Readme

Basic idea

The goal of the project is to improve accuracy of measurement of respiratory rate through mobile devices. To achieve this, the developed program follows the idea of calculating the RR through 2 simultaneous ways by capturing the video of a user's face. Those ways are

1. By extracting PPG signals from the video frames.
2. By audio processing the breathing sound from the video.

Code Explanation

1. **extract_color_channels.m** and **ippg_compute.m** as the name suggest extract color channels from a video and then compute the ippg signal

2. **AudioProcessing.m** is used to process the audio part of the signal.

3. **Execute.m** executes both video processing and audio processing and then compares peaks to give the final answer.

Algorithm

There are 3 parts of the process

1. Video Processing

The algorithm used in video processing is as follows

1. Processing the video frame by frame
2. Detecting of ROI as the user's face in every frame (Viola Jones Method)
3. Refinement of ROI with appropriate HUE and STD masking
4. Extraction of color channels from every frame by averaging over face pixels.
5. Detrending as a preprocessing step for extraction of PPG signals
6. Extraction of PPG signals from the green channel
7. Filtering it with a bandpass filter of 0.05-1 Hz
8. frequency(Butterworth Filter)
9. Signal is finally normalized as
   v'(t) = (v(t) - mean(v(t)))/standardDeviation(v(t))
10. Breaths in a given time is calculated as number of negative peaks in the signal

2. Audio Processing

The algorithm follows

1. Reading the Audio part from the Video format
2. Downsampling it so that the further processing consumes less time.
3. Taking out the absolute value of the function
4. Applying a low pass 3rd order Butterworth Filter
5. Normalizing the signal by amplitude scaling
6. Finding peaks in the obtained signals gives breaths in given time

3. Combining above obtained signals

After obtaining the above signals every audio peak is checked with a PPG peak. If that peak corresponds to a peak in the PPG signal that peak is considered otherwise it is rejected.Then the final RR is Calculated using the accepted peaks.

Certain factors on which final answer depends

1. HUE and STD masking values in ROI refinement.
2. Bandpass filter cutoff frequencies in video processing
3. Low pass filter cutoff frequency in audio processing
4. Filter orders
5. Minimum Peak Distance in finding peaks

Points to take care

Above implementation uses 3 toolbox from MATLAB - signal processing, image processing and computer vision toolbox

While developing an app for the above implementation a thing to be taken care of is when we extract audio signals from a video it is very noisy so if one can embed a synchronized voice recorder along with the video recorder he/she can get a more clear and noise free audio signal

References

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