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Measurement of Heartbeat Rate by GFT and SDM in Facial Video

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Abstract: **Human body is effectively tested only by the heartbeat. Based on the heartbeat rate many diseases can be found. In this paper, we have proposed effective method for detecting heartbeat. This method overcome the difficulties in the previous methods proposed like, subject movement in the unrealistic environment etc. The proposed method detects the feature point using GFT and SDM in Facial video. Before this Face quality Assessment is also included. This need to be tested on the MAHNOB-HCI database which includes realistic scenarios. This method will achieve good experimental performance.**

***Index Terms*—GFT – Good Feature to Track, SDM – Supervised Descent Method, Facial Video, Heartbeat Rate**

I. INTRODUCTION

Heartbeat rate of a human body is number of times heart beats per minute. This measurement of heart beat, will gives lots of information about human body[1] like, a diabetic patient can continue his exercise or not, if his heart beat rate is not good, he cannot do the exercise regularly and it will also helps in detect the glucose level in blood.

Usually the heart beat rate is measured by the ECG – Electro Cardio gram, which consist of sensors and monitor to display the heart beat rate. But using the blood circulation in the face [3]-[7], the heart beat rate will be detected. The blood flow throughout the whole body and in heart its flow in the aorta [8]-[10]. The proposed method uses a feature point in the forehead and cheeks GFT. The head motion also changes for both internal and external of face acquisition phase. In sometimes, the face quality is low because the bad pose, blurring of the face and the light conditions are poor.

(a) (b)

Fig.1. a) Feature point obtained by GFT, b) facial landmarks of SDM

Quality of the face frames are preserved by the FQA (Face Quality Assessment). In FQA the low quality frames will be automatically deleted. The feature point extraction can be done individually by GFT and SDM [3]-[4]. But the combination of these two methods will improve the feature point tracking in an effective way. The method consists of following steps to detect the heartbeat rate [5],

1. Face Quality Assessment
2. Feature Point Tracking
3. Signal Generation
4. Heartbeat rate measurement

Let us see these steps in detail in the following sections.

PROPOSED SYSTEM

The flow diagram will clearly explain the proposed system in the graphical way.

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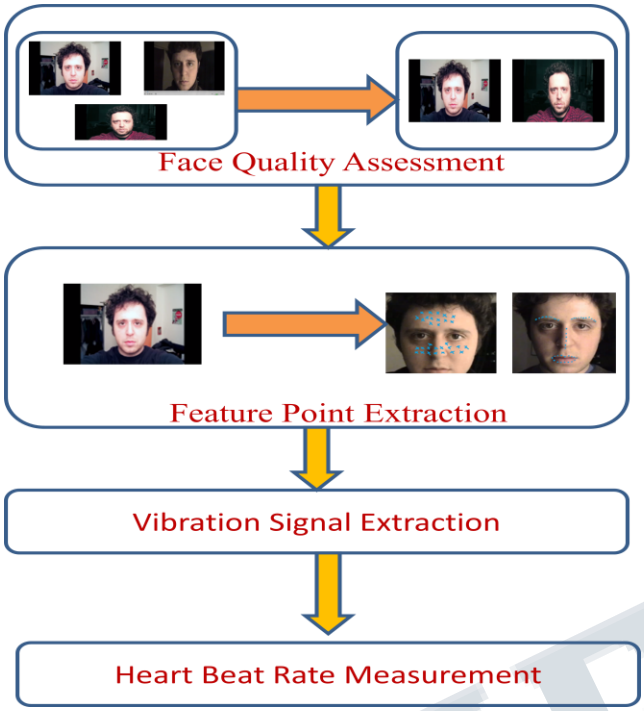

Fig.2. System diagram for proposed method

From the block diagram, first the quality faces are obtained by the Face Quality Assessment. Then the features are extracted by GFT and SDM [4]. GFT mainly concentrated on the Forehead and cheek, and the SDM concentrated on the edges and corners in the face. These features are combined to form the Signal generation.

From the signal generated, heartbeat rate is measured. The following sections clearly explain these modules in detail.

III A) FACE QUALITY ASSESSMENT

The videos are obtained from the real times environment like from the hospital. Videos are transformed into frames [11] for further processing. In real times environment we have some complications like, unrealized movements of face, low level of brightness and motion blur etc. so in order overcome this difficulty, face quality assessment need to be done. Low quality faces will be detected by the following metrics,

- brightness
- Resolution
- Out-of-plan face rotation
- Sharpness

The metrics [12] threshold values as 0.80, 150x150, 0.20 and 0.8. The frames below these threshold values will be deleted, that is low quality faces are discarded by FQA [13].

B) Feature Point Tracking

The feature point will be tracked and then they generate trajectory and keep record the various head motion extraction and to find the cyclic trajectory extraction of the points by removal of non-cyclic components. In the GFT based tracking [14] will produces the two problems: i) erroneous to track the points ii) completely miss to track the edges and corners. In the observation SDM will not miss any feature points. SDM in presence of varying head motion as long the facial video is qualified by a FQA. Thus the combination of GFT and SDM uses 60 points. In the GFT to track more motion in that face, but the SDM have no voluntary motion are accepted. Hence, combination of GFT and SDM will have voluntary and non-voluntary face motions are considered. So, that they will produce a optimized results. In the proposed method face is passed to GFT tracker from feature points and merged with SDM non-facial trajectories. In the location of tracking a facial point with the location of frame is n of the video sequence t.

C) Vibration Signal Generation

In the previous module trajectory will be the input to the vibration phase. In the above phase it is very noisy one e.g., varying a head motion, vestibular activity and facial expression. In the phase, uses the 8^{th} order Butterworth band pass filter with the frequency of [0.75-5.0] Hz [11] then the human heartbeat rate lies within the range.

Then the moving average window (length is 350 in our experiment). Then the filtered feature points in (GFT and SDM) and vibration signal extraction output will pass through Heart Beat Rate calculation module.

D) Heartbeat Rate Measurement

In the blood circulation of the face through the aorta vein, used measure the heartbeat rate [15]. We deploy a Principal Component Analysis (PCA) algorithm to filtered noisy trajectories (S) to separate of head motion.

Hence, we have to apply a PCA algorithm to measure a periodic variation of head motion to calculate a heartbeat rate [16]. We then apply a Fast Fourier Transform (FFT) on the inverse of Digital Cosine Transform (DCT) and

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then select the first harmonic feature to obtain the heartbeat rate.

E) Combining GFT AND SDM

In the method uses a feature points like forehead and cheeks to express the changes in the face intensity levels. We use the velocity parameter to minimize the residual function [13].

In the low quality frames in videos the GFT tracking have some problems:

- Low value of tracking window: It will mainly focus on forehead and cheeks. The difficulty of track of other feature points. In the heartbeat rate measurement that features have a low spatial frequency.
- Window size: in the GFT method, window size is small, in the variation of window is not reliable. And it will cause a discontinuity in subsequent frames.
- Large optical flow in video frames: There is a vary of head motion and face expression changes then optical flow is too high and miss the calculation of optical flows.
- Lose to track a long video sequence: In the GFT method have a high cost in calculation of threshold value. It will become more cost and become less throughput.

Instead of track the feature points [15] in GFT, we introduce a Active Appearance Model (AAM). In the SDM uses a non-linear least square function to estimates a test images. The minimization function can be defined as in the SDM.
The SDM will overcome the difficulties in GFT,

- Low texture in tracking window: It uses more than 49 landmarks around nose edge and corners, lips and eyes.
- Window size: They will uses the window based "neighborhood sense", it will not use any window based method.
- Large optical flow in video frames: In the large difficulties occurrence[16] of optical flow vector in the GFT, but the SDM uses bias factors and descent direction which have large space with large efficiency.
- Lose to track a long video sequence: It will not use any reference points to tracking. In the SDM will detects each and every edges and corners of facial region

V. EXPERIMENTAL ENVIRONMENT AND DATASETS

In the section describe the experimental environment we have to evaluates the performance.

Experimental Environment:

In the system was implemented the combination of C++ (GFT) and Matlab (SDM). We have to use three database to demonstrate the result of FQA. We use the first database as the MAHNOB-HCI and collect 180 videos from 10 subjects and employ a FQA in the proposed system. The second database is collected from 5 webcams in 1,2,3,4 and 5 meters distance [12] of the same object. The room light condition was change from dark to light. The third database consists of 110,000 video frames of about 3,500 seconds. The following scenarios are in our system:

- Scenario 1: (Normal) In the subjects are exposed in the normal facial expression or voluntary head motion in 60 seconds.
- Scenario 2: (Internal head motion) Subjects are made the facial expression such as smiling, talking, laughing and angry in the camera about 40 seconds.
- Scenario 3: (External head motion) Subjects are made a variable head motion in different direction of the cameras about 40 seconds.

VI. CONCLUSION

Thus the feature point extraction on the high quality faces obtained from FQA was done. Then the vibration signal generation for Heartbeat rate measurement. We hope the process will yield a better result.

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