EXPERIMENT 11

Aim : Heart-rate-measurement-using-camera

Thoery :

Abstract :

- Heart Rate (HR) is one of the most important Physiological parameter and a vital indicator of people's physiological state
- A non-contact-based system to measure Heart Rate: real-time application using camera
- Principal: extract heart rate information from facial skin color variation caused by blood circulation
- Application: monitoring drivers' physiological state

Methods

- Detect face, align and get ROI using facial landmarks
- Apply band pass filter with fl = 0.8 Hz and fh = 3 Hz, which are 48 and 180 bpm respectively
- Average color value of ROI in each frame is calculate pushed to a data buffer which is 150 in length
- FFT the data buffer. The highest peak is Heart rate
- Amplify color to make the color variation visible

Usage Notes :

- When run, a window will open showing a stream from your computer's webcam

- When a forehead location has been isolated, the user should press "S" on their keyboard to lock this location, and remain as still as possible (the camera stream window must have focus for the click to register). This freezes the acquisition location in place. This lock can be released by pressing "S" again.

- To view a stream of the measured data as it is gathered, press "D". To hide this display, press "D" again.

- The data display shows three data traces, from top to bottom:

    1. raw optical intensity
    2. extracted heartbeat signal
    3. Power spectral density, with local maxima indicating the heartrate (in beats per minute).

- With consistent lighting and minimal head motion, a stable heartbeat should be isolated in about 15 to 20 seconds. A count-down is shown in the image frame.

- If a large spike in optical intensity is measured in the data (due to motion noise, sudden change in lighting, etc) the data collection process is reset and started over. The sensitivity of this feature can be tweaked by changing data_spike_limit on line 31 of get_pulse.py. Other mutable parameters of the analysis can be changed here as well.

How it works:

This application uses OpenCV to find the location of the user's face, then isolate the forehead region. Data is collected from this location over time to estimate the user's heart rate. This is done by measuring average optical intensity in the forehead location, in the subimage's green channel alone (a better color mixing ratio may exist, but the blue channel tends to be very noisy). Physiological data can be estimated this way thanks to the optical absorption characteristics of (oxy-) haemoglobin.

With good lighting and minimal noise due to motion, a stable heartbeat should be isolated in about 15 seconds. Other physiological waveforms (such as Mayer waves) should also be visible in the raw data stream.

Once the user's heart rate has been estimated, real-time phase variation associated with this frequency is also computed. This allows for the heartbeat to be exaggerated in the post-process frame rendering, causing the highlighted forehead location to pulse in sync with the user's own heartbeat.

Support for detection on multiple simultaneous individuals in a single camera's image stream is definitely possible, but at the moment only the information from one face is extracted for analysis.

The overall dataflow/execution order for the real-time signal processing looks like:
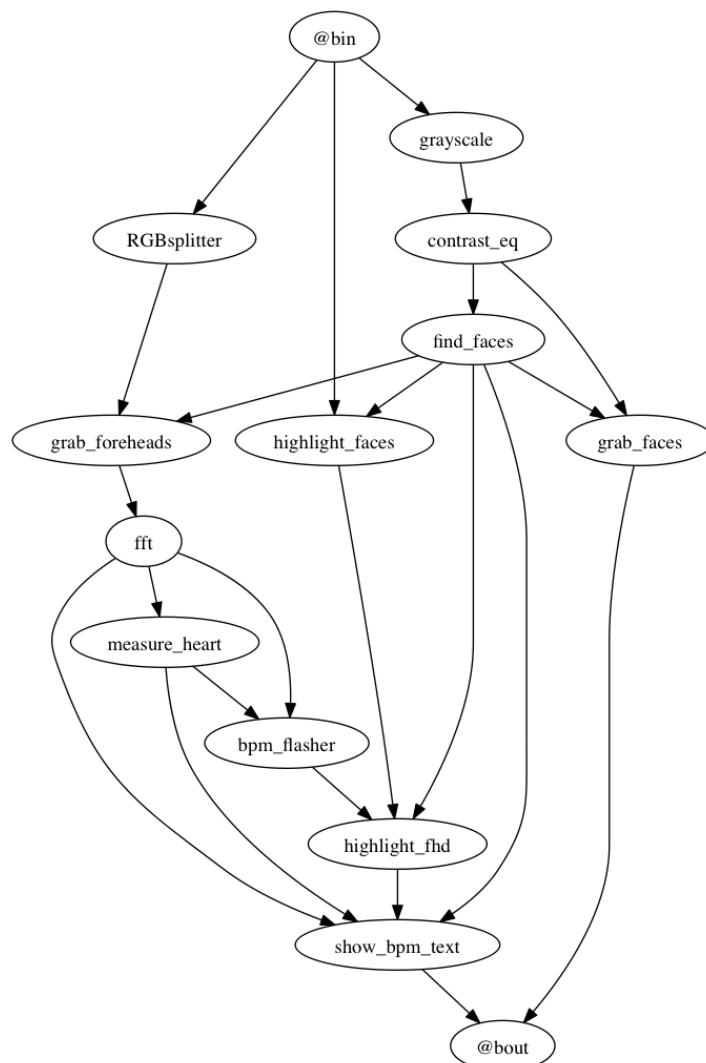
Code
https://drive.google.com/drive/folders/1m6xG9O17Pn1ndpN7Db99YsReG9MneaXh?usp=drive_link

Output: