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Temperature and Mask Detector using Thermal Camera and Open CV based on Color Features

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Abstract

The current situation demands the prevention of the spread of the virus, one of which is by wearing a mask and checking the body temperature. This paper serves as a means of detecting the body temperature by using a thermal camera and the mask with a web camera. The camera is the sensor, and a buzzer is an actuator that go off automatically. A mask detection device is a tool that detects visitors who wear masks. It works by detecting the visitor's face using a camera and Open CV or digital image processing. Then, the data will be processed and compared to the one that has been input into the program. This program is able to detect masks and provide warnings if the visitors do not wear masks in a public space. When the body temperature detector detects a visitor of the normal category, which is 36˚C - 37.5˚C, the buzzer does not go off; when the body temperature is higher than 37.5˚C, the buzzer goes off automatically. An error occurred due to the dark conditions, and from the five trials with 100 cm distance, 60% of the trials were successful. Therefore, it was concluded that the testing of the mask detector succeeded with more than 60% success when the lighting was sufficient; and the distance ranged from 100 cm. This system experiment with five experiments on each sample obtained pretty good results. To get good results, the light determination is very influential.

Keywords*:* Mask detector, Temperature, Color feature, Vision

Abstrak

Situasi saat ini menuntut pencegahan penyebaran virus, salah satunya dengan memakai masker dan mengecek suhu tubuh. Makalah ini berfungsi sebagai sarana pendeteksi suhu tubuh dengan menggunakan kamera termal dan masker dengan kamera web. Kamera adalah sensornya, dan buzzer adalah aktuator yang mati secara otomatis. Alat pendeteksi topeng adalah alat yang mendeteksi pengunjung yang memakai topeng. Ia bekerja dengan mendeteksi wajah pengunjung menggunakan kamera dan Open CV atau pengolahan citra digital. Kemudian, data tersebut akan diolah dan dibandingkan dengan data yang telah dimasukkan ke dalam program. Program ini mampu mendeteksi masker dan memberikan peringatan jika pengunjung tidak menggunakan masker di ruang publik. Saat pendeteksi suhu tubuh mendeteksi pengunjung kategori normal yaitu 36˚C - 37,5˚C, buzzer tidak berbunyi; ketika suhu tubuh lebih tinggi dari 37,5˚C, bel berbunyi secara otomatis. Terjadi kesalahan karena kondisi gelap, dan dari lima uji coba dengan jarak 100 cm, 60% dari uji coba berhasil. Oleh karena itu, disimpulkan bahwa pengujian detektor topeng berhasil dengan keberhasilan lebih dari 60% ketika pencahayaan cukup; dan jaraknya berkisar 100 cm. Percobaan sistem ini dengan lima percobaan pada setiap sampel diperoleh hasil yang cukup baik. Untuk mendapatkan hasil yang baik, penentuan cahaya sangat berpengaruh.

Kata-kata kunci*: Detektor masker, Suhu, Fitur warna, Penglihatan*

1. Introduction

Sensor technology has advanced that it lets us do physical observation. In the future, this sensor technology that uses cameras will take part in all human activities. Covid-19 is one of the health problems that shake worldwide. Although Indonesian people have to get dose 3 of vaccines, covid-19 still becomes a specter [1].

As an effort to stop the spread of the coronavirus, body temperature checking is vigorously conducted [2]. The body temperature indicates the individual's condition, whether they are healthy or not. However, the observation reveals that the temperature checking did not obey the recommended distance. On the temperature checking site people keep a one-arm distance, less than one meter. Within this close distance, if someone coughs or sneezes, the others can get infected by the coronavirus through droplets that spread in the air. The distance recommended by WHO (World Health Organization) is about 6 feet or 1.8 meters [3] [4] [5].

Besides checking the body temperature, wearing a mask is another effort not to spread the coronavirus. Several public places require us to wear masks, assisted by the security staff. Numerous studies propose the effectiveness of a camera, where you can help the security in real-time [6] [7] [8] [9]. The sensor is like the eyes in human anatomy. To obtain the information from the sensor, one cannot leave out the development of camera vision as a sensor device electronic that can immediately provide the information. The technological advance in terms of camera use makes it easy not only it helps us know the condition around us but also can immediately provide them [10] [11].Based on these problems, the design of a body temperature detection device using a thermal camera and a mask detection device using a camera was vital. A thermal camera sensor is used to identify the human body temperature, while the web camera reads the distribution of temperature data and the use of more masks at one time and measurement from a long distance. This tool helps someone check other people's body temperature because the monitoring is indoor, so there is no need to go out to get close to other people. This technique can reduce the spread of the coronavirus.

2. Method

To achieve the objectives of the research, this paper is structured based on hardware and software so that it is sustainable. In this system there are input, process, and output. The input data of this system was obtained by sensors and cameras, then processed by the microcontroller and PC to produce the output, namely, temperature and face detection data. The devices used in this system are cameras, thermal cameras, and ultrasonic sensors to figure out the distance of accurate temperature readings. To achieve the objectives of this research, two plans were carried out, namely, designing the hardware and software. The system block diagram on this paper can be seen in **Figure 1**.

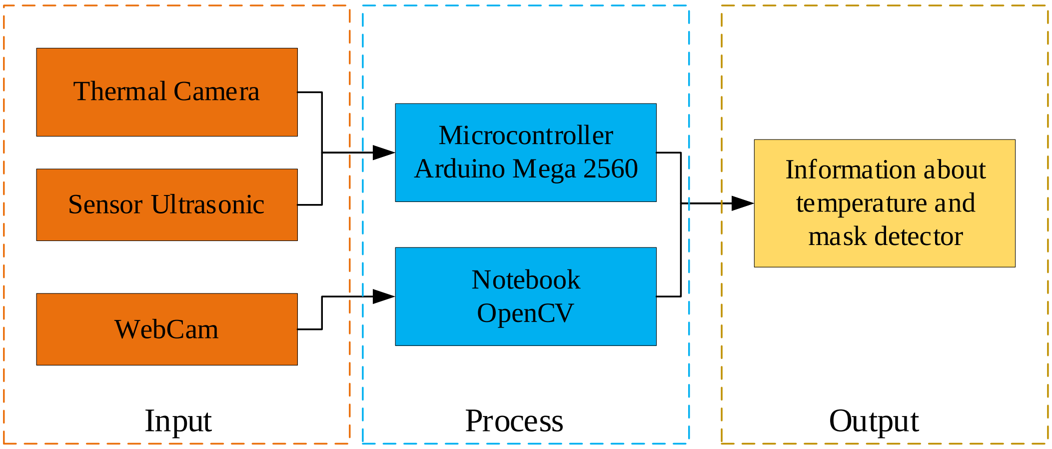


Figure 1. Block Diagram System

a. Hardware Design

The objective of planning this is to find out the temperature that was readable. The hardware design uses an ultrasonic sensor, thermal camera, and Arduino Mega 2560 microcontroller stages to the reach objectives, as in **Figure 2**.

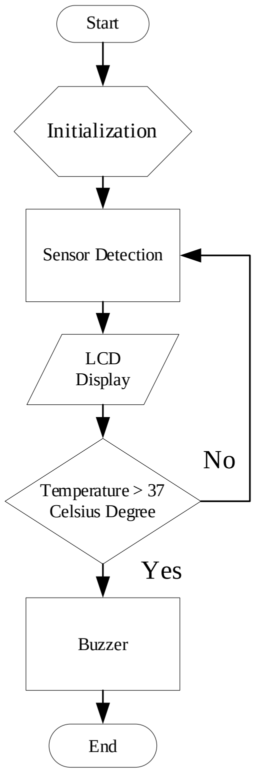


Figure 2. Flowchart System

The flowchart in Figure 2 indicates that the moment the system starts, the initialization process begins on the I/O port, then the HC-SR04 ultrasonic sensor and the AMG8833 thermal camera sensor will detect if there is an object, that is human, with distance a maximum of 25 cm; when the distance exceeds 25 cm, the LCD reads "Too Far Away". If the thermal camera sensor detects an object, the results captured by the thermal camera and ultrasonic HC-SR04 will be processed by Arduino Mega 2560, and later channel the output to LCD ILI9341 in the form of appearance image, temperature, and distance from the person or the object being measured, and the 16x2 I2C LCD shows the temperature and distance. When the temperature output exceeds the normal body temperature or is above 37.5˚C, the buzzer goes off. The circuit can be seen in **Figure 3**.

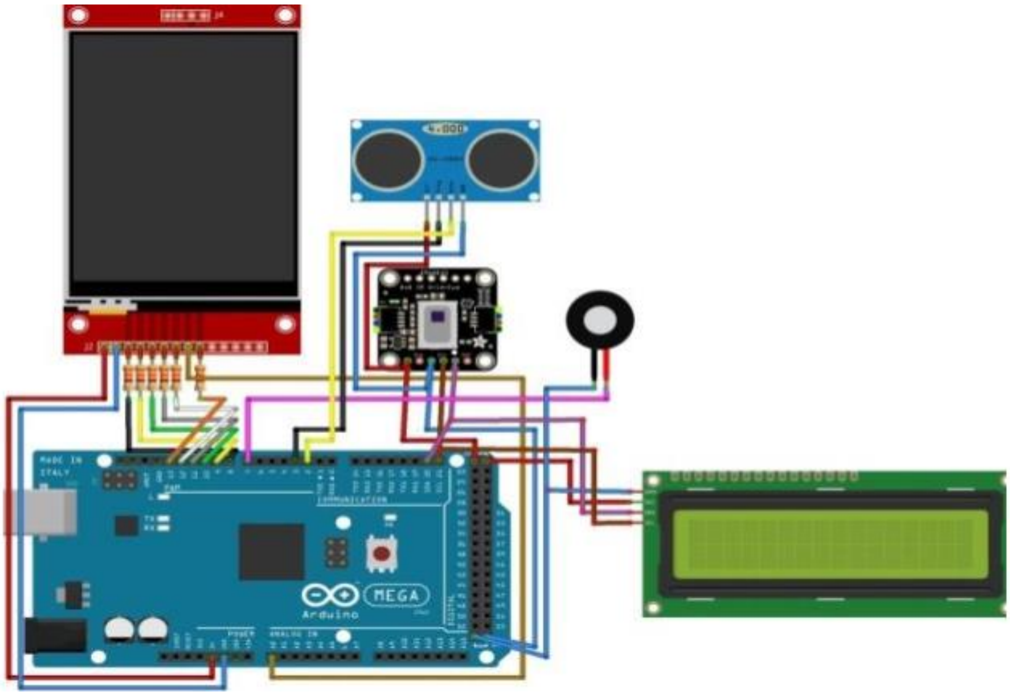


Figure 1. The Circuit of the Electronic Temperature Detector System

Figure 3 shows several components that have been assembled, in the form of an AMG8833 thermal camera connected to Arduino with VCC pins to 5V pins, GND to GND pins, SCL to SCL pins, and SDA to SDA pins. ILI9341 2.8 TFT LCD is connected with pin VCC to pin 5V, GND to pin GND, CS to pin 8, RST to pin 9, DC to pin 10, MOSI to pin 11, SCK to pin 12, MISO to pin 13, and LED to pin 12. pins A0. Ultrasonic sensor is connected with VCC pin to 5V pin, GND pin to GND, Trigger to pin 3, Echo to pin 2. 16x2 LCD is connected with VCC pin to 5V pin, GND pin to GND, SCL pin to SCL, and SDA pin to SDA. Also, Buzzer is connected with Data pin to Pin 7, and GND to GND pin. The design of the body temperature detection system is built using a thermal camera and uses an Arduino Mega 2560 microcontroller. That's when the system starts, so the initialization process is carried out on the I/O port, then the ultrasonic sensor HC-SR04 and the AMG8833 thermal camera sensor will detect whether there are objects, namely humans with a maximum distance of 25 cm; when the distance exceeds 25 cm, the LCD displays "Too Far". If the thermal camera sensor detects an object, the results captured by the HC-SR04 thermal and ultrasonic camera will be processed by the Arduino Mega 2560, which then transmits the output to the ILI9341 LCD in the form of an image of the appearance, temperature and distance from the human or object being measured, and the LCD 16x2 I2C is the temperature and visibility distance. When the displayed temperature output exceeds the normal body temperature or more than 37.5˚C, the buzzer will sound. The temperature on the thermal camera can be seen from the RGB data, as shown in **Figure 4**.

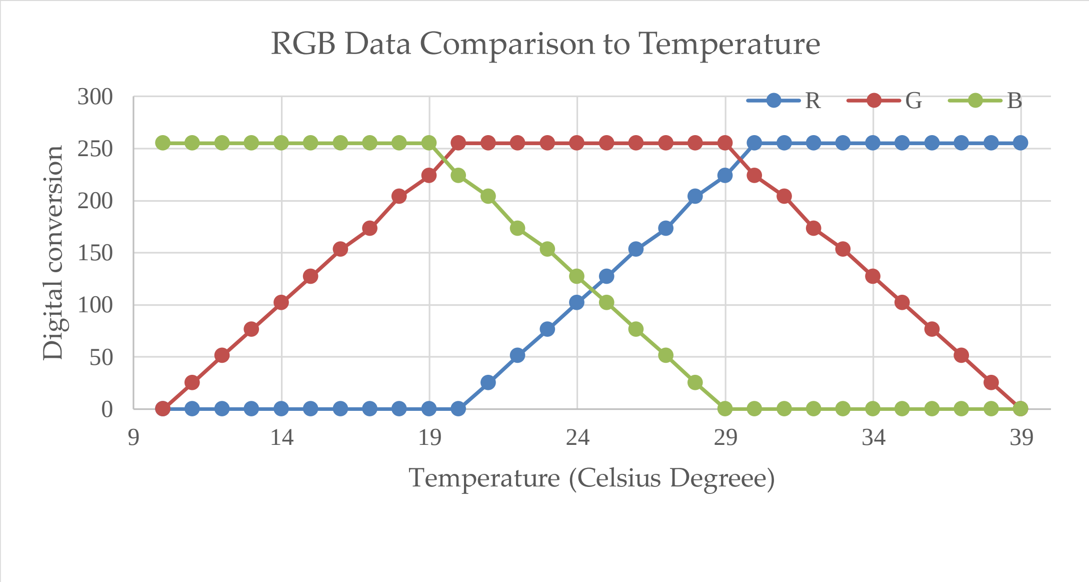


Figure 4. RGB Data Reading

Figure 4 is an RGB data read; In order to determine the reflectance temperature of the color, a color map of the maximum and minimum temperature scores was used for the color map, 18 false colors were created. From the graph in Figure 4, it is known that red indicates high temperature, and blue indicates low temperature.

b. Software Design

This subsection is for mask detection software planning. To detect masks, there are the following steps: (1) Camera captures images, (2) normalization of camera data, (3) pre-processing of data, (4) setting of color filters, (5) cleaning of noise, (6) detected objects with a mask or not. The face detection method can be seen in **Figure 5**.

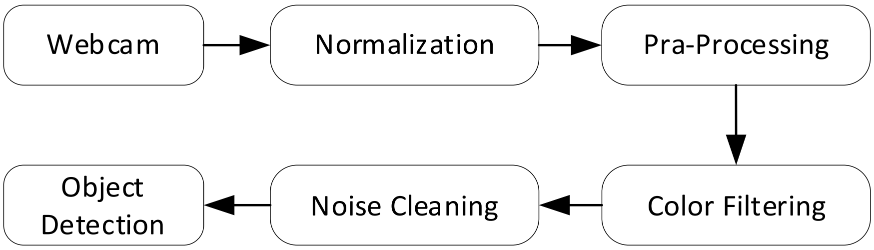


Figure 2. Face Detection Method

Mask detection using OpenCV with a webcam; if the face and nose are not visible (wearing a mask), the mask is on, and if the face and nose are visible, the mask is removed. In the process of reading the face and nose objects, the camera will match the RGB color determination algorithm files. When the mask is removed, there is a system for sound notification. Some aspects of the limitations for detecting masks are variations in face position, face shape, face distance, and lighting in detection. Open Capture Vision is an Application Programming Interface library that allows computers to see objects such as humans or which objects the computer can make decisions, take actions, and recognize an object, which are the targets in this study, namely the face and nose. Mask detection flowchart is presented in **Figure 6**.

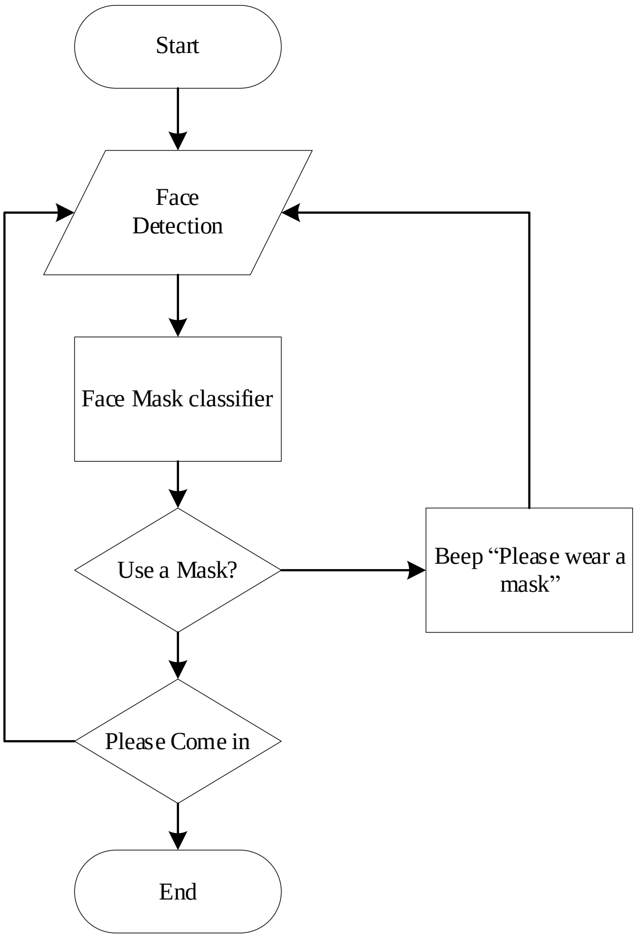


Figure 3. Mask Detection Flowchart

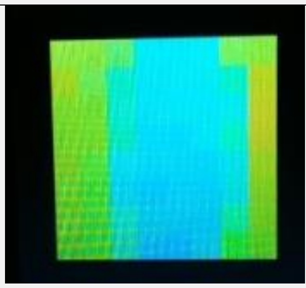
3. Results and Discussion

To ensure that the design of the body temperature detector using a thermal camera, AMG8833 temperature sensor, and ultrasonic sensor met the expectation, it was necessary to carry out various tests. These tests also served to find out the performance and function of the tool, so it works optimally.

a. Temperature Body Test

This test was carried out by bringing the forehead closer to the front of the AMG8833 thermal camera sensor with a maximum distance of 25 cm and to the Thermo Gun according to the predetermined distance. The tests were carried out to prove the Temperature Detection system on the tool was working properly. This is evidenced by the detection of human body temperature under normal and abnormal conditions which are shown on the output in the form of an LCD and a buzzer. Table 1 shows the results of testing the body temperature detection system. Test of body temperature system is presented in **Table 1**.

Table 1. Test of Body Temperature System

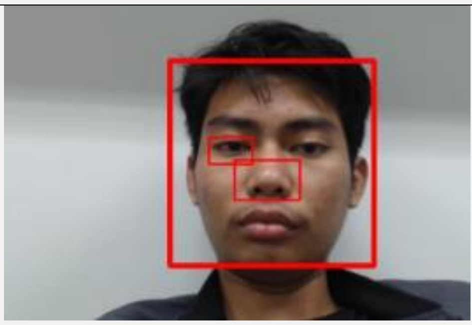
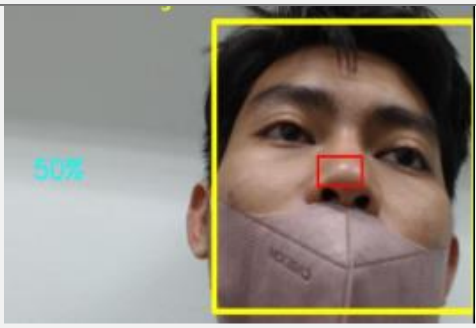
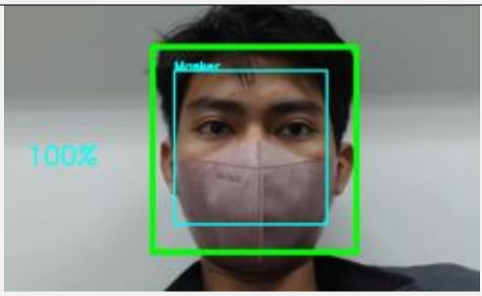
No	Temperature Detection	LCD	Buzzer
1	36.41		OFF
2	77.37		ON
3	18.30		OFF

Based on **Table 1** Test Results for All Body Temperature Detection Systems, it was known that the AMG8833 temperature sensor worked effectively with a set point of ±25 cm. When someone was detected according to the set point distance of ±25 cm, the AMG8833 temperature sensor read the person's temperature and displayed it on the LCD. When the object's temperature was in normal human temperature conditions of 36°C-37.5°C, the buzzer did not go off, while when it detected a temperature of more than 37.5°C, the buzzer went off.

b. Mask Detector Test

The mask detector using this webcam is tested under three conditions: when a person is not wearing a mask, when wearing a mask incorrectly, and when wearing a mask correctly. Not only that, the mask detection testing was also influenced by the distance and lighting. Table 2. is an example of how the detector do mask detection and shows wrong use of a mask and the correct use of a mask. Test of the mask detector is presented in Table 2.

Table 2. Test of the Mask Detector

No	Sample	Note
1		Not Using a Mask
2		Wrong Use of Masks
3		Correct Use of Masks

The test was carried out five times with a number of stages of attention to the use of masks, distance, and lighting. The objects used are using a mask, using the wrong mask, and not using a mask, with a distance of 20 cm, 50 cm, and 100 cm. Lighting also affects, namely from light, medium, and dark. The test results can be seen in Table 3.

Table 3. Results of the Mask Detection Test

No	Test	Distance	Lighting	Success	Failure
1	Not Using a Mask	-	-	5	0
2	Wrong Use of Masks	-	-	4	1
3	Correct Use of Masks	-	-	3	2
4	-	20 cm	-	5	0
5	-	50 cm	-	4	1
6	-	100 cm	-	3	2
7	-	-	light	5	0
8	-	-	Dim	3	2
9	-	-	Dark	0	5
10	Not Using a Mask	20 cm	light	5	0
11	Wrong Use of Masks	50 cm	Dim	4	1
12	Correct Use of Masks	100 cm	light	3	2

From the tests carried out, an error was detected. Distance and lighting greatly affect to produce a face detector. From table 3 above, the error moment of dark lighting is obtained, and from 5 attempts at a distance of 100cm, only 60% of the experiments were successful. Therefore, the test of the mask detector can be said to be successful with success above 60% if the lighting is good and the distance is around 100 cm.

4. Conclusion

The design of the body temperature detector using the AMG8833 thermal camera sensor with an output in the form of an image display and the temperature on the ILI9341 TFT LCD has worked well, thus helping in determining the temperature of the human body non-contact. When the human body temperature detected is in the normal category, namely 36˚C - 37.5˚C, the buzzer does not sound, while when the human body temperature is more than 37.5˚C, the buzzer sounds. An error was found when the lighting was dark, and from 5 attempts at a distance of 100 cm, only 60% of the experiments were successful. So, the test of the mask detector can be said to be successful with success above 60% if the lighting is good and the distance is around 100 cm.

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