Indian Institute of Science
Bangalore, India
भारतीय विज्ञान संस्थान
बंगलौर, भारत

Contactless Heart-Rate Measurement

A project on Digital Image Processing

(E9 241)

Submitted by

Abhishek Tyagi
MTech I year
CDS Dept
Sr no - 17907

Submitted to

Dr. Rajiv Soundararajan
Dr. Soma Biswas

Problem Statement

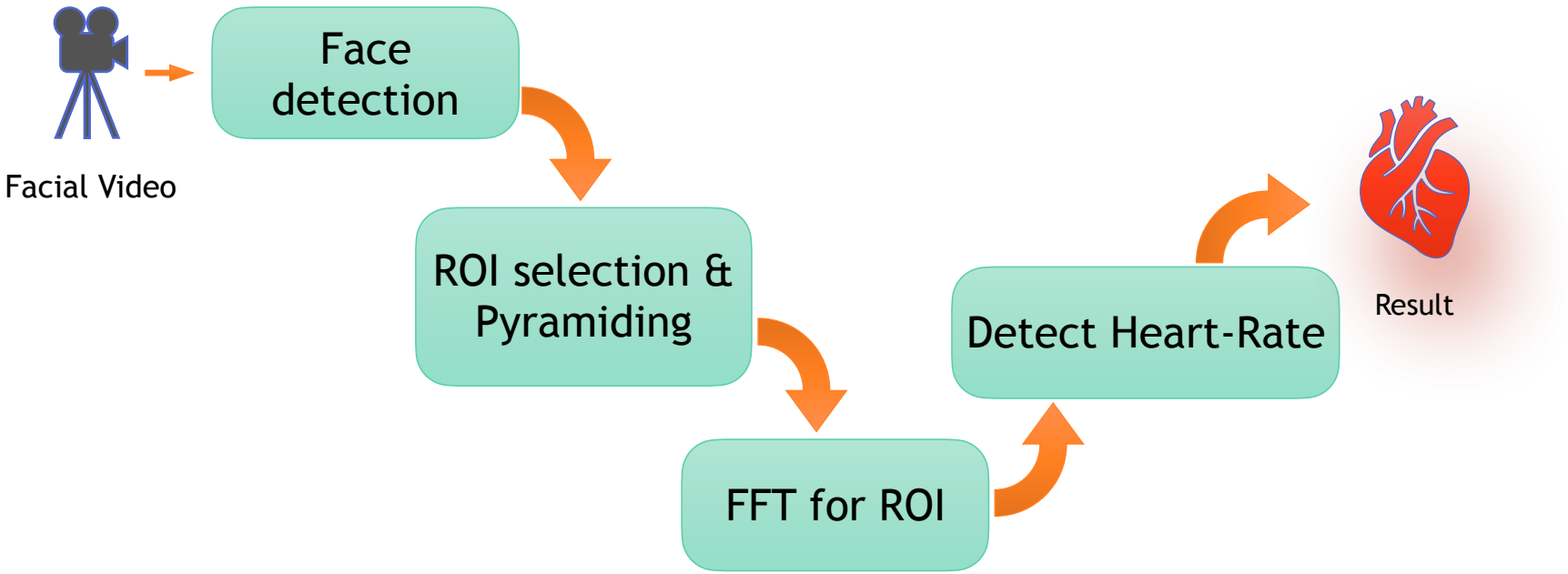
Today, the effect of COVID 19 has led all large/small scale organizations/institutions to monitor the health condition of visitors.

One of the important tool used to monitor one's physical health is one's heart-rate. But the challenge here is that traditional optical based sensors are needed to be touched to one's skin to be able to detect his heart rate. And this method puts him at risk as same sensor comes in contact with ever visitor and sanitizing the sensor after every use is hectic process.

Proposed Solution

- The problem is solved by developing techniques that can measure one's heart-rate without touching the sensor or coming in contact with the optical sensor.
- Using the concept of Eulerian Video Magnification, the frequency range in which heart-rate can lie is amplified and peak with maximum amplitude is identified.
- An approach and its practical implementation that uses video processing to estimate heart rate is presented in this project.

Algorithm flow



Explanation

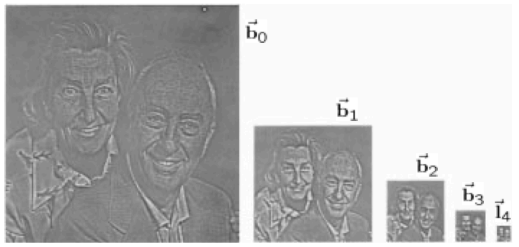
Region on Interest :

- After decomposing the input video in a set of frames, using Haar-cascades to detect face from the input frames.
- Primary objective of this project is not to detect face, therefore haar-cascades method is used as it is a simple yet efficient method based on machine learning to detect face and is known to be implemented in consumer hardware.

Pyramiding :

- 3 level laplacian pyramiding is used.
- A laplacian pyramid is similar to a gaussian pyramid but saves blurred image difference.

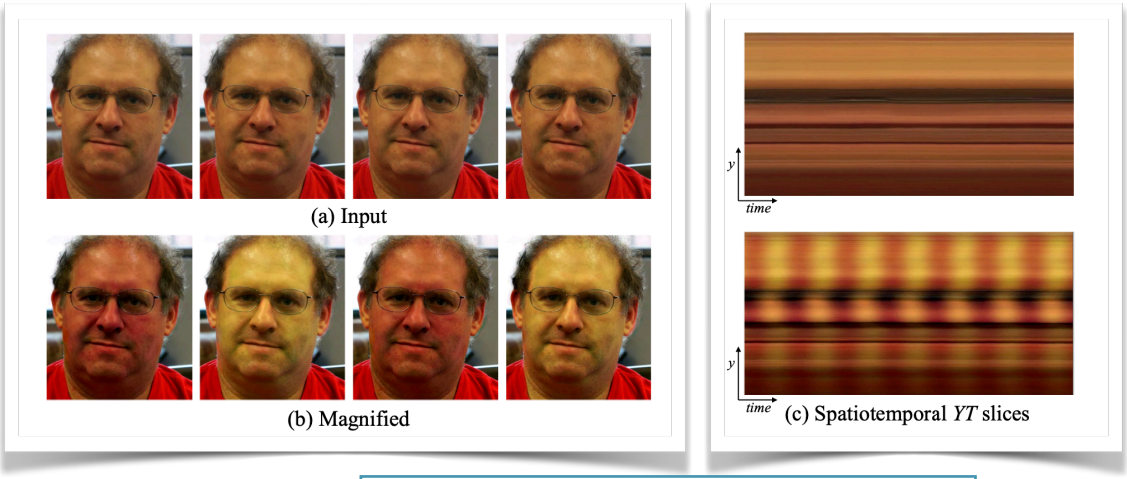
A Laplacian pyramid with four levels:



Explanation cont.

Fourier transform:

- The concept of Eulerian Video Magnification is applied on the lap-video (video received after pyramiding) to detect Heart-Rate " ref : http://people.csail.mit.edu/mrub/papers/vidmag.pdf"
- Basic approach of this algorithm is to consider the time series of the color values at any spatial location(pixel) and amplify variation in frequency band of interest (1 Hz to 1.8 Hz)



Ref : http://people.csail.mit.edu/mrub/vidmag/

Results verification

- Readings taken simultaneously using optical sensor present in Samsung Galaxy Note 9 (as shown in the image alongside) are assumed to be accurate

Time	Actual HR (bmp)	Calculated HR (bpm)	Relative error (%)
9:15 pm	92	81.29	11.64
9:30 pm	85	77.58	8.73
11:00 pm	94	87.76	6.64
3:00 pm	70	67.17	4.04
4:00 pm	72	68.89	4.32
1:00 pm	67	66.43	0.85
10:00 am	79	84.35	6.77
7:00 am	104	88.91	14.51
3:00 pm	74	69.97	5.45
6:00 pm	63	66.12	4.95
			6.79

Software & Hardware used

Hardware :

- This project has been completed on a MacBook Pro with :
  - 2 GHz Quad-Core Intel Core i5 processor
  - 16 GB Memory clocked at 3733 MHz
  - 720p HD webcam for input clip

Software :

- Development of this project has been done on Spyder IDE in Python 3.8.5 using libraries :
  - OpenCV
  - NumPy
  - SciPy
- Video clip is recorded using builtin application “Photo Booth”

Conclusion

- The results show good accuracy when compared to optical heart rate sensor (assuming it to be 100% accurate)
- Lightning conditions are affecting the measurement as can be seen in error table, the readings taking very early in the morning or very late at night (in absence of daylight) are most inaccurate
- Overall accuracy calculated ~ 93.21 %