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Optical and Heart Monitoring Using Facial Image Processing and Fast Fourier Transform

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Abstract

The prolonged use of Laptops, Mobile phones, and many digital screens, leads to many health issues such as damage of eyesight and unusual heart functioning. Our goal is to identify the cause and alert the user to take necessary precautions from excessive use of digital screens. By staring at the computer screen or while reading, our blink rate decreases by 60%. To prevent ocular conditions, we need to make the person blink when the blink rate is not enough. This software monitors and detects when the blinking rate is abnormal and recommends blinking eyes. The software uses video-based heart rate detection system to enable contact-free detection of a person's physical behaviour under relaxed and active conditions. This enables the person to protect themselves from dry eyes which leads to computer vision syndrome. Using a computer long time also leads to stress so the software uses the same video data to get the person's heart rate and alert the user when heart rate increases abnormally. Our system uses face detection for Region of Interest (ROI) constrained near-real-time signal analysis to detect the heart rate.

Keywords: stress management, eye strain detect, blink detect, Abnormal heart rate, medicine, facial image processing

1. Introduction

Nowadays, there is an increase in stress among the workers due to prolonged usage of computers. It leads to many health issues such as damage of eyesight and increased heart rate increases the heart disease. Digital screen usage reduces blinking rate by 60%. Our aim is to create a system which can efficiently monitor the computer users and give them Real Time feedback based on their blinking rate and heart rate. Therefore, we can reduce the ocular condition in eyes which is caused by dryness on the surface of the eyes and also detect the heart rate using a contactless method to measure the sudden raise in heart rate due to the stress caused by working for a long stretch without relaxing or taking break so that we can suggest them to take a break when needed. To achieve our goal, we suggest that by using a laptop or a desktop with a webcam can be used to achieve our goal. The program we developed with help of all the references has the ability to monitor the heart and blinking rate of the user. A cardiac arrest alerting system was developed and implemented using Internet of Things. (Aditya, et. al., 2017)

2.Literature Survey

2.1.Robust Algorithm For Remote Photoplethysmography In Realistic Conditions

This paper (Artemyev, et. al., 2020) discusses how change in heart rate leads to heart disease. They have studied 13,499 men and 15,826 women without known cardiac issue. Mikhail Artemyev discusses on improving the photoplethysmography signal by using the novel robust method for accurate pulse rate estimation from video in different conditions. They are using the algorithm which uses cPR + fine (cPR - central pulse rate without refinement and fine - pulse determination algorithm with no central pulse detection step). They propose this method to solve the inaccuracy in heart rate when sudden facial changes are observed. They are using dlib C++ library 68 facial landmarks to detect the facial landmarks other than the eyes and mouth area since they are moving. They are averaging the red, green and blue channels from each frame from the video further they apply the interpolation to R, G, B channels to apply the cubic interpolation to convert it to 256 frames per second. Then they remove the noise caused by external light source by detecting the high frequency peak greater than 7 Hz with highest amplitude and apply bandpass filter which rejects frequencies beyond the 0.75-3 Hz range and applying short-time Fourier transform and normalize the result to get the accurate heart rate.

2.2.Temporal Changes InResting Heart Rate And Deaths From Ischemic Heart

Cardiovascular disease in Norway from 1995 to 1997 and following them up to 2008. The result of the paper (Nauman, et. al., 2011) suggests that the normal range for resting heart rate is between 60 and 90 beats per minute. Above 90 is considered high.by comparing the people whose resting heart rates were under 70 beats per minute at the start of the study till the end, those who had the resting heart rate rose from under 70 to more than 85 were 90% more likely to have died during the course of the study. The increase in risk varies in resting heart rates of around 70 to 85 at the study's start and who had a greater than 85 at the study's end.so, we used this result to monitor the person heart rate using remote photoplethysmography technique and alert them when their heart rate increases abnormally.

2.3.Detection Of Eye Strain Through Blink Rate And Sclera Area Using Raspberry-Pi

In this paper (Reddy, et. al., 2019), they have approached the problems regarding determining the eye strain in children due to excessive usage and exposure to LCD and PDP screens. Initially they calculate the blink rate by determining the closing and opening of eyes by monitoring the region of the part sclera in the human eye. They detect this by using Modified OTSU using Colour Tracking and comparing the values of metrics derived in real time with threshold. This eye strain detection system comprises of 4 modules namely Image acquisition model (IAM), face and eye detection module (FEDM), eye strain detection module (ESDM), Alert Module (AM). They have built their system using raspberry pi which comprises Broadcom BCM2873 SoC, a 1.2GHz ARM Cortex A53 processor, an integrated Broadcom video core IV GPU and 1GB of RAM. They collect the images of eye and divide and separate them to 4 columns, in which, the detected eye regions are in column A and the results with sclera region detection using these approaches are in column B, C, D. In their research with the help of Otsu thresholding, it detects the sclera region but fails due to reflected components from the skin portion. In this paper, they used an algorithm called Modified OTSU using Colour Tracking (MOCT) is proposed and implemented by combining OTSU thresholding and colour tracking to find the area of sclera and blink rate with an accuracy from 34% (OTSU) to 83% (MOCT) and alert the consumer/care taker via SMS.

2.4.Smart Driver Assistance System Using Raspberry Pi And Sensor Networks

This project (Sanjay, et. al., 2010) is mainly focus on the safety travelling of the passengers. The passenger's safety (J. Anand, et. al, 2014) is mainly depending on the person who drives the vehicles. So, this project focus on the driver to have a safety journey. In this driver will be monitoring using the CCTV camera and especially the driver's eyes and face were monitored to identifies the driver drowsiness using face and eye detection phase and by using Haar cascade algorithm. The open cv and Haar cascade algorithm are collaborate used to perform the process of object classification. Its utilization of Lod's and multiple cameras to recognize the facial expressions. It offers high speed computation depending on the number of pixels inside rectangle feature and not depending on each pixel value of the image unlike where histograms were used. In this drunken driver can also identify using the same principle used by traffic police, by detecting drunk drivers. By electrochemical method.

2.5.EVM-CNN Real-Time Contactless Heart Rate

Nowadays there are remotely estimated the heart rate from facial videos although progress takes increasing in time with accuracy (Jose, et. al., 2013). And the heart rate in formation can be extracted from facial videos by spatial decomposition and temporal filtering. Inspired by this a new framework is introduced in this paper for remotely estimating the heart rate under realistic conditions by combining spatial and temporal filtering and convolutional neural network. The motion of the subject affects the performance of measurements and which are divided into two types - rigid motion, non - rigid motion. Rigid motion which includes head tilt and posture changes. non - rigid motion which includes facial expressions such as eye blinking. The methods (Qiu, et. al., 2019) in first group select the whole face as the region of interest and most of the methods used a filter to reduce the noise caused by motion artifacts and illumination variations. The methods in the other group focus on choosing a ROI of the face and estimating the HR based on this reliable region. To some extent both methods have aspects of superiority, but downsides do exist. Whole face region-based approaches usually extract a PPG signal by spatially averaging the face region at the outset and the mainly focusing on reducing the impact of interference by the noise. Partial face region selection can help decrease the time spend filtering the signal and progress has been made with better performance than the whole face region-based approach. Power spectral density of signal to estimate the HR in the procedure which requires the clear signal to obtain accurate results and which increases the computing time.

2.6.Computer Vision Syndrome

This paper (Blehm, et. al., 2005) relatively deals with problem which occurs in eye. The problem which occurs in the eyes due to restless usage of computer screen is commonly known as computer vision syndrome. This paper tells the condition that causes the computer vision syndrome. The paper result states that dryness is also one of the reasons that leads to eye problem also called as ocular condition. This dryness in eye, is mainly caused by less blinking rate of the person.

2.7.Automated Detection Of Eye Related Disease Using Digital İmage Processing

Across the world around 1.3 billion individual experience long distance and short distance vision impairment. In order to prevent this, in this paper they have used image processing to diagnose eye diseases. In image system processing systems (Rammyaa, et. al., 2019), they have used two known techniques namely ultrasound and optical coherence tomography (OCT) (Kumar, et. al., 2019). The special type of ultrasound called eye or orbit uses high frequency to measure and create detailed image of our eye, by portraying sound waves of frequencies surpassing the scope of human hearing between 2 and 15 MHz OCT can give cross sectional pictures of organ texture on the micron scale (1-15µ) in real time (Sibia, et. al., 2014). They have also used Retinal Fundus Photography to acquire colour pictures of interior parts of eye to detect the presence of scatters. To detect eye diseases, they have used DIP based techniques for automated diagnoses.

3.Proposed System

Our objective is to track and monitor the eyes and the heart of the user in real time and in case of any defects or abnormalities, our software will alert the user immediately to rectify the problem. The goal is to reduce the eye strain and user stress.To achieve our goal, we suggest that by using a laptop or a desktop with a webcam can be used to achieve our goal. The program we developed with help of all the references has the ability to monitor the heart and blinking rate of the user. We have used python as our programming language for completing this project. This program monitors the user using a webcam and applies image processing techniques and makes use of signal processing libraries available for open source online to give notification when abnormal blinking or heart rate is detected. Thus, users are made to protect themselves from getting dry eyes and increased stress levels which leads to improvement in their health and leads to a healthy life. Figure 1 shows the block diagram of the proposed system.

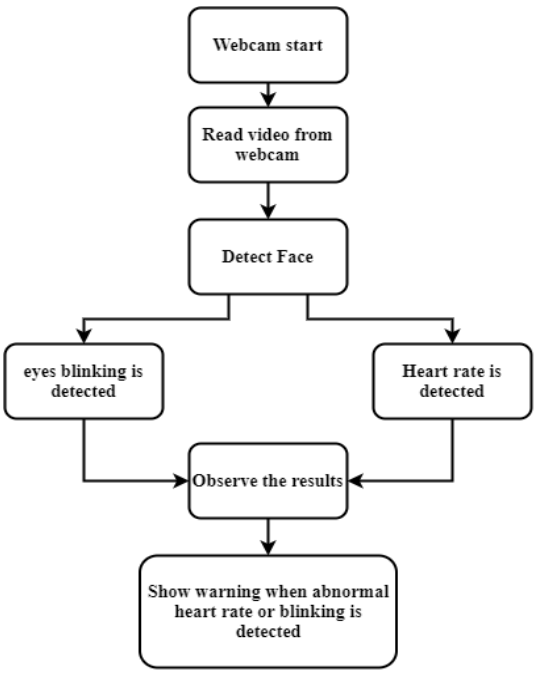


Figure 1 Block Diagram of the Porposed System

4.Implementation

4.1.Processing

When the program is initiated, the software analyses the given input devices to read the user's video live stream. The dlib shape predictor 68 face landmark data in feed into the program during initiation. It then applies the user's face with the pre-fed dlib shape predictor which has a 68 facial landmark points in order to process the video. The software then processes the image taken through our live stream using Open CV method to crop the video and captures the face alone to enhance the video colours. With the help of dlib face landmark data, the region of interest is drawn on both the cheeks and contours on eyes (as shown in below figure), that is draws or borders the extreme end of the eye for precise readings. Next, our module initiates both the eye and heart rate monitoring simultaneously at the same time, in which it detects the blinks with respect to contour changes and calculates the heart rate by applying FFT to colour average calculated from region of interest frames and heart beat frequency is split from the noise to get the heart rate.

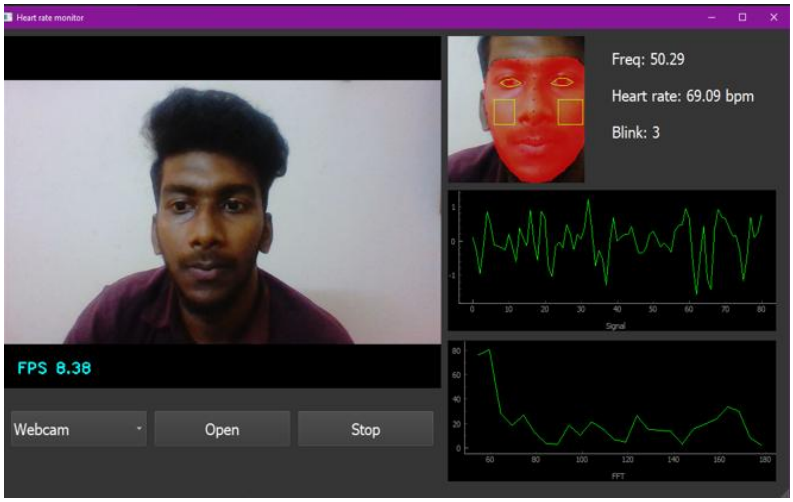
4.2.Detecting Abnormalities

When the blink is detected by calculating the change in the dimension of the contour drawn over the eyes by using OpenCV it further moves to the protocol of analysing the user whether he/she blinks more than 15 counts per minute. If this blinking of more than 15 times prolongs, then the contour of detecting and tracking eyes continues. And if not, the software will alert the user to blink by indicating them via a pop-up window. Also, in the case of heart rate monitoring, if the heart beat per minute is below 80 and stable there will be no warning and the monitoring continues. If the heart beat elevates to more than 80 beats, then the software will alert the user through a pop-up window to calm down and take a deep breath until the heart beat returns to normal and stable state. When the user enables the stop function, then the code is stopped/killed.

5.Result and Output

5.1.Output

Figure.2.GUI Output



Interpretation of figure-2.

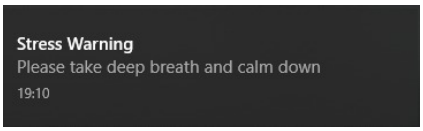
The GUI combines the different components of the program together and present it in understandable format to the user.

Figure.3. Blink rate warning

Interpretation of figure-3.

The above image represents the notification warning given when the blink rate is abnormal

Figure.4. Heart rate warning



Interpretation of figure-4.

The above image represents the notification warning given when the heart rate is abnormal

Table.1. Observationmade using the software for 10 minutes

Time in Minutes	Blink Count	Heart Rate (BPM)	Blink Alerts	Heart Elevation Alerts
1	17	62	0	0
2	19	61	0	0
3	19	62	0	0
4	16	71	0	0
5	13	72	1	0
6	11	75	1	0
7	16	81.6	0	1

8	24	80	0	1
9	19	76	0	0
10	22	70	0	0

Interpretation of table-1.

We ran the test to observe eye blink rate and heart rate for 10 minutes. As we can see from the above readings the blink rate reduces gradually and the heart rate elevates till mid-session due to prolonged use of computer. From the above table we can see that for the blink rate, in the 5th and 6th minute there is a warning to blink and in the heart rate monitoring, the 7th and 8th minute shows the heart rate stress warnings. But after the 6th minute the blink counts increases due to the alert of the software indicated via the pop-up window. Also, after the 8th minute the heart rate reduces to normal state after the warning via the pop-up window.

6. Conclusion

We all are using the laptops, computer for various purposes. But prolonged usage of these electronic devices makes the person eye affected such as dry eyes with leads to Ocular Condition. Ocular condition is a problem which occurs in the eye due to the lacks of blinking. To avoid this problem using the webcam the blinking rate will be observed when the blinking rate is abnormal it's gives a warning. Using computer, laptops frequently which increase the stress level of the person and to overcome this problem we used face recognition system which uses the webcam of the device to observe the heartbeat of the person. When average heart beat is high then the notification is given to user as "Take a deep breath and be cool" The main motivation behind this work is to increasing the safety level of eye and heart by the continuous monitoring of eye and heart which can be done.

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