Heart Rate Monitor Using Mobile Camera

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***Abstract*— Telemonitoring is a tool having proven results which demonstrate clinical benefits in reducing moratality and hospitalization Smartphone's video cameras become more powerful and also the devices itself is used by many people. It allows utilizing them for many every-day tasks. One of such suitable application of the widely used smartphones is monitoring the health. In this paper we propose an approach to detect the photoplethysmograph signal from the fingertip by using a phone's camera and built-in LED. The proposed solution allows detecting the correct heart rate.**

***Index Terms*— photoplethysmography; camera; smartphone;heart rate;LED**

I. INTRODUCTION

Self monitoring of the vital parameters is very important for timely detection of health diseases. The blood pressure, heart rate and its changes are most important parameters in this case. The occurrence of heart failure (HF), a chronic disease related with high mortality and morbidity is rapidly growing. Under this setting, HF monitoring program allows early detection of patient condition, as well as therapeutic adjustments which might prevent hospital readmissions and helps improving quality of life. Home telemonitoring is a best tool for HF management encompassing use of communication technologies to monitor various physiologic parameters. Heart rate (HR) and heart rhythm are two of these features. The it is one of the important factors regarding prognosis and treatment of HF. Variation of heart rhythm, quantified by heart rate variability (HRV) parameters, are frequently seen in HF and proper management should be done especially with atrial fibrillation (AF) which increase substantially the risk of stroke. The analysis of HRV has also been extensively used [4], [3] in the study of heart rhythm, namely AF.

Almost all of the recent smartphones are equipped with the high resolution cameras and LEDs. It is similar to the construction of the pulse oximeter. So it is used for express-measurement of the vital characteristics of the heart and the respiratory system.

Here in this paper the idea behind is to develop the PPG measurement system for obtaining the pulse rate which is based on the images, captured from the smartphone's camera.With this it is possible to monitor HR and HRV at a faster rate and comfortably at home with an every day device like the Smartphone. Moreover measurements can be made anywhere and at any time.

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II. EXISTING SYSTEM

The current trend in health monitoring systems is to move from the hospital to portable personal devices. This work shows how consumer devices like heart rate monitors can be used not only for applications in sports, but also for medical research and diagnostic purposes. There are many devices available in the market to measure the heart rate like strapless heart rate monitor, heart rate monitor watch,heart rate devices using bluetooth,etc.Recent technological advances in electronic and biomedical engineering are making it possible to move health monitoring away from the hospital and the clinic to portable personal devices.Smartphones and biometric sensors are now available to all. To get started using your biometric sensors, you'll first need to enable Bluetooth on your phone's system settings. In most cases this will mean enabling Bluetooth on your phone by going to your phone's Settings page and turn ON the bluetooth.In case of biometric devices you need to have the external biometric sensor that connects to the android app.There are applications available that works on the mobile phone also only drawback with this kind of app is that they are not compatible with android devices they are only supported in ios.So we need to have an application which will be supported in all the Android devices.

III. PROPOSED MODEL

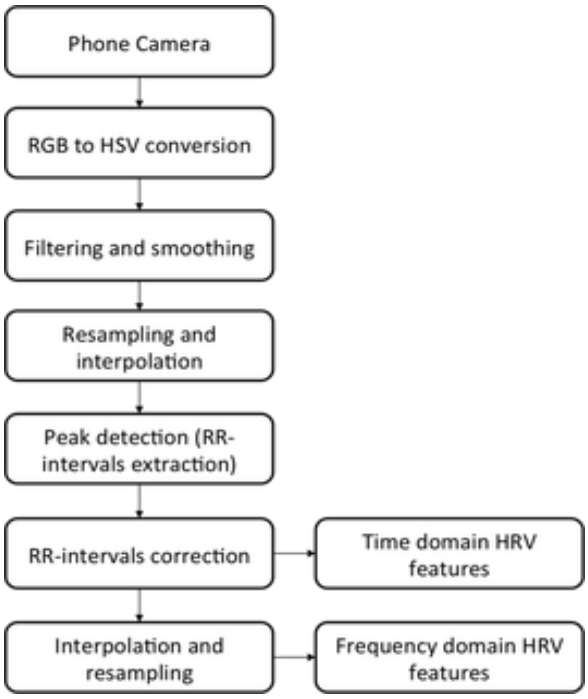

Fig 1 Basic Block Diagram

A detailed block diagram of the system is shown in Fig.1.Smartphone's cameras has become more and more powerful as well as the devices itself has become used by many people which allows utilizing them for many daily tasks. One of such efficient application of the widely used smartphones is monitoring the condition of health.
We propose an approach to detect the photoplethysmograph signal from the fingertip using a phone's camera and built-in LED. The solution allows detecting the accurate heart rate and is manageable to different situations of wrong usage of the system.

Method:-

- Data acquisition from the phone's camera
- Filtering & smoothing
- Resampling with cubic spline interpolation
- Peak detection
- Artifact removal and features extraction Comparison with range of values stored

Data Acquisition:-

The image captured from the camera of smartphone has to be in a proper exact position so resampling of figure is conducted using the basic cubic spline method where the images are brought in horizontal direction as to need and in right size by applying the Resize form.

The approached we are using is based in and proved to be the most versatile in terms of supporting different devices and light conditions. The photoplethysmogram (PPG) is computed by adding the number of pixels whose red component is above a specific threshold, computed during an initial phase.

$PPG(i) = \Sigma\ Pred;\ Pred > Thr$ *where* $i=1$ *to* N

The calibration phase occurs in the first 5 seconds of the measurement. During this time, for each frame, we compute and store the 90% percentile for red band of each pixel. After 5 seconds, and the threshold is computed as the mean of all the values stored.As stated in higher values of this threshold result in a smoother and cleaner signal: the threshold is closer to the maximum value of the pixels and only significant pixels are summed up in equation . However, if the threshold is too big the signal looses relevant information, deteriorating its shape and results become compromised. If the threshold is too low, the signal becomes more sensitive to noise, including undesired artifacts**.**

Data validation:-

Thresholds: To mitigate miscalculated values, thresholds are validated throughout the measurement. The validation is done by storing in every frame the ratio between the computed threshold and the average of red pixels plus its standard deviation. This tells how different the threshold is from the average maximum values of the red component in a single frame. Then, for each window of 32 frames we verify that the mean of those ratios is within a fixed range of values.
Colors: Whenever a finger is placed into the camera, the chromatic components of the captured images are narrowed down to a small set of its color range – from 0 to 255. Each color has a smaller intensity variation along the frame. It becomes possible to predict when the user's finger position is in place. The method used is based on [5], where the minimum and maximum value of the average and standard deviation of the red, green and blue bands are verified against predefined constants. These values must be flexible to account for different camera sensors and skin characteristics.And these constants can be adjusted during the calibration phase.

Movement: One of the drawback of smartphone is being prone to sudden movements of the device while the user is holding it, having a direct negative impact on signal quality. However, most smartphones nowadays come equipped with a variety of sensors such as the accelerometer. This allows the detection of those sudden movements and prevents the application from reading invalid data. For this work, instant acceleration is computed every half a second and compared against a maximum value previously chosen. If this limit is reached, the measurement will stop. It is a simple and naive solution, it prevents major movements from the user.

Signal processing:-

Once the photoplethysmogram (PPG) signal is acquired, the data is processed to compute the heart rate and detect the prescence of irregular heart beat, it is called as a atrial fibrillation. For this study, each measurement was stored and later processed . Work is currently in progress to integrate all computations with the Android application. This subsection describes the methods used to extract the physiological features desired. Heart rate after that the signal filtering is done ,allowing a more accurate peak detection. A rectangular smoothing function is thus applied [4], where X is the original signal and W is the size of the window used. Afterwards, a discrete wavelet transform is performed.Signal peaks were then detected, counted and average within windows of 5 seconds. The first estimate of HR was obtained using the number of peaks computed from the filtered signal and the duration of the signal.Simultaneously, the power spectrum density (PSD), along with a Welch periodogram, was computed to obtain another estimate of HR. The maximum frequency of the periodogram between 0.7 and 3.5 Hz (42 and 210 beats per minute respectively) is considered as the second estimate and the final heart rate value is computed.

IV. CONCLUSION

The paper is devoted to measure the photoplethysmography with a smartphone's camera.It is shown that only the red channel have similar characteristics for various models of the smartphones whereas the green and blue may vary . moreover, such information can be used to filter the wrong-usage of the system, i.e. when the finger was not placed correctly.

REFERENCES

[1] A. Reisner, P. Shaltis, D. McCombie, H. Asada, "Utility of the Photoplethysmogram in Circulatory Monitoring," Anesthesiology, vol.108, issue 5, May 2008, pp 950-958.
[2] P. Leonard, N. Grubb, P. Addison, D. Clifton, J. Watson, "An algorithm for the detection of individual breaths from the pulse oximeter waveform," Journal of Clinical Monitoring and Computing, vol 18, 2004, pp.309–312.
[3] H. S. Friedman, "Heart rate variability in atrial fibrillation related to left atrial size," The American Journal of Cardiology, vol. 93, no. 6, pp. 705–709, Mar. 2004.
[4] D. Scherr, P. Kastner, A. Kollmann, A. Hallas, J. Auer, H. Krappinger, H. Schuchlenz, G. Stark, W. Grander, G. Jakl, G. Schreier, F. M. Fruhwald, and MOBITEL Investigators, "Effect of home-based telemonitoring using mobile phone technology on the outcome of heart failure patients after an episode of acute decompensation: randomized controlled trial," Journal of medical Internet research, vol. 11, no. 3, p. e34, 2009.
[5] W. Khan, Y. Xiang, M. Aalsalem, and Q. Arshad, "Mobile phone sensing systems: A survey," IEEE Communications Surveys Tutorials, vol. 15, no. 1, pp. 402–427, 2013.
[6] A. Smith, T. Ferriss, "Home health monitoring may significantly improve blood pressure control," Kaiser Permanente Study Finds, http://xnet.kp.org/newscenter/pressreleases/co/2010/052110telehealthstudy.html, May 21, 2010.
[7] S. Linder, S. Wendelken, E. Wei, S. McGrath, "Using the Morphology of Photoplethysmogram Peaks to Detect Changes in Posture," *Journal of Clinical Monitoring and Computing*, vol. 20, No. 3, 2006, pp. 151-158

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