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Early Identification of Covid-19 Symtomps Based on Intelligent Internet of Things

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ABSTRACT
Covid-19 infected 570 thousand people in Indonesia at the end of November 2020. The government has made several efforts, such as applying WHO-recommended health protocols. There are still a number of people, though, who don't follow health protocols because they feel just fine. This is caused by the lack of information about early symptoms of Covid-19 in human's body, so they don't know whether they are in a normal condition, or they carry Covid-19 symptoms. This research is carried out to develop a device based on the internet of things to identify the body condition of a person related to Covid-19 symptoms so that people using this device can obtain information about their body and what steps or protocols to act as follows.With the Decision Tree method, this system will be developed to make rules based on WHO regulates to identify the condition of the body. The result of this research shows that in 7.9 seconds, the server can handle 100,000 data from internet of things device and the web application can handle 4000 requests in 20-24 seconds at the same time.

Keywords - Internet of Things, Decission Tree, Advanced Message Queuing Protocol

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I. INTRODUCTION

Coronavirus disease (Covid-19) is a new coronavirus-induced infectious disease called SARS-CoV-2 that has infected human's respiratory systems. By November 2020, there are 570.000 confirmed Covid-19 cases in Indonesia with a 19, 8 % cases increase rate, 61 % recovery rate and 35,6 % mortality rate [1]. Indonesia's COVID-19 Response Acceleration Task Force and government have made efforts to prevent Covid-19 cases from rising by applying "3M health protocol" (https://corona.jakarta.go.id/en) such as wearing a mask everywhere you go, washing your hand with soap and running water, and maintaining a safe distance of 1.5 to 2 meters [2]. There are however, many people who do not yet appreciate the meaning of performing the health protocol. Based on the data gathered by The Task Force, There are still people gathering and making crowds in public places such as restaurants (30.8%), households (21%), sports facilities (18.8%) and public roads (14%) [3]. These People's ignorance of the health protocol forms a new cluster of Covid-19, which makes cases of growth unclear. Many people that come to public places do not know their own body condition that can hold viruses in their body. This makes certain people to transfer viruses to other individuals in the same place [4][5][6]. Some research has been done to prevent the transmission of viruses. There is research to develop the internet of things devices to prevent the growth of cases in such situations [7][8][9]. This device will help people know their body's condition, so that when it changes, the person can be aware. The device can detect the body temperature, which may be the early detection of Covid-19 symptoms [10][11][12]. Other research that has been done is Location Mapping of Covid-19 active cases [13]. From this mapping system, we can gather data about Covid-19 cases in a location, so that people can anticipate coming to the location infected by the viruses. The research, however, still focuses on the location and human's body temperature. While, people do need to recognize other Covid-19 early signs so that they can be handled in 3-7 days by the medical team [14][15]. Therefore, another research needs to be conducted to develop a system that can alert people about other early symptoms of Covid-19 in their body, such as pneumonia and acute respiratory infections (ARI), and provide step-by-step guidance about what to do. Decision Tree is the method that will be used to create hierarchy processes to get early symptoms in the body of humans. This study aims to improve the recommendations for individuals infected with Covid-19.

II. LITERATURE REVIEW

Previous research on the diagnosis of covid-19 symptoms has developed a system that uses the temperature of the human body as an indicator to identify the state of the body [10]. This system consists of Node MCU 8266, Sound Sensor, Thermal Imaging Sensor, SIM900A, and Cloud for Analysis. The MCU node stores human temperature data read by the sensor and then send it to the cloud using SIM900A with HTTP request data communication. This system then warns anyone with body temperature over 37°C, which would be an early symptom of Covid-19 infection in the body. However the system has not provided its users with any suggestions about what steps to take. Another research that has been conducted is the development of a mobile application to identify Covid-19 symptoms in the human body. It can inform conditions and recommend to users what action they need to take if their body shows Covid-19 symptoms [16]. However, with this mobile apps, users cannot identify the temperature of their body immediately, so they have to take their temperature with other tools themselves. There is also research that developed a biosensor model based on membrane-engineered mammalian cells [17]. This research focused on how the sponsor works and didn't provide information about Covid-19 symptoms. Another example of products that have been created to help people recognize Covid-19 is a helmet that can process the image of their users [18]. The image proceeds with facial-recognition technology to inform the users the conditions of their body. This product is limited to those who want to travel a long way by motorbike or bicycle. There is a device that has been developed to monitor Covid-19 patients in the hospital room. This device monitors body temperature, room temperature, level of Carbon dioxide in the room, and patient heart rate. The outcome of this device is detailed on the state of the body of the patient in real time and the contact between patients and the medical staff can be minimized [19].

III. METHODOLOGY

The system to be developed will consist of internet of things (IoT) devices, a cloud server and a web application. The IoT system can be used 3 times a day in 3 minutes. This system can read body temperature (C), heart rate (BPM), and the body's oxygen level (SpO2). The data that is read by the device will be sent to the cloud so users can access the data through the web application and will be able to know the state of their bodies.

3.1 Analysis and Design of System Arcitecture

The IoT device consists of Wemos D1, OLED 128x64, GY-906 temperature sensor and MAX30102 heart rate sensor. The cloud server will be built with Linux OS, consisting of the RabbitMQ service, the Apache Web Server and the MySQL.

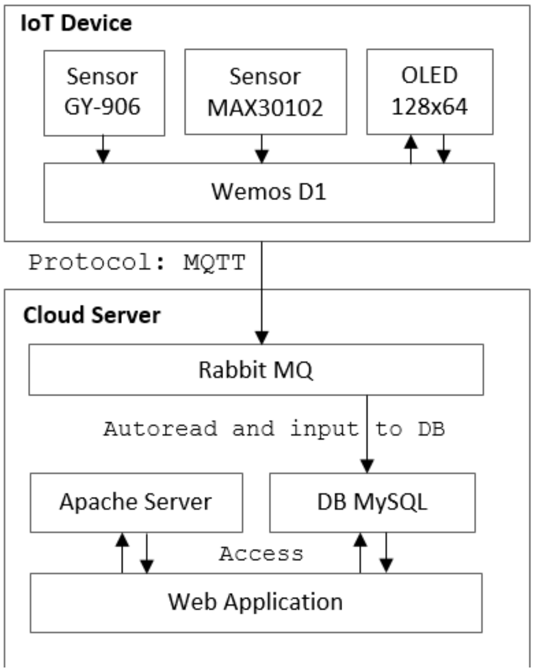

Figure 1: IoT System Architecture

There are some communication protocols that can be used to create connections from the IoT device to the cloud server, i.e. MQTT, SOA, and REST-API [20][21]. In this research, RabbitMQ will be used to send data from the IoT device to the cloud server through the MQTT protocol. This RabbitMQ consists of 1 exchange and 3 queue that will be used to store data such as body temperature, heart rate, and oxygen level. The data in RabbitMQ will be stored in the MySQL database every 1 minute. This process will use Python script every minute through the contrab service. The web application development will use the Apache Server library to collect, process and display data from MySQL.

3.2 Phase of Condition Analysis

The decision tree method will be used to process the information of the body and provide early identification. There are 3 conditions based on WHO that will be used. normal condition, upper respiratory tract infection without complication (URI) condition, and pneumonia condition [22]. These conditions will be process using algorithm as following below.

IoT Early Identification of Covid-19

Declaration

```
SpO2: float
BPM: float
Temp: float
```

Description

```
IF ((SpO2 > 94 AND SpO2 <100) AND
(Temp < 37) AND (BPM > 60 AND BPM
< 100))
 THEN
  Kondisi = "Normal"

ELSE-IF ((SpO2 < 93) AND (Temp >
38) AND (BPM > 40 AND BPM < 60))
 THEN
  Kondisi = "Inspection of the
upper respiratory tract without
complication"

ELSE-IF ((SpO2 < 90) AND (Temp >
38) AND (BPM < 50 OR BPM > 100))
 THEN
  Kondisi = "Penumonia"

ELSE
 THEN
  Kondisi = "System can't
identify your condition, please
consult to doctor"
END-IF
```

Figure 2: IoT Early Identification of Covid-19 Algorithm

If a person's body condition is normal, there will be no information about what action to take related to Covid-19. As for the other two conditions, there will be information about what actions to take.

3.3 Testing

At this point, the tests carried out include measuring the ability of the RabbitMQ server to handle the sending of a lot of data from IoT devices, measuring the ability of web applications to handle user requests and measuring the output of web applications. When testing the RabbitMQ capacity, the RabbitMQ PerfTest tool will be used to send one hundred thousand data packets simultaneously to the queue. From these measurements, you can get information about the size of the data packet and how long it takes for RabbitMQ to handle the data packet. The Webserver Strees Test application is used to calculate the performance of web applications by simulating 4000 users who simultaneously access them. Unit testing involves data requests, data transfers, user wait time, client health and bandwidth. From this test, you'll get details about the ability of the web application to manage requests.

IV. RESULT AND DISCUSSION

The result of this system development is an IoT device to cloud server service communication system and a web application that can be used to view a person's body condition data. The communication data system is built on based on MQTT protocol in RabbitMQ server addressed in 31.220.48.158 and 15672 ports with 3 queues in 1 "eHealth" exchange that is dbs,.mcu1.bpm, dbs.mcu1.sp02 and dbs.mcu1.temp.

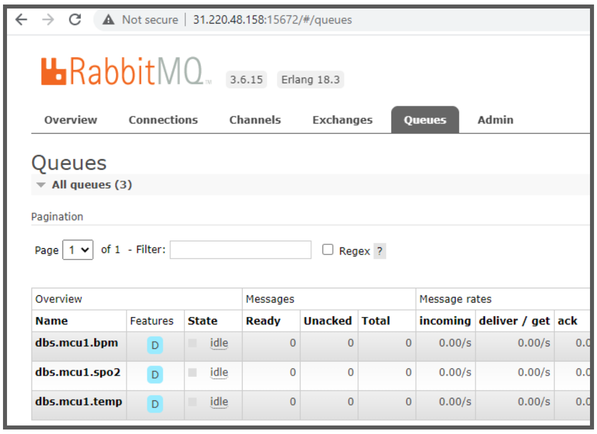

Figure 3: Lists of Queue in RabbitMQ

The 3 queues shown in the figure 3 above are in normal condition. It takes 0.20 seconds for each queue to get new data per 7 bytes.With RabbitMQ Perftest, the server is tested by measuring times needed to handle incoming messages and the required capacity to handle the message. This test is conducted by sending 100,000 messages at the same time.

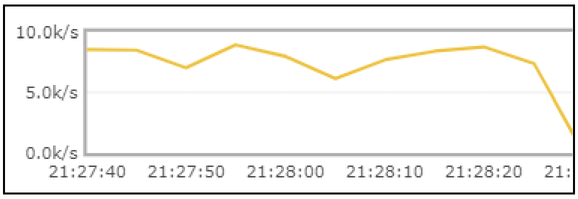

Figure 4: Message Rate in Queue

Figure 4 shows that the average size accepted at the same time is 6 to 9 kilobytes and needs to be treated in 7.9 seconds. The test shows that RabbitMQ performs well in the handling of sending a lot of data. web application that is used to view the latest data, graph, and symptom identification in the body can be accessed in http:/31.220.48.158/ehealth/

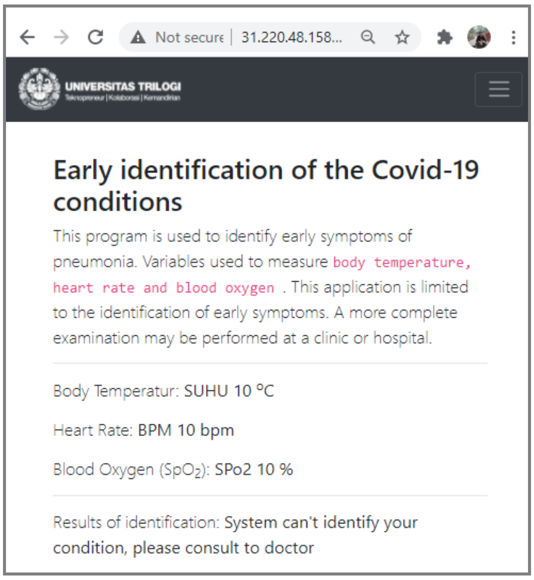

Figure 5: Web Application Page for Identification Covid-19 Symptomps

Figure 5 shows that the information shown would guide users to visit a doctor if the rules in the decision tree are not fulfilled. In this condition, The system can not define and provide suggestions about what to do. The Web application is developed using responsive layout so that the screen size follows the size of the user's device. the web application page then tested with the webserverstress tool to know whether the web can support multiple users accessing at the same time. Request data, transferred data, and user wait time are the units that are tested.

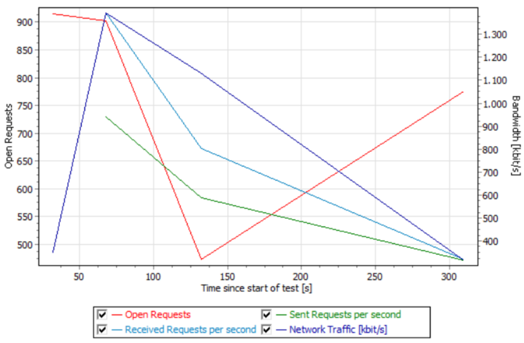

Figure 6: Open Requests and Transferred Data

Figure 6 shows that more than 900 open requests are sent to the web page by users and decrease at the 140th second, then increase at the 300th second. In the 75th second, Network traffic increases and follows the sum of the largest open request. The time required to receive data packages is about 30 to 36 seconds when the open request is high. The ability to send responses to users, however is quicker, about 20 to 24 seconds. From this test, it is shown that the server capability and complexity of the web application is capable of managing user requests.

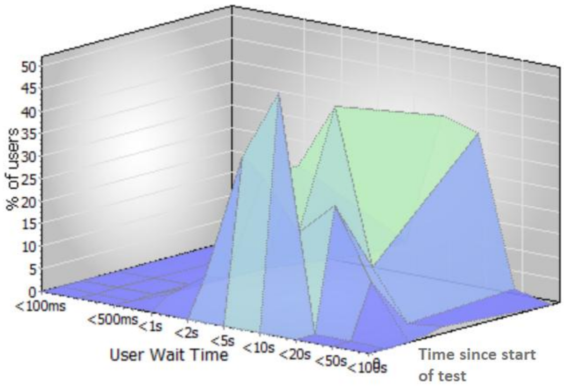

Figure 7: Spectrum of Click Times

From figure 6 above, it is shown that user wait time increases in the 20th to 50th second with 4000 users and 900 requests and decreases in the 50th to 100th second. From the analysis, it is concluded that it does not take long for users to get the responses when they visit the web application.

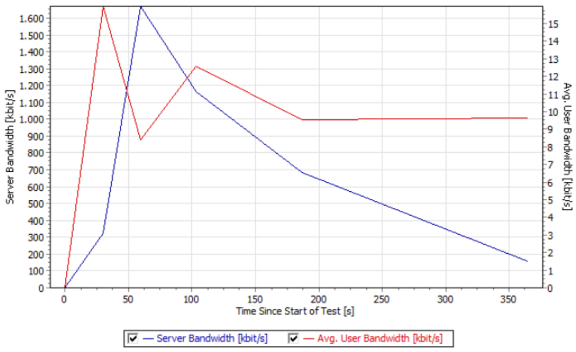

Figure 8: Volume and Bandwidth

From these measurements, you can get information about the size of the data packet and how long it takes for RabbitMQ to handle the data packet. The Webserver Strees Test application is used to calculate the performance of web applications by simulating 4000 users who simultaneously access them. Unit testing involves data requests, data transfers and user wait time. From this test, you'll get details about the ability of the web application to manage requests. The total bandwidth that the server requires to accommodate 4000 users is 1000 Kbps and the user bandwidth is 24 Kbps. The results of this test can be inferred that the program can store adequate bandwidth on servers and users.

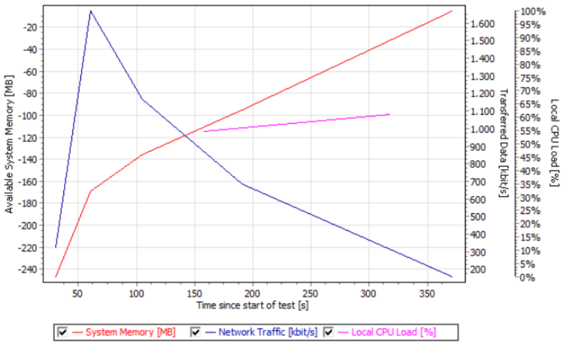

Figure 9: Test Client Health

Figure 9 provides a graph of the system output used by the user. Measured variables include device memory, network traffic and Processor load. Figure 11 shows that as network traffic increases, memory consumption increases while the CPU load is in a steady position. Memory use is calculated to be 1 MB on average and the CPU load is 50 percent. In the meantime the total network traffic is 1000 Kbps. The results of this test suggest that the program does not affect the output of the computer used by the user.

V. CONCLUSIONS

This early symptom identification system of covid-19 may be one of the solutions that can be used by people to gain body condition information and advice on what steps to take related to covid-19. The RabbitMQ server is one of the best solutions for handling massive data sent to an IoT device. The web application will perform well with this server. Further research that can be conducted is the application of Time Series method to identify condition patterns in patients with upper respiratory tract infection (URI) or pneumonia so that the medical staff can monitor patients in real time without reaching them. The development of the IoT device distribution map is also necessary to analyze patient's body condition patterns in one area so that authority can be informed to provide policy and act quickly.

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