Heartbeat Detection using Webcam

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Synopsis

1. Introduction

As a result of sitting down jobs, a lack of exercise, and unhealthy eating habits, there are more and more cardiovascular diseases in the population today, which increases the number of deaths each year. To live a proper healthy life, we should be able to understand our bodies. However, many pieces of equipment that are used to measure heartbeat are expensive and not readily available in many locations or even available 24/7, so this project will use a webcam to take live snapshots of your face and by calculating the variation in colours that your forehead unites, it will be possible to measure heartbeat. The process begins with your heart pumping blood through your veins, which alters the intensity of the colours on your body. A simple camera or webcam will take a live video of you while focusing on your forehead, changing the image or dividing it into RGB, but only the green image is used to calculate your heart rate. A webcam will detect minute changes in green colour that are impossible to see through a fake beard. Our major objective is to develop a system that uses a consumer-grade camera to assess your heart rate. We will display blood pressure and heart rate after computing them in real-time on the camera app. An online pulse monitor is a self-monitoring device that enables real-time heart rate measurement and display. It is primarily used to collect heart rate information while engaging in various forms of physical activity. Hospitals typically utilize many sensors and wired medical heart rate monitoring machines.
Consumer-grade heart rate monitors are wire-free and made for regular use. The patient's face is first detected, and then, using a physiological signal called a photoplethysmograph (PPG), we use pre-established formulae and methods that we took from the study material that is provided below to compute the patient's heart rate.

2. Objective

- This project can display a user's heartbeat in an existent time employing a webcam.
- It is a PPG (Photoplethysmogram) resolution based on a colour amplification process which makes it possible to see the colour of your face change as blood rushes in and out of your head.
- This project lets you picture your face as it pulses in real time. Since it is competent to perceive your pulse, it also estimates your heart beats per minute (BPM).
- To provide a no-contact heart rate measurement service that does not require visiting a medical facility.
- To lessen the quantity of inefficiency and delay brought on by numerous specialists.

3. Related work

PPG is a non-invasive photoelectric technique for monitoring changes in living tissue's blood volume.PPG peripheral pulse can reveal the cardiovascular state by revealing blood oxygen saturation, heart and respiration rates, cardiac output, and blood pressure[1]. The facial video is the source from which the PPG signal is extracted. Additionally, it demonstrates how BP and HR are inferred from the retrieved PPG[2]. The fundamental concept is to extract HR from the colour fluctuation in facial skin caused by a heart pulse, and the implementation was carried out using a straightforward camera in an indoor setting with continuous ambient light[4]. The technique is for omitting the background and outer pixels, however, some sections of the face will appear like hairs at the corners of the bounding box. Consumer cameras capture images in RGB (red, green, and blue) values, with the green channel supplying data that enables heart rate measurement[3].

4. Methodology

The planned structure must be vigorous and firm enough so the real time data handling can be performed devoid of any damage to data. Our solution is based on the following steps: frame capture, face detection and region-of-interest (ROI) definition, trace extraction, frequency domain filtering, peak detection and recurring

point of interest analysis, heart rate display, and software implementation. To be specific, the ROI definition improves ROI information utilization. The anticipated framework is shown in Fig.1, and detailed as follows:

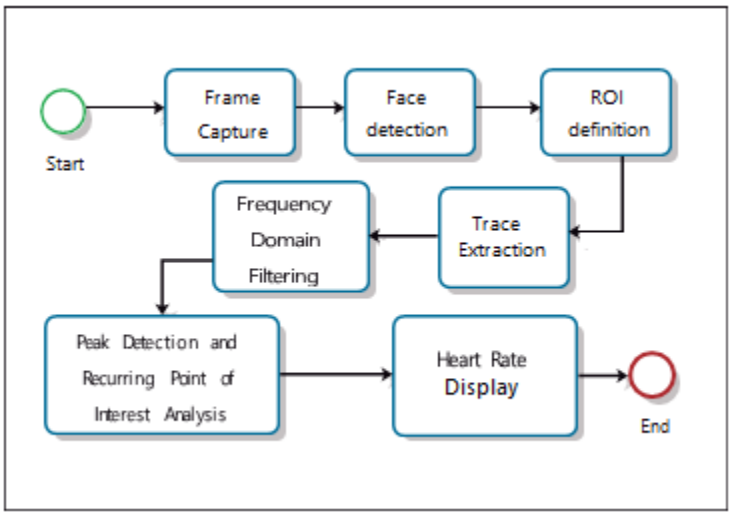

Fig.1. Program workflow

5. Plan of work

The various steps involved in the implementation will be carried out in the following phases:-

Phase I: 1 month

Frame capture: The first step involves the achievement of a frame through a webcam connected to the computer. As per with most webcams, the apprehended frame is in the RGB colour setup. Though the resolution is not so vital, it is essential that the webcam is capable of seizing the raw data, without any compression.

Face Detection and ROI Definition: The second step contains facial recognition over the attained frame. By default, only one face is to be detected in this project. The third step entails describing a bounding box above the formerly detected face. The ROI is defined as h x w, where h is the height of the bounding box of the detected face and w is 55% of the width of this bounding box. The resulting ROI is to be studied in the next stage. The ROI is kept the same for the residual frames.

Phase II: 1 month

Trace Extraction: In the fourth step, for each frame n, the ROI consists of a colour image h x w with three frequencies, Red, Green and Blue. This image is standardized, eliminating the mean value for every frequency, creating the variance between samples unitary as follows:

Ci=Ci n - ii

where i is for R, G and B, μi and σi are the mean and standard deviation for each frequency, respectively.

Frequency Domain Filtering: In the fifth step, the signal of interest is the trace, T (n). Algorithms are not practical for each new trace sample, but relatively once every two seconds. The algorithm takes the trace values for the last 10 seconds and stores them in a vector. It is then changed to the frequency domain with a Fast Fourier Transform - FFT of 2048 points.

Phase III: 1 month

Peak Detection and Recurring Point of Interest Analysis: This is the sixth step, which executes the heart rate estimation by studying the prevailing peaks in the found signal in the prior step.

Heart Rate Display: The last step comprises putting on a poignant average filter of size 3 i.e., the outcome exhibited on the screen is an average value between the last 3 estimates.

Software implementation: The software is executed on a Windows setting using python programming language supported by two libraries OpenCV and FFTW3. The OpenCV library offers the essential resources to the facial recognition algorithm and the frame capture through the webcam linked to a computer. The FFTW3 library is used because of the FFT algorithm it provides, as well as to deploy complex numbers when wanted.

References:

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