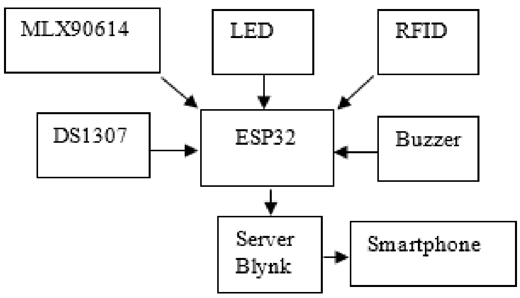

Figure 1 Tool system diagram.

MLX90614 is a body temperature sensor used in this study. The sensor is still capable of detecting the temperature of the surrounding room [13], therefore, an LED is given as an indicator that the temperature sensor has detected the temperature value on the user's body. The use of LEDs as a checking indicator has been mentioned in a study conducted by Farid in 2020 [11]. After the indicator light is on, the user is welcome to take attendance by bringing the card closer to the RFID reader. After the reader reads the user's card ID, the buzzer will give a signal that the card has been read. DS1307 as RTC will be triggered to provide timely information in the form of day, date, month, year, hour, minute, and second when the user does attendance. Body temperature data, user identity, and time will be processed in ESP32 and sent to the Blynk server which will then be displayed on the smartphone. To better understand the working system of this tool, the author makes a system flowchart which can be seen in Figure 2.

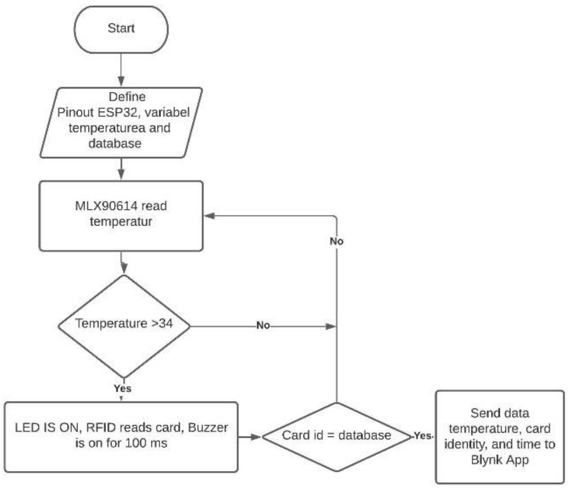

Figure 2 Alarm system flowchart.

When the tool is first turned on, the first process that is carried out is the declaration of pinout on esp32 and the declaration of variables in the form of temperature, card owner identity database, and time which runs along with the western part of Indonesia time. The temperature variable will serve as temporary storage of the temperature value detected by the MLX90614, the card owner's identity variable is in charge of storing information in the form of the card code and the name of the card owner, and the time variable is in charge of storing information on the current running time. When the variable declaration has been made, ESP32 calls data from MLX90614 in the form of temperature information that is captured continuously. The temperature sensor will continue to work to read the temperature value even though there is no object in front of it, but the ESP32 must be able to distinguish room temperature from body temperature by stating that when the detected temperature rises exceed 34 degrees Celsius, then the temperature value is the body temperature value. When the ESP32 gets a temperature value above 34 degrees Celsius, the LED indicator will light up. This process also signals that the RFID reader is ready to read the user's card. After the user brings the card closer to the RFID reader, the buzzer will sound for 100 ms and the ESP32 will perform the process of comparing the read card code with the identity variable of the card owner. but if the code being compared matches, the data on body temperature, name of the card owner, and time of arrival will be sent to the smartphone with the Blynk application.

In making it easier to read the wiring in this study, the wiring hardware will be made in the form of a table that can be seen in table 3 and a circuit drawing will be shown in each component testing discussion.

Table 3 Wiring pinout tool.

ESP32	DS1307	MLX90614	RFID	LED	Buzzer
3.3v	VCC	VCC	VCC	-	-
GND	GND	GND	GND	Katoda	Katoda
21	SDA	SDA	-	-	-
22	SCL	SCL	-	-	-
13	-	-	RST	-	-
19	-	-	MISO	-	-
23	-	-	MOSI	-	-
18	-	-	SCK	-	-
12	-	-	SDA	-	-
27	-	-	-	Anoda	-
14	-	-	-	-	Anoda

4. RESULTS AND DISCUSSION

By what has been stated in the research method, testing will be carried out based on the performance of each component. The first test was carried out on the MLX90614 component which is a body temperature sensor. In testing the temperature sensor, the circuit used can be seen in Figure 3.

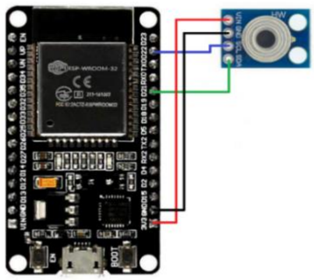

Figure 3 Wiring ESP32 with MLX90614.

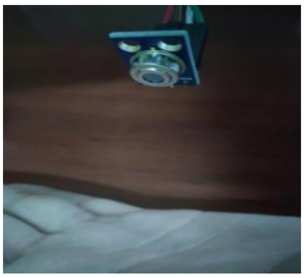

Figure 4 Testing MLX90614.

In figure 4, it shows the MLX90614 body temperature sensor is measuring the temperature value on the user's body by firing infrared at the object in front of it. To distinguish room temperature from body temperature, sensor data retrieval will be indicated by a lit LED. To find out the temperature value that is read, the temperature value will be displayed on the Arduino IDE serial monitor. Before taking data, the body temperature detected by MLX must be converted to Celsius units. As mentioned in the research conducted by Egi Aswiranda, the formula for temperature conversion from Fahrenheit to Celsius is as follows in equation (1) [14]:

$$\text{Celsius} = (\text{Fahrenheit} - 32) \times (5/9) \quad (1)$$

This formula will be changed in the form of Arduino programming so that the temperature value read by MLX90614 immediately displays temperature value information in units of degrees Celsius. To prove that the temperature conversion value is following the given formula, the value processed by esp32 will be compared with manual calculations by taking 5x numbers. An example of calculating the temperature conversion from Fahrenheit to Celsius is as follows:

$$\text{Celsius} = (\text{Fahrenheit} - 32) \times (5/9)$$
$$= (85°F - 32) \times 5/9$$
$$= (53) \times 5/9$$
$$= 29{,}44\ °C$$

As previously mentioned, programmatically taking numbers and manual calculations were carried out 5 times and the results showed the same value. Then the results of the comparison of temperature conversions based on calculations from ESP32 and manual calculations are written in table 4.

Table 4 Comparison of temperature conversion.

No.	ESP32 Convertion		Manual Convertion	
	Temp (°F)	Temp (°C)	Temp (°F)	Temp (°C)
1.	85	29,44	85	29,44
2.	88	31,11	88	31,11
3.	91	32,78	91	32,78
4.	94	34,44	94	34,44
5.	97	36,11	97	36,11

After the calibration of the conversion, the calculation has been successfully carried out, the next step is to take data in the form of testing temperature values on 5 different subjects. The test results can be seen in table 5.

The test results on the MLX90614 were compared to the DS8826 infrared thermogenic and the results can be seen in Figure 5.

Table 5 MLX90614 test result.

Subject	First Test	Second Test	Third Test	Avg
1.	35.67 °C	35.70 °C	35.49 °C	35.62 °C
2.	36.81 °C	35.92 °C	36.10 °C	36.28 °C
3.	34.90 °C	35.05 °C	35.11 °C	35.02 °C
4.	34.85 °C	34.49 °C	35.02 °C	34.79 °C
5.	34.77 °C	34.50 °C	34.45 °C	34.57 °C

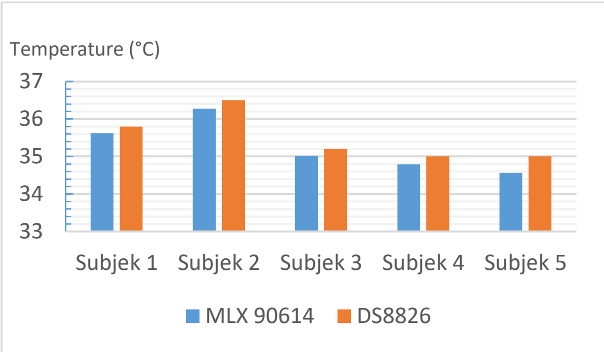

Figure 5 Temperature comparison graph.

MLX90614 is given another test of the distance between the sensor readings and the body. This is done to get the best distance in reading body temperature values. This distance test is carried out with the same subject but it has 5 different distance values and the test results can be seen in table 6.

Table 6 Distance of temperature sensor with body.

No.	Distance	Temperature
1.	0 cm	45,21 °C
2.	1 cm	35,25 °C
3.	3 cm	35,23 °C
4.	5 cm	35,33 °C
5.	7 cm	34,05 °C

From the distance testing that has been carried out, the MLX90614 can work ideally at a distance of 1 cm to 5 cm, if the distance between the body and the sensor is too close, the temperature value will increase and if the distance between the body and the sensor is further away, the temperature value will decrease and get closer to a room temperature value. This is also proven by research conducted by Joshua in 2020 [15].

The next test is a test of RFID which can be seen in Figure 7. The series of RFID readers against ESP32 can be seen in Figure 6. RFID testing was carried out by 5 different card subjects and each card was tested for similarities 3 times. The test results show the same value even though the test is carried out 3 times, this indicates that the RFID reader works well and can be seen in table 7.

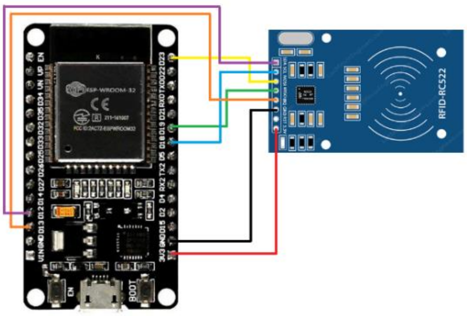

Figure 6 RFID circuit with ESP32.

Figure 7 Testing RFID reader.

Table 7 RFID reader test results.

Card	First Test	Second Test	Third Test
1	185,162,24,137	185,162,24,137	185,162,24,137
2	220,40,86,211	220,40,86,211	220,40,86,211
3	150,246,144,26	150,246,144,26	150,246,144,26
4	28,104,223,13	28,104,223,13	28,104,223,13
5	6,184,201,28	6,184,201,28	6,184,201,28

After testing the RFID reader, the next step is testing the RTC ds1307 which functions as time information. In this test, the ds1307 will provide timely information in the form of days, dates, months, years, hours, minutes, and seconds after the identity of the RFID user has been identified. The data collection of the test results was carried out on 5 different subjects. The ds1307 circuit with ESP32 can be seen in Figure 8.

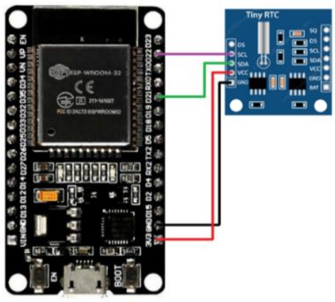

Figure 8 DS1307 circuit with ESP32.

Table 8 Test results DS1307.

No.	Card ID	Attendance		
		Day	Date	Time
1	185,162,24,137	Thursday	24-6-2021	9:10:32
2	220,40,86,211	Thursday	24-6-2021	9:11:45
3	150,246,144,26	Friday	25-6-2021	8:48:55
4	28,104,223,13	Friday	25-6-2021	9:21:23
5	6,184,201,28	Friday	25-6-2021	10:11:36

The three main components of the preparation of the tool have been tested. The next thing to do is to connect the tool to the internet and the Blynk application to do online monitoring. After the device was connected, testing of the device was carried out on 10 different subjects to take attendance and measure body temperature for each subject. The table of test results can be seen in Table 9 and the monitoring display using the Blynk application can be seen in Figure 9.

5. CONCLUSION

From the research that has been done, it can be concluded that the internet of things-based attendance and temperature detection tool has been successfully made with the components of a temperature sensor of type MLX90614 and has calibrated the conversion value from Fahrenheit to Celsius with a comparison of calculations with programs and manual calculations that show similarities.

Table 9 Tool Test Results on Blynk

Name	Card ID	Attendance			°C
		Day	Date	Time	
Retno	220,40,86,211	Monday	28-6-2021	9:10:11	34,41
Wulan	150,246,144,26	Monday	28-6-2021	9:11:23	36,05
Fajar	185,162,24,137	Monday	28-6-2021	9:33:15	35,63
Rini	28,104,223,13	Wednesday	30-6-2021	8:30:02	35,20
Ilham	6,184,201,28	Wednesday	30-6-2021	8:35:12	35,05
Kusuma	12,128,286.24	Wednesday	30-6-2021	9:02:41	34,77
Riski	132,96,3,49	Friday	2-6-2021	10:05:22	34,35
Dinda	174,124,15,113	Friday	2-6-2021	13:14:21	35,22
Andre	151,99,91,239	Friday	2-6-2021	13:21:13	35,60
Ari	196,122,237,4	Friday	2-6-2021	13:25:14	36,02

By 100%, the temperature sensor is also calibrated with a temperature detector that already exists in the market with the DS8826 type which shows almost the same temperature value, temperature sensor MLX90614 has an ideal reading distance value with a distance of 1 cm to 5 cm from the human body. If the distance between the body and the sensor is too close, the temperature value will increase and if the distance between the body and the sensor is further away, the temperature value will decrease and get closer to the room temperature value. RFID reader which can read the user card and the ESP32 can compare the card owner's code with the card owner's database, the ds1307 which provides information on arrival time, as well as monitoring attendance information from the Blynk application on a smartphone connected to the device.

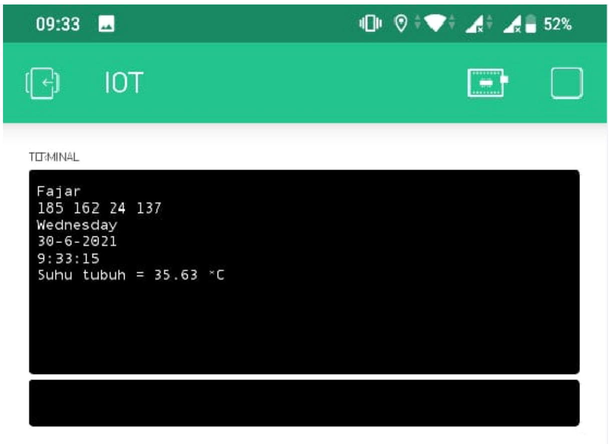

Figure 9 Monitoring Display on Blynk App.

In the final test results in Table 9, it is found that 10 users have successfully performed attendance and can be monitored through the Blynk application. One example of a user is Fajar who takes attendance on Monday, June 28, 2021, at 8:40:21 WIB and his temperature was 35,63°C.

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