Design and Development of Body Temperature Sensor for Attendance Machine

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Abstract*—In the face of the Covid-19 pandemic, health protocols have been implemented by checking the body temperature and limiting the number of people in the building. To support the implementation of the new normal period protocol, many activities that were not previously carried out have now become mandatory to prevent the spread of the Covid-19 virus. Measuring temperature and limiting the number of people in the building are new activities that must be done at this time. Therefore, it is necessary to develop a tool that can assist the process of checking body temperature and identify and limit the people who will enter the building in order to meet the specified requirements. This tool can take temperature measurements on the face without physical touch and also identify and record faces for verification of the attendance process, as a temperature measuring device developed by Omron in the form of the D6T-44L infrared sensor which is combined with the use of a camera and will be processed in a mini-PC that can communicate with a server via the internet network.

Keywords—thermal scanner, IR scanner, attendance machine, body temperature.

I. INTRODUCTION

The new virus that causes pneumonia originally came from Wuhan, Hubei Province, China. This virus is identified as the seventh coronavirus and threatens world health. The World Health Organization (WHO) announced the official name for the disease caused by the virus as Coronavirus Disease 2019 (Covid-19) which is declared on January 30, 2020 [1].

At the end of June 2020, there are nearly 10 million confirmed cases and nearly 5 million deaths due to Covid-19, and the number of positive cases and deaths is still increasing which poses a serious threat to international. The spread of the Covid-19 virus is increasingly widespread and has become a pandemic around the world [2].

Until now, the virus has not had a vaccine and what we can do to prevent its spread is by following the health protocol ordered by the government: living a healthy lifestyle, using masks, washing hands and maintaining distance between people. To protect and prevent the spread of the virus, especially in work and industrial environments, the government through the Ministry of Health issued the Ministerial Decree No. 328 of 2020. One of the rules that must be applied is to limit the employees' body temperature, and for those who want to do activities must have a body temperature below the 37.3 degrees Celsius [3]. There are several things that are regulated in health protocol such as applying a capacity limit in a building which is stated in Pergub DKI Jakarta No 101 tahun 2020 [4] limiting physical interaction to a minimum distance of 1 (one) meter between students or education staff, and regulating physical distance between active people in the building by scheduling some workers to do work from the office and some others to work online from home. Before entering the building, everyone is required to wear a mask and wash their hands and then the security guard will take their body temperature measurements, the body temperature allowed to carry out activities should be less than 37.3°C.

The number of access gates that must be guarded and the number of building users who will access the building at the same time causes long queues to appear and requires more guards causing high costs every month. This is due to the implementation of this new regulation still relies on person and manual equipment and is not connected to one another and has a limitation on consistency and working hour. As shown in Fig. 1 the use of personnel to supervise and implement health protocols has a very high risk for examining officers and has the potential to be a means of spreading viruses from a direct person to person contact.

Fig. 1. Body temperature measurement

This situation requires that we add several activities that have never been carried out before and result in an increase in operational costs that must be kept to a minimum, but activities to prevent the spread of the Covid-19 virus must be carried out. Teaching and learning activities must continue to run with the new normal condition by implementing health protocols for the new normal condition. Currently this pandemic has entered a new normal period, so that the most effective and most economical cost-effective sustainable handling is needed.

Fig. 2. Queuing at entrance

The current condition with all efforts to implement health protocols using manual tools for checking body temperature and administration to collect all attendance takes approximately 40-50 seconds per person when carried out by 3 workers, where 1 person measures body temperature and 2 others write the temperature data and check the health statements. In the morning when all student and employee arrive at the same time, we will see a long queue in front of the entrance gate as shown in Fig. 2. Currently, the officers who carry out inspections and collections are employees who have been scheduled to do that and can only be done in the morning before doing their main job as a lecturer or administrative staff. In the future, to implement this safety protocol during building operational hour we have to employ workers to do this job. To reduce the operational cost and more controlled access we only open the gate on schedule activity and then door will be closed after that, however, it will not be very convenient for all employees and students. If in the future we move to another campus building in Cikarang, we will have more entrance gates and access to enter the building; it means that we will spend a lot of operational cost if we still use the same method.

This research will focus on finding and applying technology that can assist in implementing health protocols and reducing the risk of transmission of the Covid-19 virus.

The ability of the tool to measure body temperature and identify and record in order to limit people who may enter the building is the main objective of this study. The tool created must also have good economic value at an affordable price with low operating costs but still reliable.

II. RESEARCH METHODOLOGY

The results of temperature measurements from the Omron D6T are combined with the images obtained using a camera attached to the temperature sensor. The camera is used to detect faces as a trigger to carry out the temperature measurement process and issue a voice command to attach the ID card to the sensor, to read the RFID, to recognize and to save it into the memory in the device. The workflow of sensors and cameras when taking temperature measurements is illustrated in the Fig. 3.

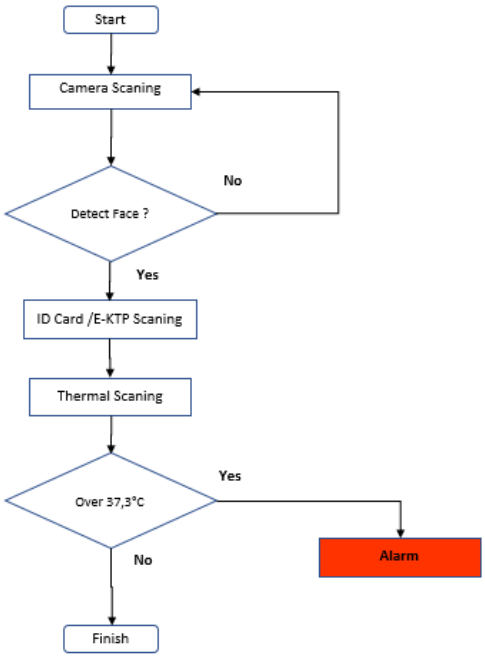


Fig. 3. Flowchart of temperature measurement

The results of the temperature sensor readings that have been processed by the micro controller will be further processed by the mini-PC, which includes an application to process the images obtained from the camera which will detect the presence of a face to ensure that the measured temperature is right on the human face.

This mini-PC will also provide output in the form of an image that is displayed on the LCD screen and a voice as an indication of what steps should be done by the person who does the inspection.

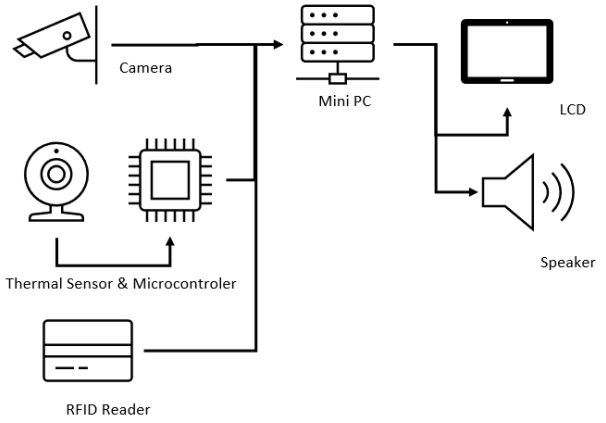


Fig. 4. Schematic diagram of temperature measurement

In conducting this temperature measurement experiment (Fig. 4), the researchers only did one type of sensor, namely the Omron D6T-44L which uses infrared waves. The Omron D6T-44L sensor is combined with the Arduino Atmega microcontroller using 2LC communication. In combining these two components there is no difficulty, and the results of the sensor readings can be read on the microcontroller. Meanwhile, to position and cover the sensor at the same time, a 3d printed plastic is adjusted to the size and installation of the sensor on the web camera used.

Fig. 5. Omron D6T-44L

TABLE I
OMRON D6T-44L DATASHEET

Item	Model	D6T-44L-06	D6T-8L-09	D6T-1A-01	D6T-1A-02
Object temperature detection range *2		5 to 50°C	5 to 50°C	5 to 50°C	-40 to 80°C
Reference temperature detection range *2		5 to 45°C	5 to 45°C	5 to 45°C	-40 to 80°C
Output specifications		Digital values that correspond to the object temperature (Tx) and reference temperature (Ta) are output from a serial communications port.			
Output form		Binary code (10 times the detected temperature (°C))			
Communications form		I2C compliant			
Temperature resolution (NETD) *3		0.06°C	0.03°C	0.02°C	0.06°C

Item	Model	D6T-1A-01	D6T-1A-02	D6T-8L-09	D6T-8L-09H	D6T-44L-06	D6T-44L-06H	D6T-32L-01A
View angle *1	X direction	58.0°	26.5°	54.5°		44.2°		90°
	Y direction	58.0°	26.5°	5.5°		45.7°		90°
Object temperature output accuracy *2	Accuracy 1	±1.5°C max. Measurement conditions: Vcc = 5.0 V (1) Tx = 25°C, Ta = 25°C (2) Tx = 45°C, Ta = 25°C (3) Tx = 45°C, Ta = 45°C						Within ±3.0°C Measurement conditions: Vcc = 5.0 V Tx = 25°C, Ta = 25°C Central 16x16-pixel area
Current consumption		3.5 mA typical		5 mA typical				19 mA typical

Based on the data sheet of the Omron D6T-44L-06 product [5], the temperature range that can be measured falls into the temperature range of the human body temperature. This sensor also uses an infrared wave measurement method that allows measurements to be made without the need to come into contact with the object being measured. The type of communication and output provided by this sensor can also be connected to the microcontroller used.

From the datasheet of the sensor given by Omron manufacturer, the accuracy of the Omron D6T-44L sensor is 1.5 degrees Celsius as shown in Table 1.

III. RESULT AND DISCCUSSION

Fig. 6. Thermal sensor installation

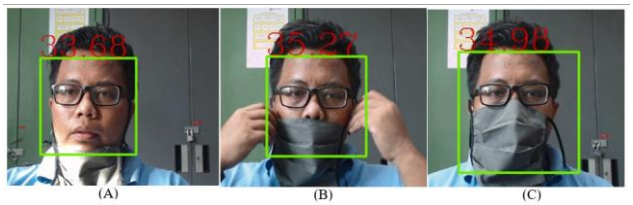
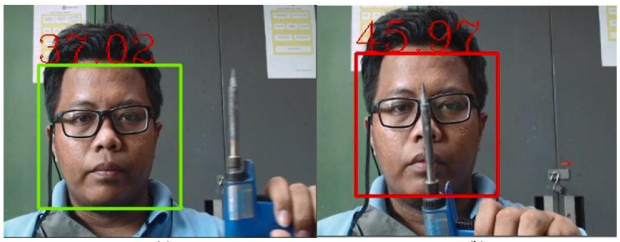


Fig. 7. Face tracking testing

The results of the sensor readings (Fig. 6) that have been previously processed using a microcontroller then further processed using a minicomputer. In this minicomputer the processing of data from various inputs are processed. In this minicomputer apart from the temperature sensor there is additional input from the camera as input in the form of images/videos. The video captured by the camera will then be processed using the computer vision method so that the computer can identify that the object it captures can be recognized as a human face through special characteristics that exist on the face such as the distance of the eyes [6] as shown in Fig.7.



(a) (b)

Fig. 8. Thermal scan area: (a) a green box indicates thermal scan area of a face, the average temperature in the area is 37.02 °C, (b) a red box indicates thermal scan area of a face and a high temperature object (a solder in the front of the face), the average

After the computer successfully tracks the face (Fig. 7), the temperature measurement will be read in the area that has entered the frame that has been detected as a face. According to the program, the color of the face frame will also change as a sign of the permissible body temperature threshold status. If the inside of the frame shows normal temperature, the face frame will be green and if an abnormal temperature is detected, the face frame will turn red as shown in Fig. 8. At the top of the frame there will also be a temperature reading in the face frame area [7].

Fig. 9. Graphic user interface (GUI of face detection and temperature measurement system

The Graphical User Interface (GUI) as shown in Fig. 9 is designed to be able to display information received by the sensor and information related to recorded data, such as images captured by the camera, body temperature captured by the temperature sensor, and also date and time. In addition to the data on the image displayed on the screen, information that will be communicated to all employees and students who will use the tool can also be added. In addition to the screen for the main display in the graphic user interface, a dialog box is also prepared which is used for setting and calibration. The making of a graphic user interface design using a visual studio program which is not only a display but also the same program is used to perform data processing. The data obtained from the results of temperature measurement and recording data is stored on the server which can be viewed through the attendance system application (Fig. 10). This app will be used by the human resources department to calculate the attendance and record health conditions based on body temperature.

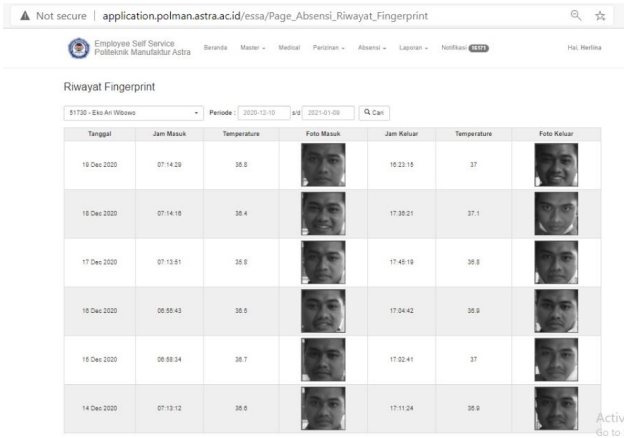


Fig. 10. Storage data on attendance application system

IV. CONCLUSIONS AND RECOMMENDATIONS

Based on the research and experiments conducted, the author will be able to make some conclusions about the tools developed in this study, including:

1. This tool can recognize human faces and perform facial tracking, and it can still function properly even though the detected face is covered by a mask.
2. The tool developed can measure body temperature and provide a warning if the detected body temperature exceeds the limit set in accordance with health protocols for everyone who will enter the building.
3. Access restriction to people who will enter the building can be done by identifying the identity card and data of permitted persons that have been recorded in the database. Face recordings are also saved to allow cross-checking of the recorded identities from the identity cards.

To solve the problems found during the development and experiments that have been carried out for the creation this tool, the authors recommend several things:

1. The manufacture of closed chambers can reduce the influence of the environment in temperature readings and reduce the influence of the rays that appear from the surrounding environment.
2. The addition of batteries (UPS) can keep the appliance alive and can function properly even if the flow from the power source is interrupted for a moment.
3. The system is made so that it can temporarily store data if there is a problem with the internet connection and synchronize with the server when the internet connection is reconnected.

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