Advances in Social Science, Education and Humanities Research, volume 651
Proceedings of the 4th International Conference on Innovation in Engineering and Vocational Education (ICIEVE 2021)

Application of Temperature Measurenment Contactless with Bidirectional Visitor Counter Using IoT as a Covid-19 Protocol

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***Abstract*—Adaptation due to the Covid-19 pandemic has changed the order of life. When activities begin to move again, at the same time we must remain vigilant so that the spread of the virus can be suppressed. One that can realize health protocols in public places and facilities is the engineering process, such as by providing a visitor counting system accompanied by recording body temperature as screening and being able to restrict access as a form of implementing health protocols. The system is also expected to facilitate security officers in the process of optimally implementing health protocols. The system built consists of hardware temperature sensor MLX90614 with an accuracy value of 99.50%, TOF and IR sensors to count visitors in two directions, Node MCU ESP32 as the main controller and website as information media that shows the temperature of visitors, number of visitors, number of outbound visitors, and available places. This system is also equipped with an SD card facility so that it can simplify the process of screening and recording visitors every day. This system is practical because it can be implemented on a one-door system which is usually used as an entrance and exit door at the same time.**

Keywords—temperature, measurement, visitor counter, IoT, Covid-19

I. INTRODUCTION

Corona Virus 2019 or Covid-19 is a pandemic that has resulted in high mortality rates in various countries [1,2]. A pandemic is an event that threatens public health in general [3]. On April 4, 2021, there were 1.5 million confirmed cases of Covid-19. Along with the Covid-19 outbreak, the Indonesian government issued a health protocol. The health protocol will be implemented throughout Indonesia by the government with centralized guidance by the Indonesian Ministry of Health.

Among the health protocols are using masks, maintaining distance, and washing hands with soap [4]. In various sectors, the health protocols were even mentioned, including wearing masks, washing hands with soap, maintaining distance, staying away from crowds, and limiting mobility. As time goes by, adaptation due to the Covid-19 pandemic has changed the order of life, when activities begin to move again, at the same time we must remain vigilant so that the spread of the virus can be suppressed. One that can realize health protocols in public places and facilities is the engineering process, such as by providing a visitor counting system accompanied by recording body temperature as screening [5]. It becomes a necessity to record daily screening activities and data.

One example of the application of the health protocol is in the implementation of learning that must provide sanitation and hygiene facilities to wash hands with running water and use soap, and have a body temperature measuring device shoot [6]. However, the number of those who access the infrastructure is feared not to be observed due to physical contact and restrictions on access between users and the infrastructure. Therefore, engineering is needed to minimize the occurrence of crowds between infrastructure users and other users or users and the infrastructure itself. The need for a system that can calculate mobility in a building is very useful, but access to the entrance with the same exit becomes an obstacle [7]. The engineering needed includes making a visitor recording system by utilizing sensors [8,9] as well as a system that can be stored at an access entrance but is often also accessed as an exit. The temperature detection process can also be applied automatically using sensors [10–12] to facilitate the recording process and facilitate the screening process because data processing uses a microcontroller. Recording visitors can adapt from internet-based systems or carry the concept of the Internet of Things (IoT) [13–15].

The use of observation infrastructure for access restrictions in an area is very useful for implementing health protocols and a rapid IoT-based screening process which is expected to facilitate the application of health protocols in various sectors such as schools, places of worship, hospitals, offices, recreation areas, shopping centers, lodging, and other public facilities. The system is also expected to assist and facilitate security officers in the process of implementing health protocols. The practicality of the system can also be viewed from its application. This system also becomes practical because it can be implemented on a one-door system which is usually used as an entrance and exit door at the same time.

II. Research Methodology

The system consists of hardware and software. Based on the criteria and system requirements, design specifications and requirements can be determined based on the mechatronics domain, the electronics domain, and the informatics domain. The system designs and specifications that can be applied are as follows:

- The system can check the visitor's body temperature
- The system can count the number of visitors and determine the availability of capacity
- The system can provide warning information in the form of sound
- Integrated system with IoT
- The system can perform visitor calculations in two directions
- The system has data storage

A. System Architecture

The first step in designing a system is to describe it in several forms as shown in Figure 1. The figure shows the data flow that occurs in the visitor counter system and body temperature. The entities of the system are sensors, microcontrollers, and websites. The beginning of the data flow in the system is when the sensor receives energy from the outside so that it can read and provide data in the form of sensor readings which will be processed on the microcontroller part. Furthermore, the sensor reading data will be processed into raw data and then forwarded to the website via IoT. Next, we can see the results of the data on the website that has been designed.

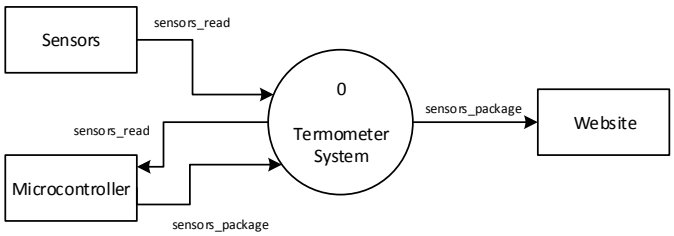

Fig. 1. DFD level 0 visitor counter system and body temperature.

A more complete data flow can be shown in Figure 2 in the form of a level 1 data diagram. In the diagram it can be seen that there is some data prepared by the microcontroller, then the microcontroller sends the data using the internet with the MQTT protocol to the HiveMQ broker. The microcontroller sends data in JSON format and creates topics that can be published on the broker. the website to be linked can retrieve the required data by accessing the HiveMQ broker using a subscribed topic. In Figure 2 it can be seen that the data stored by the HiveMQ broker is data on the calculation of people entering, calculating data for people leaving, body temperatures of people entering, and the available capacity in a room/building.

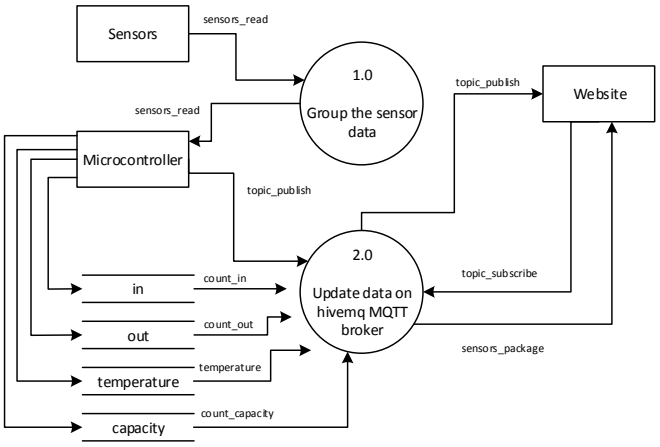

Fig. 2. DFD level 1 visitor counter system and body temperature.

B. Flowchart of Microcontroller Programming

Microcontroller programming in research has been determined based on needs and specifications. In Figure 3 at first, the microcontroller can initialize input and output. Furthermore, to communicate properly, the microcontroller must be able to communicate directly with the main devices such as Wi-Fi connections, SD card modules, and LCD modules. The system will continue to repeat until all the modules are connected. If it is connected then the microcontroller must be able to read all input from the sensor in the form of a temperature reading trigger, people entering and leaving people. The data processed by the microcontroller is then grouped into one package in JSON format so that it will be easier to send to the broker. The microcontroller must also display some pre-determined conditions as abnormal conditions, such as a temperature reading of more than 37.3°C which can indicate a fever. The evaluation results can then be recorded on a connected SD card, and turned on a notification in the form of sound.

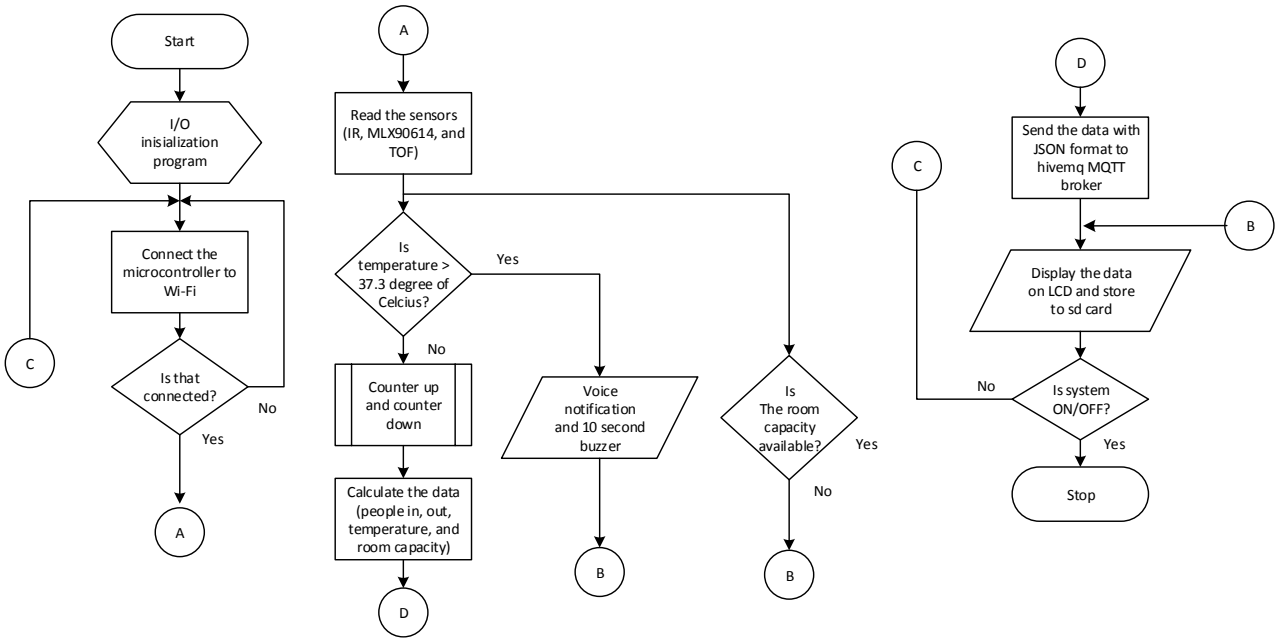

Fig. 3. Flowchart of microcontroller programming.

When the senor functionality and data processing on the microcontroller is complete. Data that has been compiled using the JSON format will be sent to the HiveMQ broker using the MQTT communication protocol. Microcontroller connected to. The data that has been packaged will then be sent for every condition of temperature readings, detection of people entering, and detection of people leaving. After the data packet is sent to the HiveMQ broker and displayed it on the LCD, the task of the microcontroller is complete. The program will continue to repeat until the system is turned off.

C. Design of Electronic Hardware

Based on the data flow in the DFD image, it can be realized that the signal processing process contained in the system includes signals in the form of triggers for people who enter, people who leave, and the body temperature of the person to be evaluated. To process quickly a microcontroller is needed to process the data in JSON format and send the data to the HiveMQ broker using the MQTT protocol. So that the available data will be quickly displayed when accessed by several operators with different devices such as using a PC or cellphone. The following block diagram of the signal processing that occurs in the electronic components is shown in Figure 4.

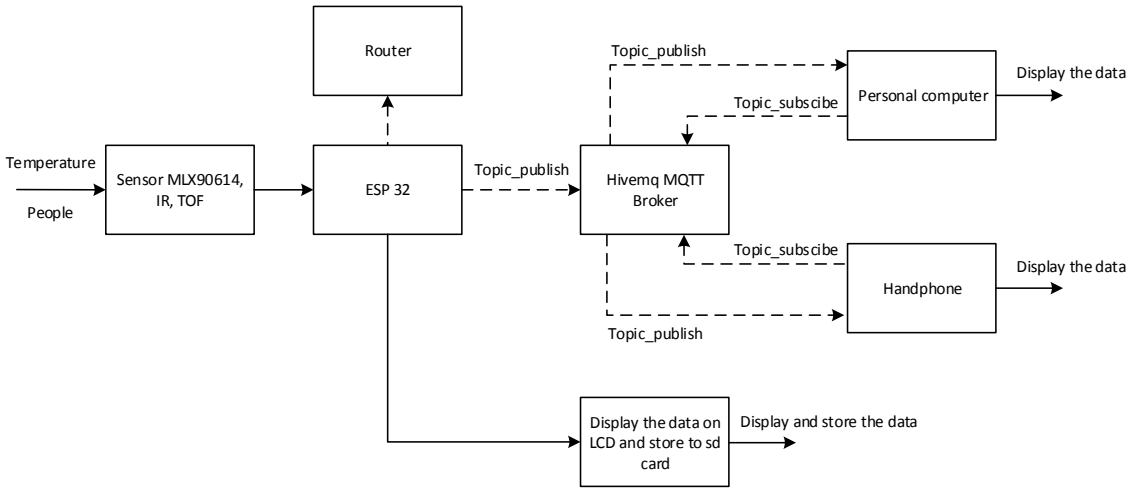

Fig. 4. Block diagram of signal processing.

D. UML Use Case

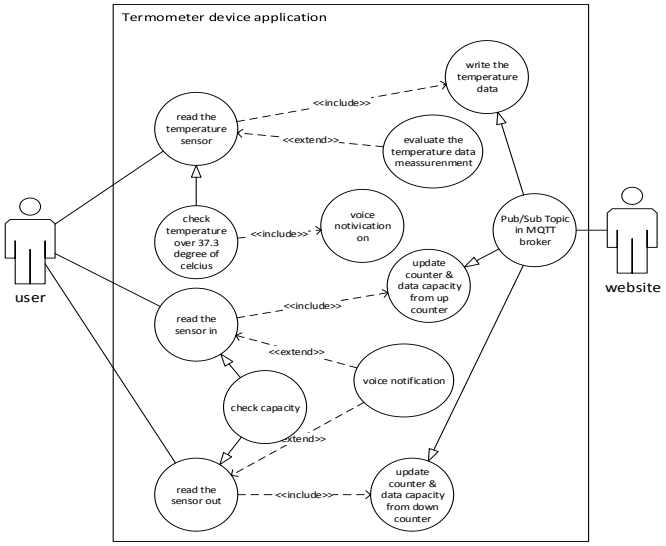

Fig. 5. UML use case diagram of system application.

The next step in realizing the system so that it can be connected using the website can be designed the initial design of the functionality of the application using the UML use case diagram shown in Figure 5. in the picture two actors are consisting of the main are users/people/visitors and the co-actors are the IoT website side. Users who want to enter are required to take body temperature measurements, the system will evaluate the body temperature of the end then there will be a notification if the temperature is below 37.3° C with the sound "Please Enter" and if a temperature is detected above 37.3° C it will appear sound notification “Your Temperature is High, No entry”. If the temperature is normal and enters the room, the system will give a notification in the form of a "Welcome" sound. At the same time, when there is an interaction between the system and the visitor, the system will perform the data retrieval process and if the visitor has entered the dining room the system can immediately perform calculations automatically while calculating the available capacity, the system is then sent to the MQTT broker in JSON format. In the same case when people in the room will go out it will automatically calculate the capacity and will give a notification in the form of a "See you" sound. At the same time when the visitor leaves the dining room, the system will process data transmission to the MQTT broker. When all data has been entered into the MQTT broker, devices such as PCs or smartphones that have become subscribers to the topic sent, the website will receive data every time there is a change in sensor readings.

III. Results and Discussion

A. System Realization

The system built consists of hardware temperature sensor MLX90614 with an accuracy value of 99.50% as shown in figure 6. In Figure 7 there are interconnected electronic components with box including:

- ESP32 microcontroller board as data processing device and connectivity device with Wi-Fi
- SD card module as a module to store data
- MP3 module to provide sound notification when the temperature reading results, when entering, and when leaving
- LCD as data display device on the functional device
- Non-contact MLX90614 temperature sensor
- Infra-Red sensor to detect people entering
- Time of Flight sensor to detect people leaving

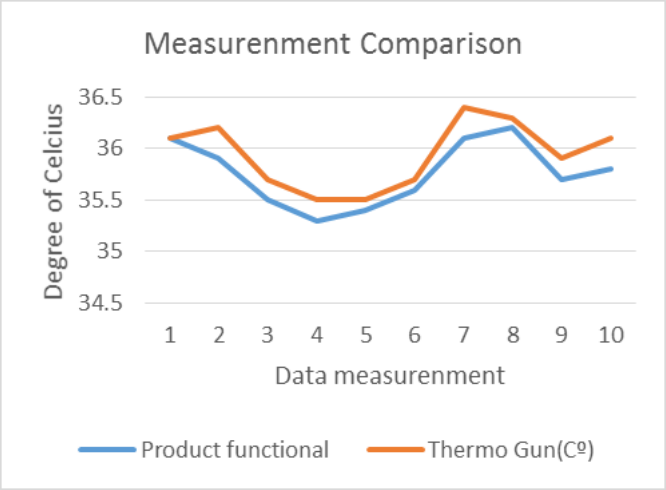

Fig. 6. Measurenment result.

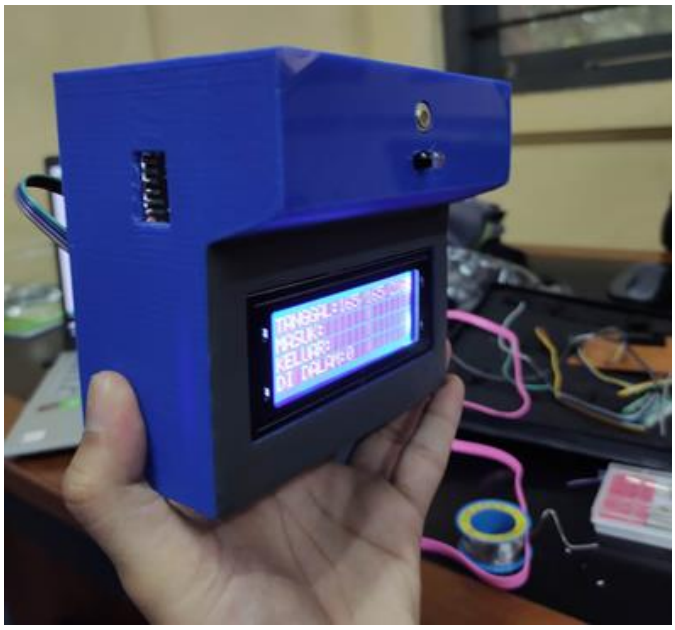

Fig. 7. System realization.

B. *Testing with Visitor*

How it works when visitors enter there are 2 stages, first the functional product detects the temperature of the visitor. Then the second stage, when the visitor enters and passes the functional product, the visitor is detected entering which is shown in Figure 8. When a visitor exits through a functional product as shown in Figure 9, the sensor will detect the visitor then the data will be sent and displayed back on the website in real-time.

Fig. 8. Temperature reading and calculation of incoming visitor.

Fig. 9. Exit end detection and capacity calculation.

C. *Data on HiveMQ Broker and Website*

In Figure 8 the MQTT HiveMQ broker displays messages published by the device to the MQTT broker in JSON format. This system uses QoS 0 which means that there is no guarantee that the message will reach the subscriber. On the Thingsboard IoT platform to be able to receive body temperature data and the number of people published by the device to the MQTT broker, Thingsboard must make MQTT integration so that it can receive body temperature data and the number of people from an external broker, namely HiveMQ. MQTT Integration Thingsboard acts as an MQTT client that subscribes to the MQTT broker.

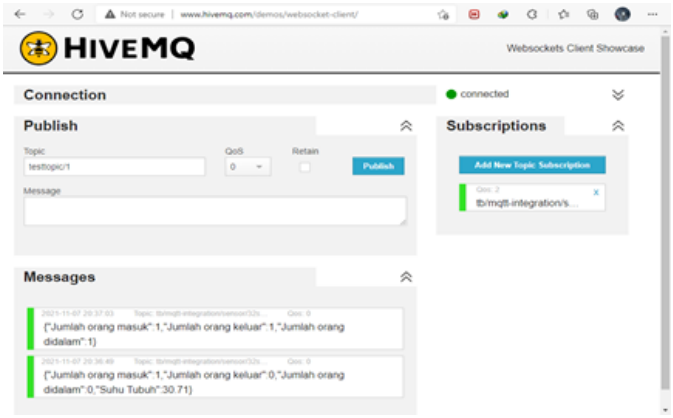

Fig. 10. Data on HiveMQ broker.

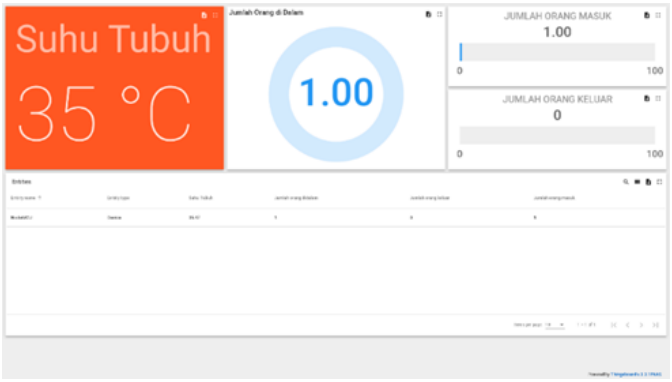

Fig. 11. Display data on website.

The purpose of the MQTT subscription integration is so that Thingsboard can receive data on body temperature and the number of people published by the device to the HiveMQ broker. After Thigsboard receives body temperature data and the number of people, to be able to view body temperature data and the number of people on the Thingsboard dashboard, the data must first be converted from JSON format to telemetry. To be able to convert JSON data into telemetry, next create an MQTT uplink. After the data is converted into telemetry data, body temperature measurenment, capacity of room, and the number of people can be seen on the Thingsboard dashboard as shown by the test results in Figures 10 and 11.

IV. Conclusion

The system is made using two sensors, namely the MLX90614 sensor as a body temperature detector, the TOF sensor as a visitor counter, the ESP32 MCU Node as a microcontroller, and Thingsboard as a Website. MQTT is a communication protocol used to send data from hardware to the Website thingsboard. The MQTT broker used is HiveMQ. Based on the results of functional product testing compared to a thermometer gun, the difference in accuracy is 0.18°C, functional products have accurate readings at a distance of 0.5-4CM. IoT based automatic temperature detector and visitor counter can be a solution in minimizing the transmission of COVID-19 and regulating mobility in a building advanced Research Plan. Subsequent research can develop product functionality with integration into standalone servers. Product functionality can be optimized and tested regularly to see the performance of the battery, connectivity, or internet data usage and handle data processing speed.

Acknowledgment

The authors thank the Universitas Jenderal Achmad Yani for supporting the research.

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