Fever Detection: Application on Thermal Imaging

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Abstract— The infrared thermography intensity is mainly a function of temperature. Infrared thermography provides a visual map of skin temperatures in real time. This feature of infrared thermography is for multiple purposes: as a sign of malfunction in mechanical and electrical maintenance or as an indicator of heat loss in buildings. The proposed system detects various indications of fever such as elevated temperatures and red eye. It is very essential to develop assisting technologies in order to provide appropriate services for detection of different symptoms of fever as fever itself can be a symptom of many other vulnerable diseases. The system processing is based on analysing the thermal image of a person taken from a thermo graphic camera and detecting the elevated temperatures at different parts of the face and also detecting the redness of the eye which itself is one of the symptoms of fever and thus gives a conclusion regarding person medical state.

Keywords: Image Processing, Histogram, RGB Image, Non-Intrusive

I. INTRODUCTION

All objects radiate heat according to given theoretical curve (according to Planck's law).Humans are Homoeothermic, they radiate heat, which must be lost to the environment to control their internal temperature. This very feature can be exploited for different for purposes in advancing technology such as thermal imaging.

A. Technology Used:

Thermal imaging cameras detect difference in infrared radiation of the object according to their temperature. Thermal imaging sensors are typically Focal plane arrays (FPAs), which measures a change in resistance on each pixel when exposed to infrared radiation – as opposed to photon detectors, which detect photons of light. Thermal cameras operate over the mid (3-5µm) to long (7-14µm) wave infrared wavelengths. Thermal imaging cameras are split between cooled and uncooled technology. Cooled cameras provide good signal to noise ratio and therefore high sensitivity, detecting temperature differences down to 0.015°C.

B. Need for such a System

According to many surveys fever is a common everyday medical problem for humans but it can be a symptom of vulnerable contagious diseases like Ebola and H1N1 (Swine Flu) which can be life threatening. Many measures are being taken to contain these diseases but still much more is yet to be done. Best way to contain these diseases is to take precautions or early detection. Technology can play a major part in this role. Present approaches which are being followed for the detection of fever just by the image of a person include just the use thermal cameras to detect elevated temperatures. Well, elevated body temperature of a person can be a result of running, smoking etc. This does not conclude that the person is suffering from fever. So we need a more robust, accurate at the same time a faster system which can process the data and deliver more accurate results.

C. System Basic Function

This system deals with the detection of accurate elevated temperatures of the face , comparison between the normal condition image and the elevated temperature condition image, object extraction and boundary tracing of the image and red eye detection(Symptom of fever). Different thermo graphic camera has different colour temperature indexing for temperature distribution. So this paper is designed for a particular thermal camera with particular colour temperature indexing as defined in fig 1.

II. METHODOLOGY

The methodology aims on processing four functions:

- Plotting the RGB plot of the thermal image.
- Comparison between original thermal image and the elevated temperature thermal image.
- Colour Mapping
- Object extraction and boundary tracing for different parts of the image and analyzing their thermal distribution.
- Red eye detection.

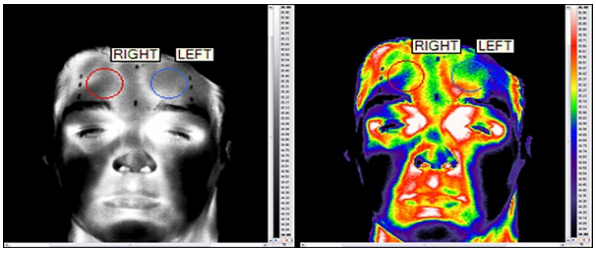

Fig. 1: Thermal image captured with colour to temperature indexing

A. Method of Detecting Elevated Temperature:

This system uses thermo graphic camera and image processing ECU which points on the face and takes images of it. The camera is placed 30cm away from the face of the driver. The thermal camera comprises of an image sensor, MCU for controlling the image sensor, and an IR filter to prevent the interference of sunlight. The facial image of the person act as an input to the system. The image captured by the camera undergoes processing done by the algorithm developed on MATLAB. The very first step is to remove the background of the image, which is a very necessary step, as while plotting the histogram or the RGB plot of the image background also contribute to the intensity changes which increases the false positives and decreases the accuracy of the system.

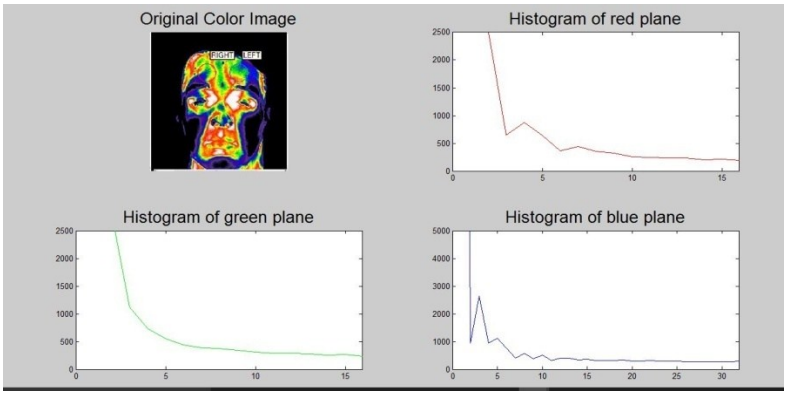

Fig. 2: RGB image plot of the normal thermal image

Then the RGB graph plot of the RGB image is plotted. This RGB graph indicates the amount of temperature distribution on a fixed scale. The temperature distribution is indicated by the color temperature of the thermal image. The temperature distribution can be calibrated for different colors to give precise value and more accurate temperature drop or rise. The coefficients of the RGB plot can now be compared the coefficients of the RGB plot of the normal thermal image and the difference in temperature can be marked.

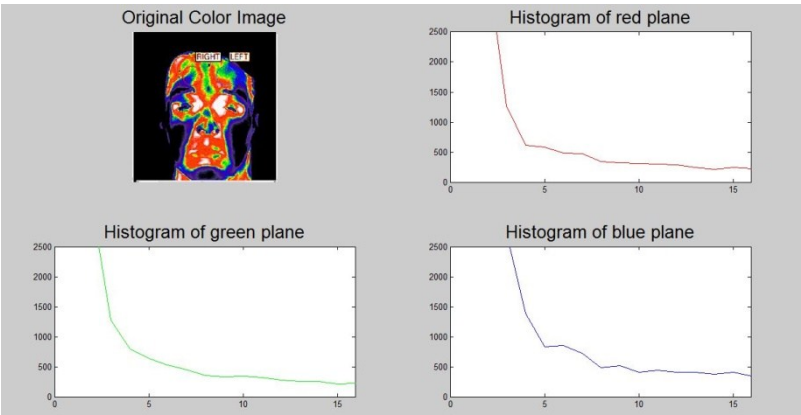

Fig. 3: RGB image plot of the image with elevated temperature

The coefficients of the thermal image of the two thermal images are stored as a matrix and are compared later on which makes the comparison easier and processing faster. For a more precise calculation of temperature distribution we use the method of object extraction and boundary tracing. The area about the eye show more elevated temperatures during fever in thermal image, so we extract area about the eye by the object extraction method and then compare to the same area of the normal thermal image without fever condition [3].The edges of the eye can be detected as to find edges this algorithm looks for higher intensity changes and uses one of the following cases; Places where the first derivative of the intensity is larger in magnitude than some threshold. Places where the second derivative of the intensity has a zero crossing. As the eye region showcase greater intensity changes than other body parts or skin the around it, so it can be easily separated by using boundary tracing [1]. The temperature distribution near the eye is compared to the temperature distribution of the eye of the normal image by plotting the RGB image plot of the eye area and comparing the intensity changes. [5]

The last step is to map the colour temperature indexing with the temperature distribution. Each row of map specifies the red, green and blue components of a single colour. An indexed image use direct mapping of pixel intensity values to colour- map values. The colour of each pixel is determined by using the corresponding value of integer matrix X as an index.

B. Method of Detection of Red Eye:

Red eye detection parameter is taken into account as red eye is a common symptom during fever and it increases the accuracy of the system to conclude and ends dilemma that the person is having fever or not. In this we use an IR camera which points at a person face and detects the eye region using object extraction and boundary tracing as the eye region showcase maximum intensity changes. In this the graph of the red plane of the normal RGB image without redness (only the eyes specifically the white portion) of the eye is plotted.

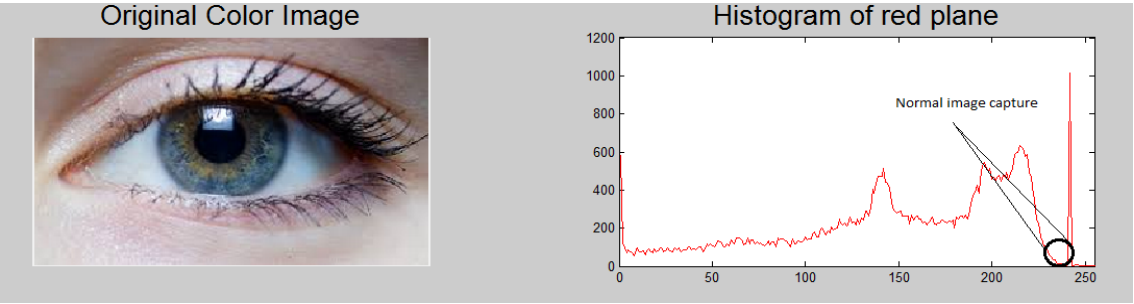

Fig. 4: RGB image plot of the normal eye image (without redness)

The above figure showcases the histogram of the original image of the eye of the driver. The histogram represents the distribution of data of the red plane of the RGB image (only the eyes specifically the white portion) on the scale of 0 to 255.As shown in the above figure that there is no intensity change nears the marked region. This verifies that there is no redness detected in the eye. Next is the case when the red eye is detected. We keep a threshold value of 60 to calibrate the amount of redness of the eye. This state shows a very large amount of colour variation and intensity changes of near about 100 which is a state well above the defined.

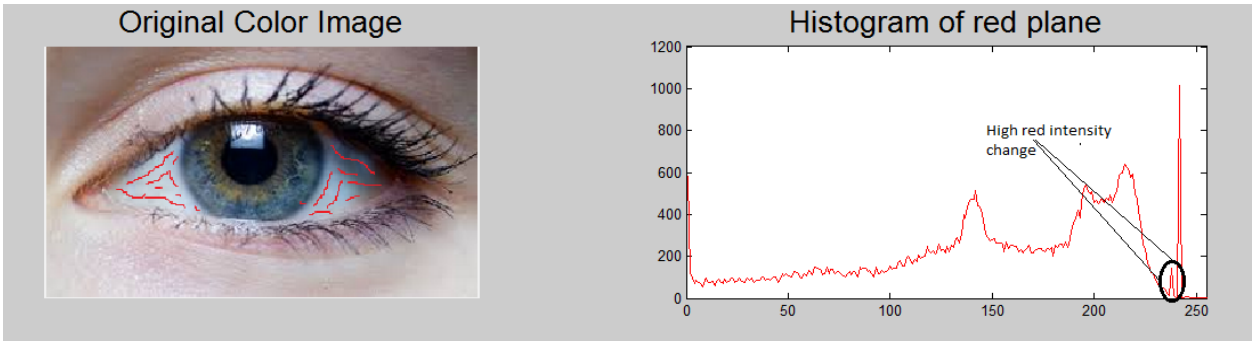

Fig. 5: RGB image plot of the eye (with redness) image

Threshold value of 60 so when such a result is obtained along with the elevated temperature of the face region or near the eye region the system immediately issues a warning signal to alert the operator regarding the person's medical state. [4]

III. FUTURE WORK

Due to the pilot nature of the system that was investigated in this project, some aspects are suggested for further development.

- Future work will focus on optimizing the high false positive rate of system caused by other parameters or factors of fever.
- Currently there is no adjustment to zoom variation; future work can be in designing an automatic zoom camera feature and to track down the direction of the face.
- Use of adaptive lighting which can be used to give better picture of the face and eyes where ample amount of light is not available.

IV. CONCLUSION

This paper aim to develop a precise, accurate and faster fever detection system. This paper provides an effective approach for the detection of fever which can play a major role in detection of vulnerable diseases and will prevent from becoming a pandemic. These systems should be installed at airports, railway stations etc. This technology and even be used to detect medical state of person sitting in a remote area and his condition can be diagnosed by a doctor miles away. This system is feasible, cheap and easy to install.

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