Heart Rate Measurement Using Webcam

supervised by

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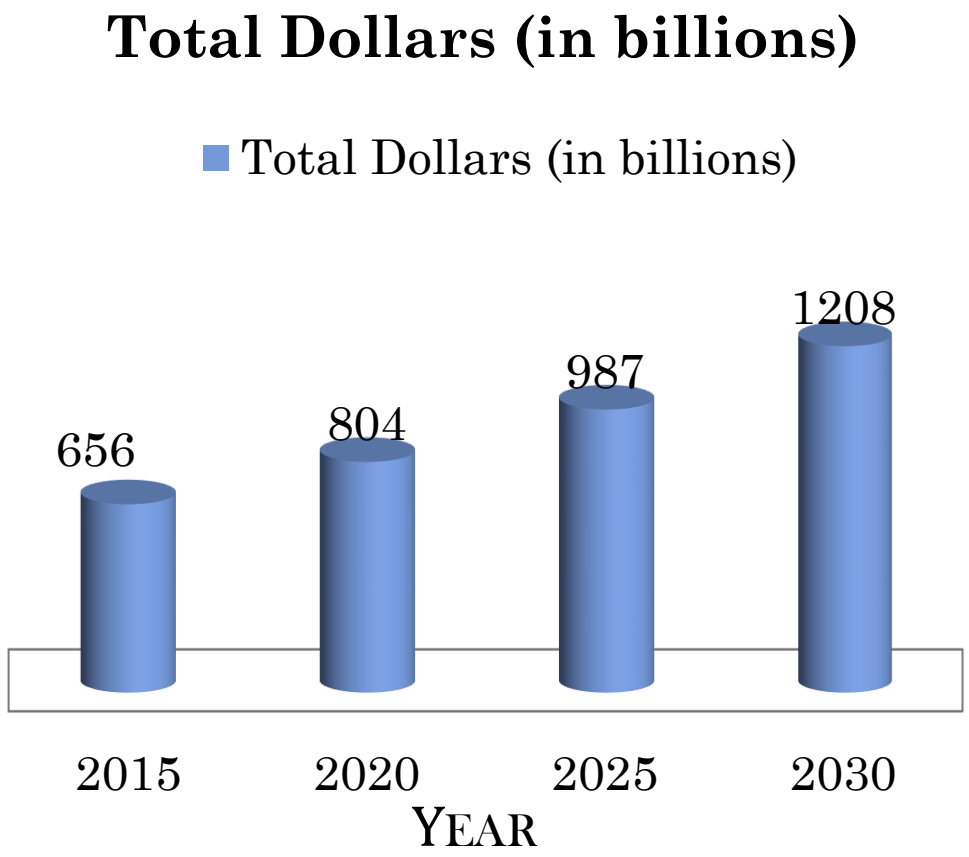
Motivation

- Cardiovascular disease is the **leading global cause of death**
- According to the statistics of the American Heart Association, it accounts for more than **17.3 million deaths per year**, a number that is expected to grow to more than million by 2030
- Total expenses for heart patients are expected to be **1208$ billions in 2030**



PROJECT OBJECTIVES

The objective of our project is to provide a new technology :to measure the heart rate that offer the following

- Present a fast, efficient, and reliable technology
- Can be measured accurately at any place or at any time
- Easy to follow up patients without the need of going to the hospital
- Easy to share between the patient and the physicians
- Designed as an application on personal computer

Review Current Methods:

1. Manual Methods (from hand)
2. Standards Method (Electrocardiogram, ECG)
3. Mobile/ Watch Applications

1. Manual method

Disadvantage:

- not accurate
- Introduces large error
- Subject to human variability

2. Standard method: Electrocardiogram (ECG)

- **Idea:** It records the electrical impulses of the heart for diagnostic purposes

- **Disadvantage:**
  - Patient must come to the hospital,
  - Difficult to follow up especially for elders and sick people
  - High cost

3. Apps

Heart Rate Phone Application

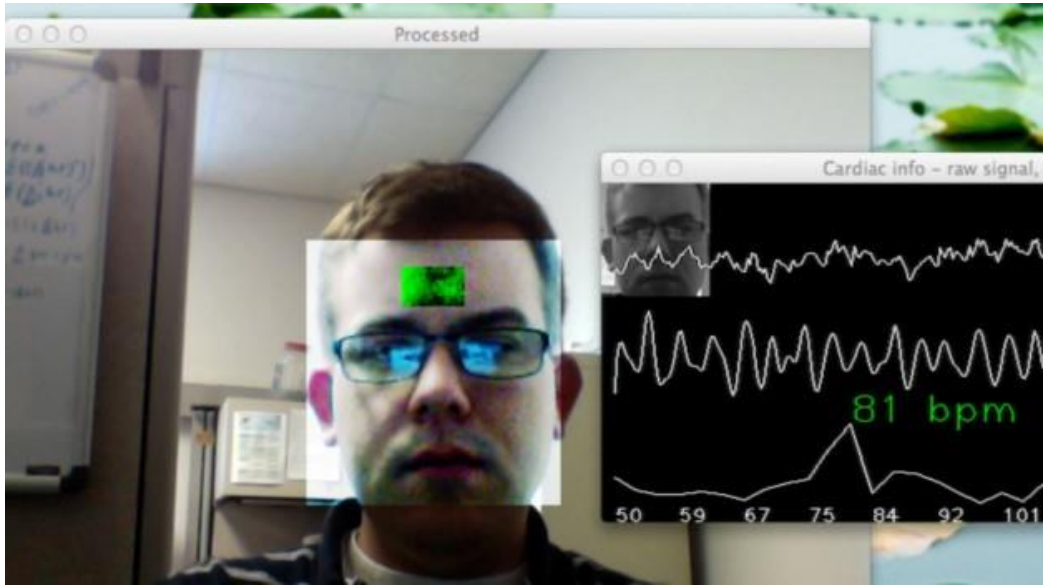
Wearable Watch

Disadvantage:

- Accuracy need more validation experiments
- Watch is expensive

Proposed Method: Measurements using webcam*

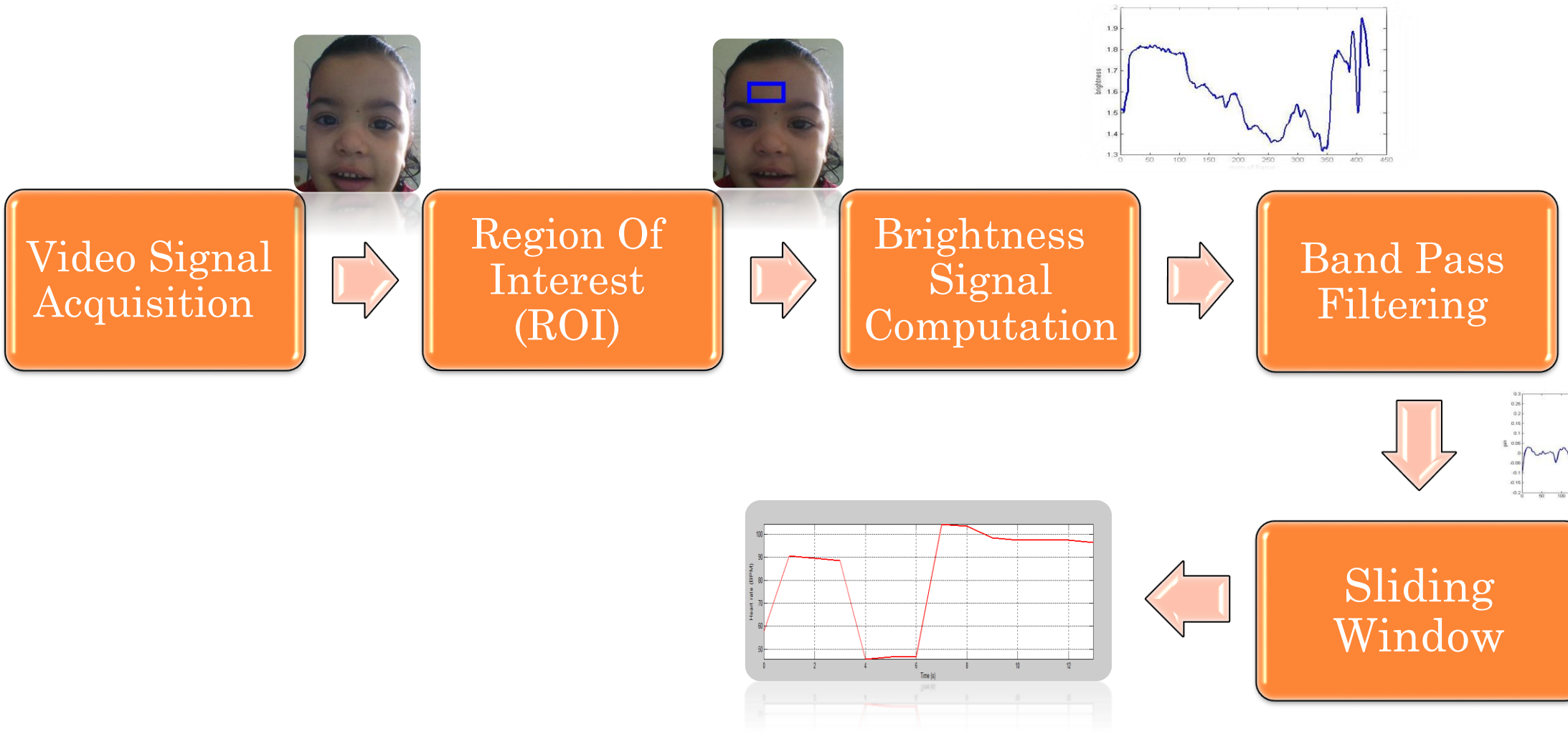
- Using this method, it is possible to visualize the flow of blood as it fills the face. From this result, it is possible to extract the subject's heart rate



- **What is different in our project:** We develop a compact program using Matlab© environment and design a GUI to facilitate using the application

*By Matthew Humphries , Measure your heart rate using a webcam and your forehead. Geek, Apr. 16, 2013

PROPOSED METHOD: FRAMEWORK



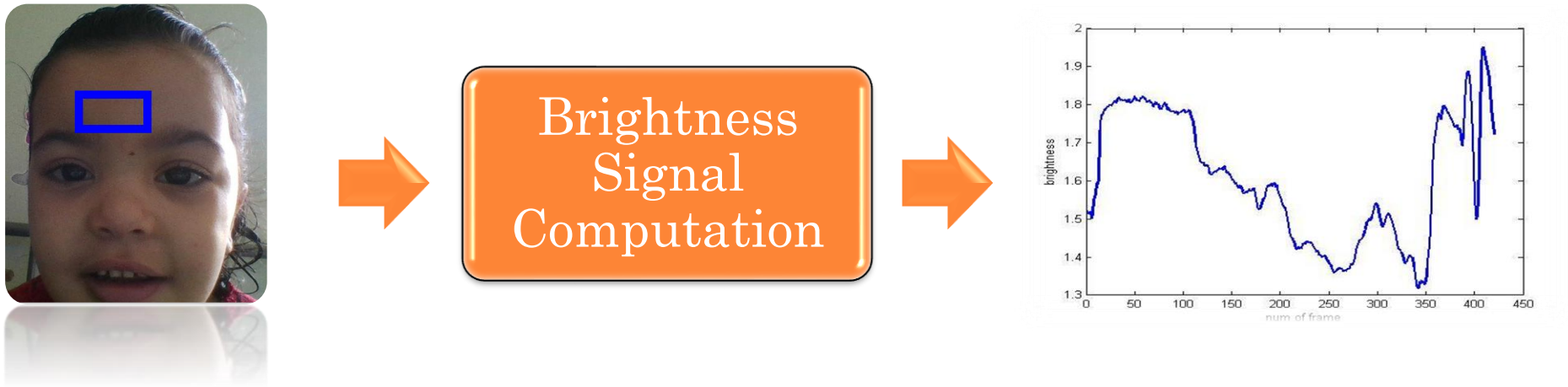
- In our project ,we use Eulerian video magnification algorithm.

VIDEO SIGNAL ACQUISITION AND ROI

- The first thing to take into account when it come The normal human heart beat t is between **60 and 200 beats per minute (bpm)**
- Video dimensions :
- **30 frame** per second
- time **10 sec**
- resolution **640x480**

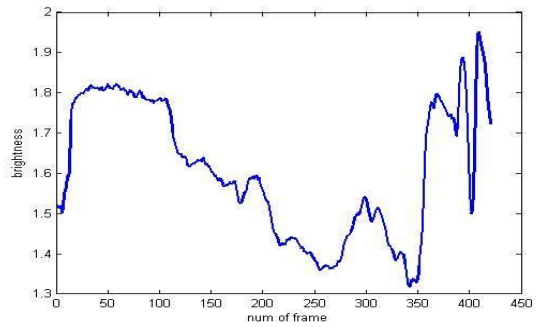
BRIGHTNESS SIGNAL COMPUTATION

- The signal we want to process is the **brightness of the skin over time**.
- We cannot ensure that all pixels in the image will contain the brightness variation that we are looking for and we want the rest of the processing pipeline to stay computationally light.

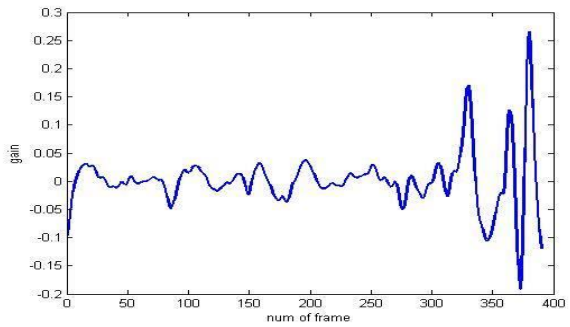


BAND PASS FILTERING

- After the signal acquisition, a band-pass filter attenuates frequencies outside the interest band.
- This reduces the noise in later processing steps (peak fine-tuning) and makes the resulting heart rate signal smoother.



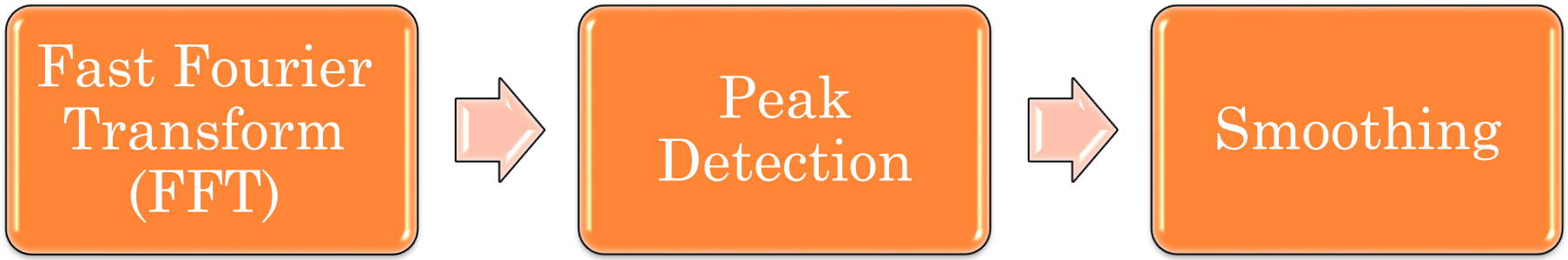
Band Pass Filtering



2^{nd} *order* BUTTERWORTH

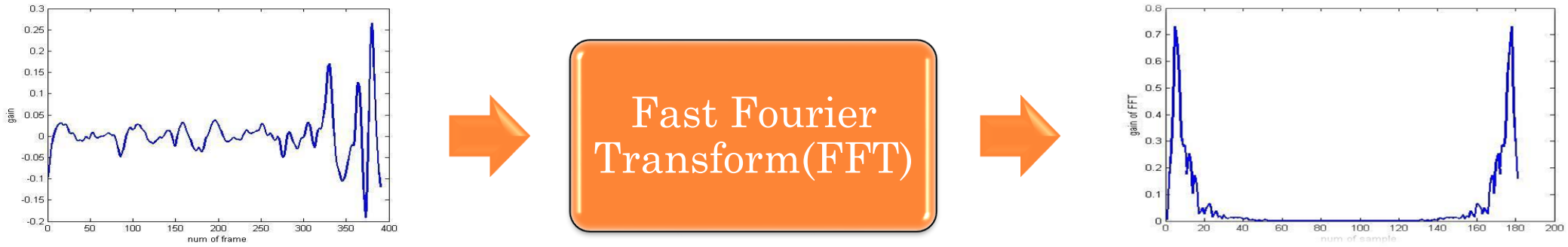
Sliding window

- In order to give a continuous estimation of the heart rate, the FFT and the following two steps (peak detection and smoothing) are repeated every 0.5 seconds.



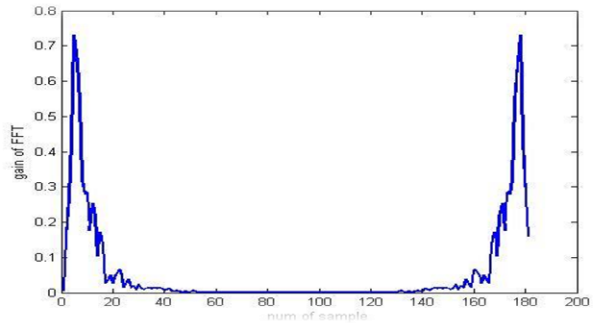
FAST FOURIER TRANSFORM

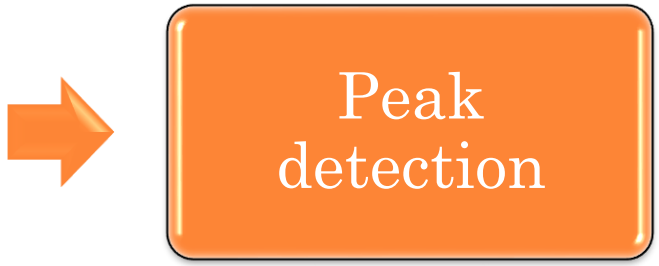
- The FFT of a real signal is a complex signal in which each complex sample represents the magnitude and the phase of the corresponding frequency.
- In our case, the phase is not needed. The FFT magnitude is easily computed.

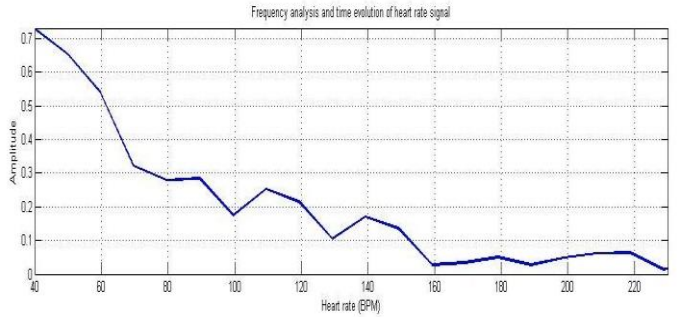


PEAK DETECTION

- Once the FFT is computed for the current sliding window contents, magnitude peaks in the interest band are spotted.
- A sample is taken as a peak if it is either larger than its two neighbors or equal to infinity.

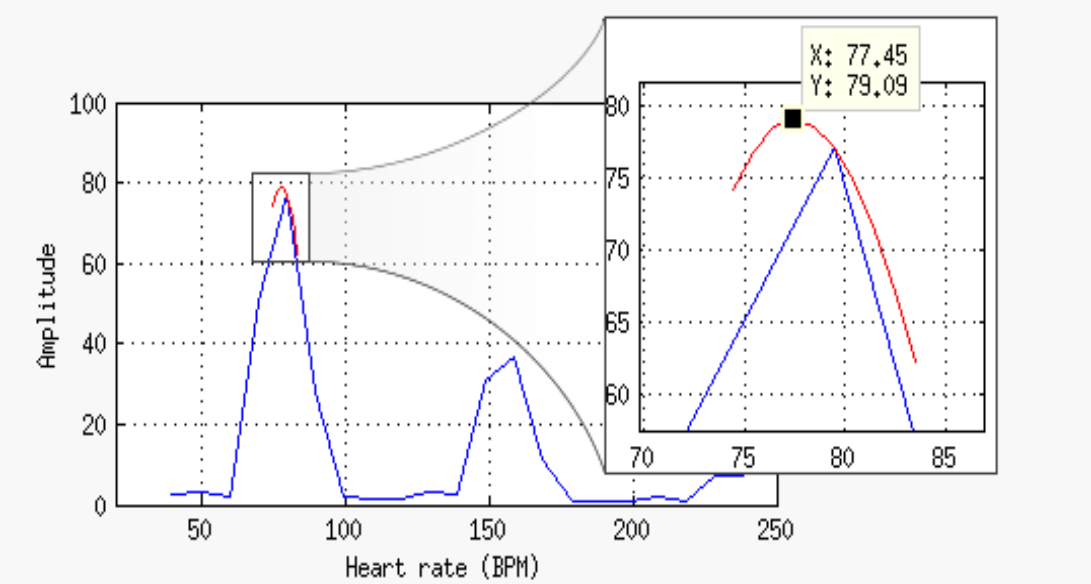






SMOOTHING

- At this stage, an approximate location for the most powerful tone in the frequency band has been found, but the possible outcomes are a discrete set in 10 bpm increments because of the frequency resolution produced by the 6-second window. We would like that the heart rate readings look more continuous, with 1 bpm frequency resolution instead.

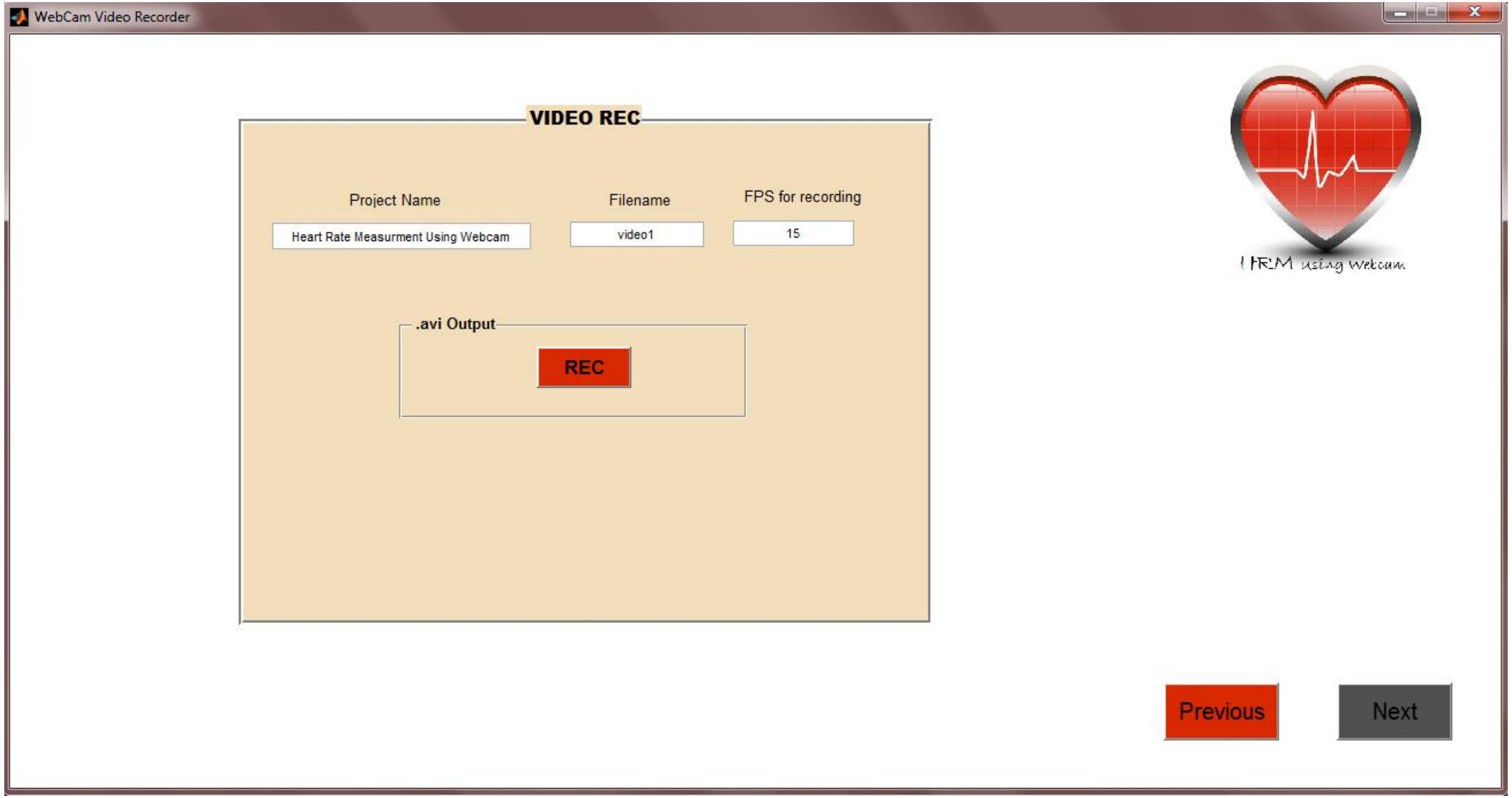


Our Complete GUI: Start Page Handle

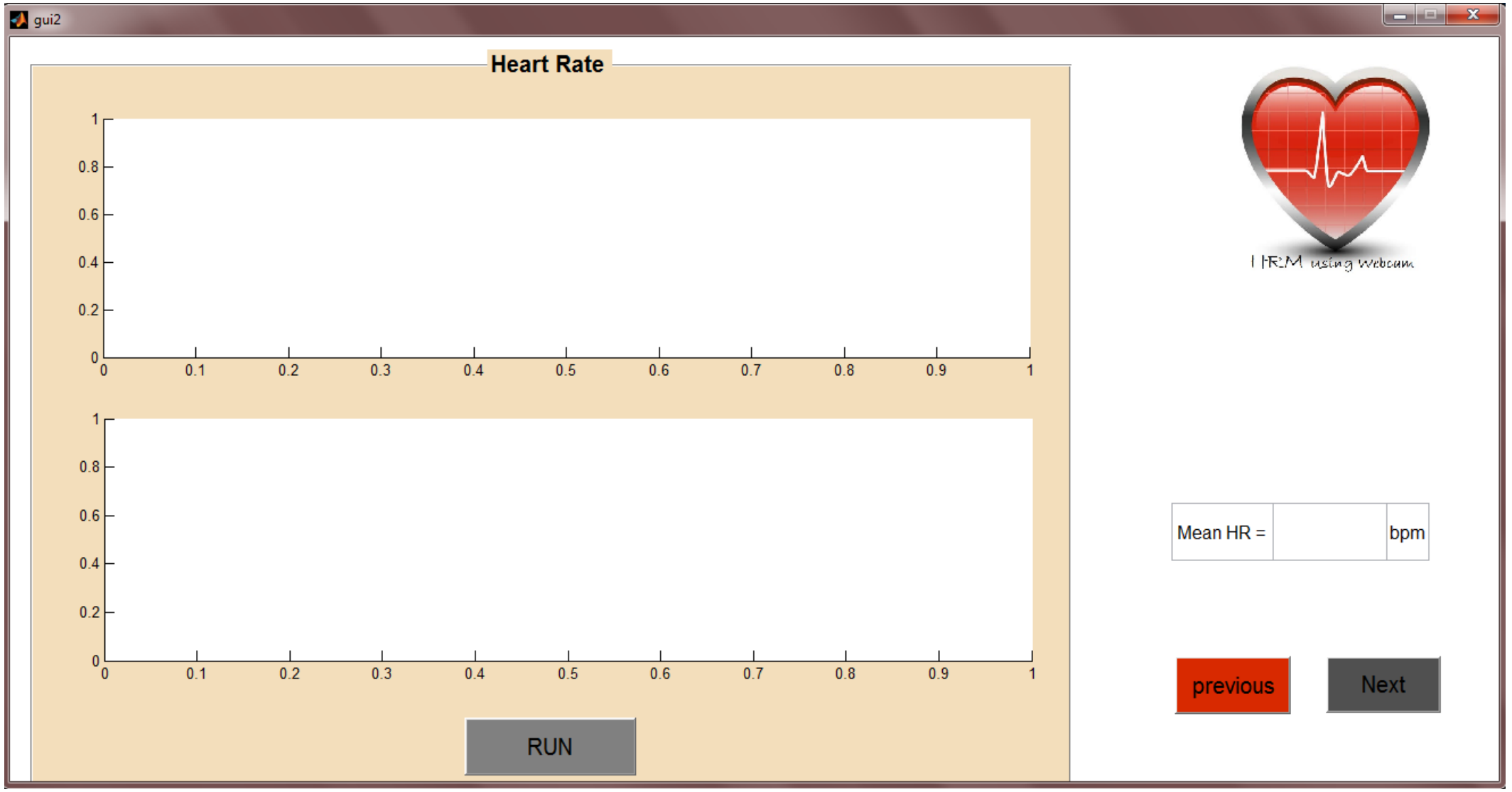
Our GUI features :

- Fully automated
- Start by Capturing the video
- End with the heart rate measurement

First Page Handle



Second Page Handle



Test and Validation

- The data base consists of **50 subjects.**
- The **ages** of the subjects are **between a three months and 82 years.**
- The data are collected from **Mansoura University Hospitals.**

RESULTS

- The program is programed to capture a video of the person face, then it processes it to output the heart rate.
- The program has been **tested on a dataset of fifty (50) persons on a laptop** with Intel(R) **core™ i5-5200U** CPU @ 2.20 GHz processor and 4 GB RAM.
- The program has achieved a promising results with an **average speed of one minute. The accuracy of our program is 93.8%± 0.01464 (accuracy=** $\frac{Our\ Measurements - Hospital\ Measurements}{Hospital\ Measurements}$ **x100%).**

Conclusion

- Our methodology offers new tool that Present a fast, efficient and reliable technology that reduce resources by using only a simple web-cam and a data analyzer.
- In addition, We introduce a simple GUI that help any user measuring the heart rate anywhere and at any time without having to go to the hospital.

Future Work

- We plane to apply this program on subjects and indicates whether it is normal or abnormal.
- Once we validate the program on a larger database and be sure that the program is reliable and robust on different patients, we will start to commercialize the product to the market.
- We plan to present our program as a commercial product that can be run on a personal computer with a camera or laptop.
- In addition, we plan to extend this program to be run as a mobile phone application.
- Our initial results indicate that our tool will represent an efficient alternative to the current techniques of heart rate measurements, especially in terms or portability and ability to be used at any place and at any time.

Full Thanks