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Non-Contact Facial Temperature Measurement Based on Thermal Technique

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Abstract: Non-contact facial temperature measurement is one of the major fields that have involved a many of research to improve the existing system. This project aims to develop the temperature monitoring system by using the non-contact technique, by extracting the temperature feature from webcam images by using MATLAB. To obtain a result of face temperature, the RGB camera is used to detect only the facial area and measures the temperature within a specific ROI at certain points. The technique of collecting the data includes three subsystems of webcam, data processing unit, and data transmission. Image processing is used to create, process, and display images. An image will be processed into 4 steps: crop image, indexed image, floating-point image, and histogram. From the result of the percentage error data analysis, it can see that the error percentage for all subjects is not more than 15%. The measurement for infrared thermometer value which almost the same as the simulation value.

Keywords: Temperature Measurement, Thermal Technique, Image Processing

1. Introduction

In this new globalization pandemic, health issues are very important to prevent chronic diseases and long-term illnesses. It was also important to maintain a healthy lifestyle by doing what is right for our bodies. Circadian rhythms and menstrual cycles are important health information about body temperature. It has also been discovered that body rhythm is related to sleep disorders and cognitive performance in daily life. However, it is not easy during daily life to monitor body temperatures with existing devices, because they are invasive, disruptive, and costly. The new technology is then required, which can monitor the corporal temperature accurately and non-intrusively [1].

The industry has long used an infrared thermometer and thermal camera, but there has been higher market demand for better and more accurate measurements. A non-contact infrared thermometer is an ideal method for such applications because it has also been identified to solve the problems related to people's temperature measurements [2].

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The use of non-contact infrared thermometers has become the preferred choice for such applications. They have also come as a solution for the difficulties involved in the temperature measurements of moving targets. The industry has used portable and spot-type infrared thermometers for some time, but the demand for better and more precise measurements has brought an incredible number of new products to the market [3].

Therefore, this project proposes the technique of comparing the measurement of a face using a webcam. Due to that, the webcam is used to extract the important sign from the face image to simulate the measurement [4]. The objectives of this project are to develop a temperature monitoring system by using the non-contact technique. To extract the temperature feature from the webcam using MATLAB. To determine the ROI of the facial area from the RGB image.

2. Methodology

This chapter discusses the project block diagram, methodology, flowchart, and pretty much the entire project, which is usually obvious. After conducting research on the thermal technique, literally, a few key features and conditions can be determined and prioritized. This chapter is usually concluded with a variety of methods.

2.1 System architecture

It is necessary to plan the architecture of the system along with the software to complete this project as in Figure 1. The system shows the temperature value at the location of the principal features such as the eyes, nose, and mouth. The whole procedure is repeated to predict the sub-features, relative to the principal feature, and verified with collocation statistics to reject any misallocated feature. When the system goes in real-time, the output capture images collected into a dataset using a webcam. The process for measurement of temperature using a webcam is shown in Figure 2.

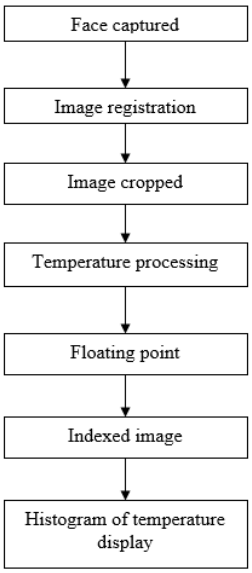

Figure 1: Workflow for system architecture

In this project, the RGB camera visualizes the facial temperature as an image and measures the temperature across a specific area at several points. Region of interest (ROI) to detect temperatures that had to be focused on the face region. The temperature range is 38°C for the highest temperature measurement for the thermal image, and the lowest temperature is 30°C is be set in this project.

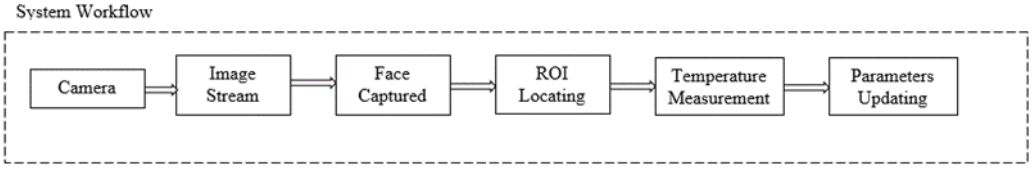

Figure 2: Process for measurement of temperature using a webcam

2.2 Dataset

For the dataset in these projects, there were 5 volunteers sat on the test chair at a distance which is 33 cm. Volunteers were requested to sit with some movement of the body and head including moving heads and backs to simulate more demanding experiments. Examples of dataset images is shown in Figure 3.

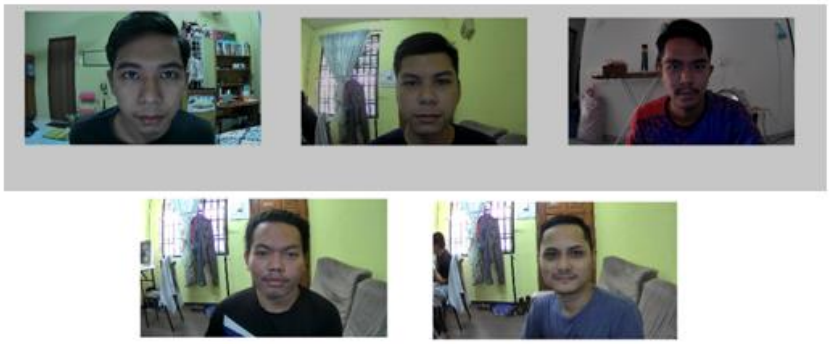

Figure 3: Examples of dataset images

2.3 Data collection and illustration

Figure 4 shows the technique of collecting the data including three subsystems of webcam, data processing unit, and data transmission. The details of the three subsystems for face detection are described as follows. Before capturing, the distance between the face and the webcam is 33cm.

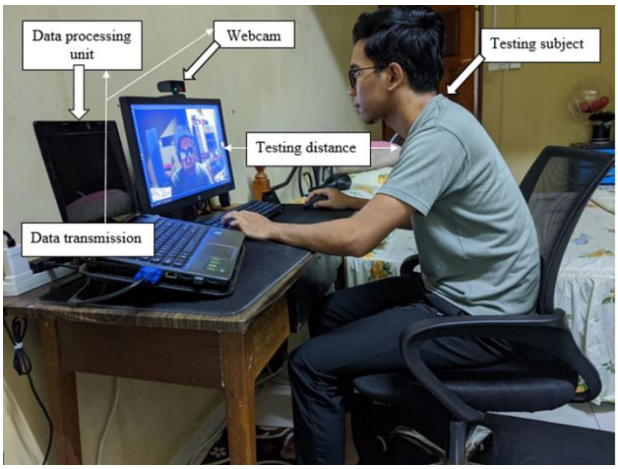

Figure 4: The overall structure of the system

2.3.1 Data processing unit

The data processing unit is a program using MATLAB. The processing of data by a laptop is known as data processing. It includes the processing of raw data into simulation format, as well as data flow.

2.3.2 Data transmission

The transmission of data from a MATLAB application to webcam hardware is known as data transmission. This is accomplished through the use of point-to-point data streams or channels. The data transmission rate is the amount of data transferred in a given time.

2.4 Image processing

Image processing is used to create, process, and display images. An image will be processed into 4 steps: crop image, indexed image, floating-point image, and histogram.

3. Results and Discussion

3.1 Results

Figure 5 shows the output of the face subject captured. The subject should be 33 cm away to capture the image, and lighting is also important for producing a clear image. After that Figure 6 shows the cropped image resized to a position that focuses on the subject's face. Cropping a picture means removing or adjusting the image's outside areas to improve the frame and change the size or aspect ratio. Extracting specific temperature data from an image is known as an indexing image. By using the webcam for this project, only grayscale images were displayed on the Figure 7 result. The floating-point function is to display the temperature value of the face subject. Figure 8 shows the value be compared on the foreheads of all subjects for the same purposes. Table 1 shows the result from all subject

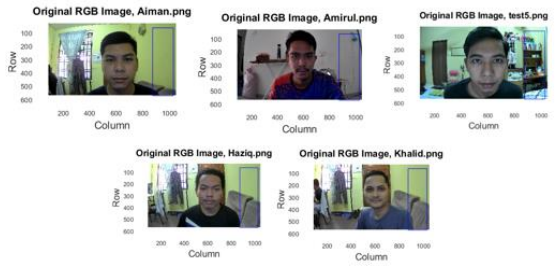

Figure 5: Camera captured results

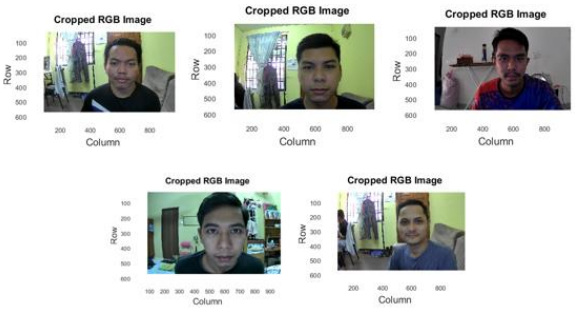

Figure 6: Cropped RGB image

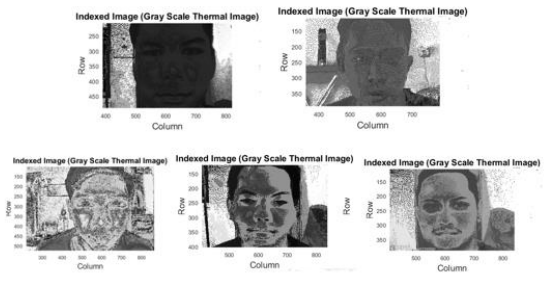

Figure 7: Indexed image results

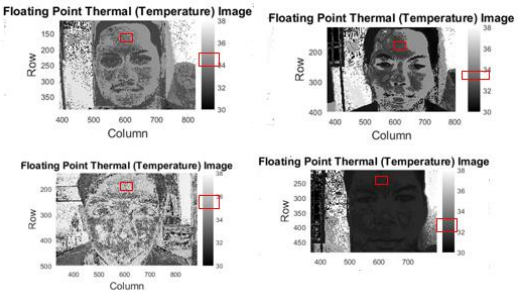

Figure 8: Floating point image results

Percent error compares an estimate to an actual value and shows the difference as a percentage. This statistic allows analysts to understand the complexity of the errors compared to the actual value.

$$\text{Percentage of error} = (|\text{Observed Value} - \text{Actual Value}|) / (\text{Actual Value}) \times 100$$

Table 1: Results from all subject

Name	Actual Value	Measured Value
Subject 1	36.6°C	34.5°C
Subject 2	36.2°C	33.5°C
Subject 3	36.4°C	35.5°C
Subject 4	36.4°C	32.5°C
Subject 5	36.6°C	34°C

3.2 Discussions

This chapter discusses the findings of the studies that have been carried out. Testing the ability of the webcam functionality has been tested to ensure that it functions as expected. From the result of the percentage error data analysis, it can see that the error percentage for all subjects is not more than 15%. It is because the ambient light in the room causes the temperature taken to be affected.

4. Conclusion

In conclusion, the non-contact facial temperature technique can extract the temperature from facial ROI by converting the RGB image into a thermal image. The technique gives the measurement of temperature from 36°C to 38°C which means that normal temperature is detected from 5 subjects. The measurement for infrared thermometer value which almost the same as the simulation value. Based on simulation results and data collected from testing, it has been proven that non-contact facial temperature measurement can extract the temperature feature from the webcam in actual real-time even though there is a slight difference in measurement. Last but not least, to produce a non-contact measurement that can operate on subjects by using MATLAB software simulation.

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