International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-5, June 2019

Motion Artifacts detection algorithm for non contact photoplethysmography using five tap filter

R.Valarmathi, R.Ramesh

Abstract: ***Heart Rate (HR) is a fore most parameter for the analysis of a patient's physiological conditions. Since the existing prototype using wearable sensor estimating the HRV during daily activity causes irritation and disturbance to the patient, this work deals with contact free photoplethysmography (PPG) that gives various benefits over contact methods. It is a simpler, low-cost and more popular method providing comfort, convenience and minimized risk of infection in medical applications. In this work, use the contact free method that measures the heart rate of a patient using an electro-optic technique. From Heart rate, corrupted PPG signal (MA) is identified and reduce using five tap Filter.***

Index Terms Motion Artifacts, photoplethysmography, Heart Rate, Five tap Filter.

I. INTRODUCTION

Photoplethysmography is a quiet optical technology [1], [2]. It utilizes at least one light-transmitting diodes to enlighten tissue with contrasting wave - lengths. The force of the non retained light at every wavelength is estimated by a photodiode. The lightweight maintenance and transmission depends upon the voyaged light way, optical thickness of the tissue, volume of blood present inside the tissue, and blood structure [3]. Two techniques for movement exist: a) transmission mode wherever the tissue test is put between the supply and besides the marker (e.g.,fingertip); and b) reflection mode wherever the device and locator are set one alongside the other (e.g., fore head). The two modes license a noninvasive estimation of assortments of the blood volume after some time realizing a photoplethysmogram (PPG). It is an optical strategy used to gauge the HRV contrasted and most normally utilized technique in prescription, Electro-cardiograph (ECG). ECG is the usually utilized strategy for HR estimation, measures the spikes of the electrical signs made in the heart that control the extension and compression of heart chambers. In any case, such systems make cumbersome for the patient since it uses a couple of sensors which are joined to the chest or uncovered body for a huge amount of time.It additionally confines the developments of the subject while estimating the HR. So these are not practical strategies for ceaseless estimation and when unconstrained development is required. Thus the photoplethysmography (PPG) strategy turns out to be significantly more reasonable method. since it is a simple, low-cost, and noninvasive strategy that appraises the beat wave of veins using an electro-optic system. [1],[2].The existing investigation on MA decline from PPG can be arranged into two general orders, viz versatile computerized flag handling and factual flag preparing. A part of the declared works used an alternate development sensor (accelerometer) so the reproduced data can be differentiated and the clean PPGr. Multiple reference versatile Noise cancellation [1] AR spectrum estimation [2] neural network [3] Contour analysis [4] Multistage LMS filter –SSM Slope sum method[5] Wiener filter[6] ,[7]Nonlinear adaptive filter and signal decomposition propose a motion detection unit for MA reduction[8]. Every one of these techniques utilizes a few sensors that are implanted in a wrist band or watch type modules and are joined to the fringe portions of the body like wrist, ear cartilage or fingertips amid day by day action which makes bothering and aggravation the patient and this methodologies give just a chart of pulses yet not give any connection with reference ECG signals [9],[10]. In some non contact PPG flag estimation strategy utilizes a basic PC web camera to distinguish HR, RR,HRV and IBI (inter bit interval). In all the literatures, it is seen that ultimate of the contact free systems to monitor physiological parameters are done in non realtime. Motion artifacts during measurement because assuming patient are ideal condition while taking video. Practically Motion artifact will affect the physical parameter performance. This work details a robust algorithm for Motion Artifacts detection (MA) in real time that is based on non–contact methods using a laptop webcam to capture the PPG signals from ten different patients facial video recorded for 30 secs. By utilizing the web camera the facial pictures are being caught for a moment which is then isolated into three separate RGB channels and evacuating the Motion artifacts utilizing five tap filters.

II. FEATURES OF MOTION ARTIFACTS

One of the most popular biomedical signal measurements is photoplethysmography (PPG), which can screen pulses and heart cycles by optically recognizing blood volume changes in the microvascular bed of tissue. PPG has turned out to be generally well known in wearable gadgets because of their transportability, however the fundamental disadvantage is powerlessness to development commotion. PPG is a signal made by evaluating the alteration in light.

Manuscript published on 30 June 2019.
***** Correspondence Author (s)
R. Valarmathi, Research scholor, Department of ECE Anna University/ Chennai, India.
Dr.R.Ramesh, Prof/Department of ECE/ Saveetha Engineering College/ Chennai, India..

It will in general be used to screen inundation of periphery oxygen (SpO2), heartbeat, and status of the anesthesia [3]. When PPG measurement, a signal gets two types of noise: high frequency noise and movement noise [2]. High frequency noise is produced by electrical noise, ie electromagnetic interference in cables. Movement noise is provoked by intentional or unintentional movements of a patient and affects a more frequency range. The noise presence distorts PPG signal shapes and such distortion of PPG signals gives wrong diagnoses. Though high frequency noise can be filtered out using a low pass filter, movement noise cannot be removed by a low pass filter. The frequency band of the motion artifacts affected by the patient's movement is 0.1Hz. The frequency range of the PPG signal pulse wave is in the range 0.5-4.0 Hz [5,6]. The removing of the motion artifacts from the PPG signal making impractical using classical filtering methods [7] The moving average technique or adaptive technique are commonly used to expel motion artifacts. The moving average technique functions admirably for discontinuous commotion, but can't evacuate the movement artifact of expansive plentiful ness or all of a sudden. In the event that the request of the moving normal channel builds, the PPG signal quality falls apart. The adaptive filter improves and does not corrupt the PPG flag, however the channel is difficult to develop continuously and appropriate for vertical, flat, and twisting movement of a finger not for progressively broad case. Because the intermingling properties of the versatile channel are likely break down as per the unacceptable estimation of the channel's organization, coefficients, and combination steady in noisy condition [8]. In this paper presented another technique that not only can expel the motion artifacts without affecting the PPG signal but can be worked in real time.

III. THE PROPOSED METHOD

This experiment involves the real time motion artifacts reduction from PPG signal with some movement as a noise.

A.Data Set.

The camera used was a (HP HD Webcam), operated with a resolution of 1920 × 1080 pixels and at 60 frames per second (fps). Data acquisition is taken by 20 patients of various ages (20 years to 55 years) and skin colors. The examinations were led inside with adequate measure of daylight. The members were told the point of this examination and were situated before a workstation at a separation of approx. 1m from the webcam. During test, patients were advised to remain stablel, inhale precipitously, and face the webcam while their video is being recorded for 1 minute progressively and the video was spared in as an AVI document. All the facial image frame (32-bit RGB) while real time HR extraction were recorded consecutively at 60 frames per second (fps) with pixel resolution of 1920 × 1080 and spared in Intel Graphics format in the laptop.

B.Motion Detection Algorithm.

The FFT algorithm is applied to eliminate MA in real time application using only the facial video. The average of R, G and B signals is determined for using FFT method. The normalized values of traces is dissolved into three different signals: R, G and B based on joint approximate diagonalization of Eigen matrices algorithm. The facial signal is collects in sitting position without any movement in real time, the patient moves their hands and heads little bit unintentionally causing the motion artifacts. Accordingly, a five tap filter is used which removes the motion-artifacts. The most important features of this method is separating three different signals, called as Red signal, Green signal and Blue signal

from the R, B and G color values of each pixel of all facial image.

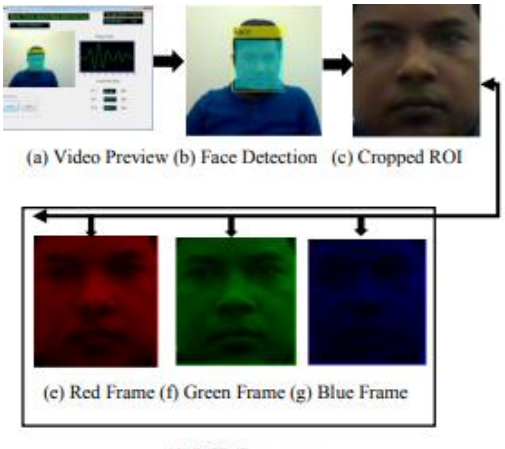

Figure 1. Feature Extraction from each image frame

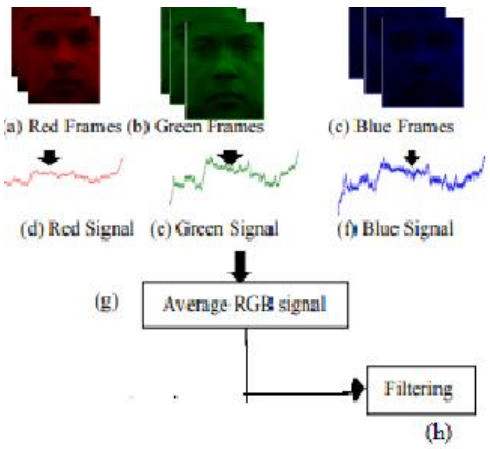

Figure 2. RGB Signals Pre-processing

A. Reading Image Frames:

The image frame is an main part of the video source which specify the start and the end point of a video. Fig. 1(a) shows the real time HR monitoring system that extracts more image frames one by one during a certain period of time.. It is necessary to note that the video resolution should remain same during the extraction of each image frame for further calculations. Hence, a robust key frame video extraction algorithm is used to maintain the same resolution to read the image frames one by one automatically.

B. Face Tracking:

It is necessary to track the facial part of patient. The real time application needs an suitablr face tracking method to make the face detection rate higher. After an image frame is extracted in real time, MATLAB tool is used to detect the face image.' Fig. 1(b) shows the detected face.

C. Region of Interest Selection:

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

R, G and B color values of each pixel in the facial image frame is the most important part. A perfect Region of Interest (ROI) is selected over the detected face using Viola and Jones method. A boosted cascade classifier is used to identify the coordinates of the location of face in the first frame. The x-y-coordinates along with the height and width that defines the patient's face. Thus, the center with 60% width and 80% height is selected as the ROI. ROI alone is separated from the entire facial image as shown in Fig. 1(c)

D. RGB Signals Extraction:

R, G and B colour values are the elements of R, G and B signals (combinedly called as RGB signals). These are extracted from the facially cropped ROI image. Every pixel of the image has 3x1 matrixes of color values consisting of Red (R), Green (G) and Blue (B) color of the image.

E. Filtering:

R, B and G signals are extracted from all red, green and blue image frames as shown in Fig. 2(a-c) are filtered by Five tap filter. A Finite Impulse Response (FIR) is an all-zero or MA (moving average) filter which uses past as well as the present input sample for calculating the output value.The FIR can be used in complex designs. It is used to ,control in a wide range of practical situations and simpler cast.. An FIR filter can generate a pure linear-phase characteristics and faster computation. It can also accurately approximate the arbitrary frequency-response characteristics.

$$Y(n) = \sum_{o}^{4} h(k)x(n-k) \qquad (1)$$

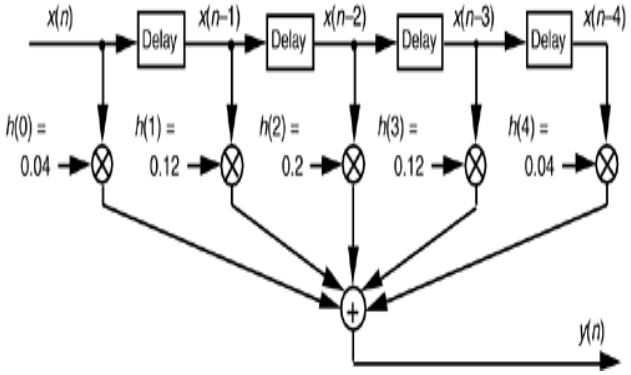

Fig 3. Five tap filter.

IV. SIMULATION RESULTS

In this prototype, the heart rate pulse waveform is recorded and is then disintegrated into 3 signals: Red, Green and Blue as shown in fig.3

The noise from all three signals is detected and eliminated giving an output clear of all the moving artifacts as depicted in fig.4

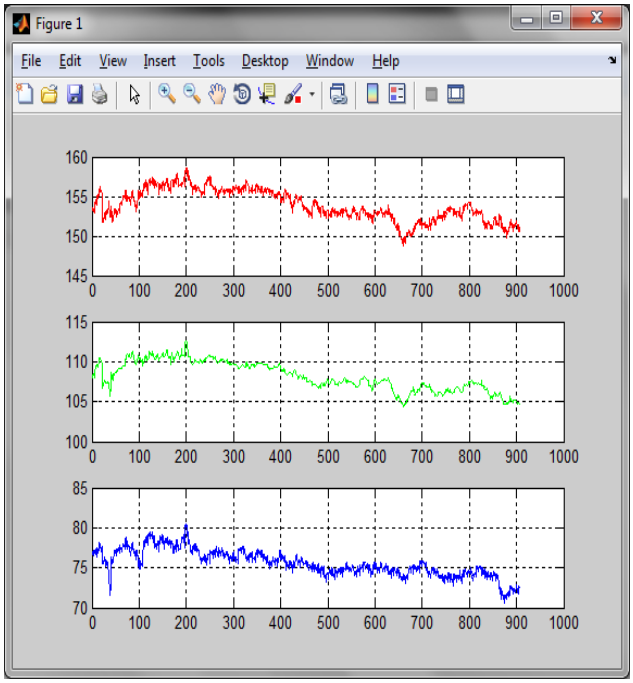

Fig 3. Separating the three signals (red, blue and green)

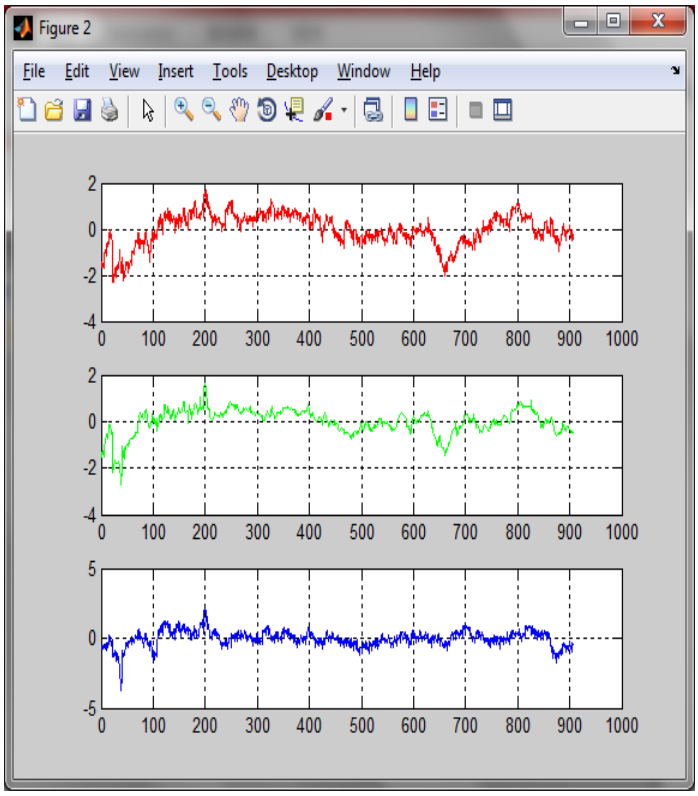

Fig4.: Removing the noise in three signal

IV. CONCLUSIONS

In this Work, a real time contact free based MA detection method is described with the help of patient facial video signal that is simple to implement, cost effective and convenient for the real time applications. Here, the main idea is to remove MA from the color variation in the facial skin.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication (BEIESP)

It is implemented using a simple webcam in indoor environment with a constant ambient light. Noise in the waveform can lead to misdiagnosis. To prevent this, this method is developed that can remove even the slightest noise due to small movement. This paper depicts how the design lessens the complexity. Further developments can be made for the betterment of a healthy life.

REFERENCES

1. Rakib Hyder, Md. Samzid Bin Hafiz, ,Sayeed shafayet Chowdhury, d Mohammad Ariful Haque , "Real-Time Robust Heart Rate Estimation from Wrist-Type PPG Signals Using Multiple Reference Adaptive Noise Cancellation" VOL. 22, NO. 2, MARCH 2018
2. Mahdi Boloursaz Mashhadi, Majid Farhadi, Mahmoud Essalat, and Farokh Marvasti "Low Complexity Heart Rate Measurement From Wearable Wrist-Type Photoplethysmographic Sensors" 978-1-5386-4658-8/18/$31.00 ©2018 IEEE
3. Rajarshi Gupta Senior Member, IEEE,Monalisa Singha Roy, Jayanta K. Chandra, Member, IEEE, Kaushik Das Sharma, Senior Member, IEEE, and Arunansu Talukdar' "Improving Photoplethysmographic MeasurementsUnder Motion Artifacts Using Artificial Neural Network for Personal Healthcare" 0018-9456 © 2018 IEEE.
4. Awais Mehmood Kamboh and Khawaja Taimoor Tanweer,Syed Rafay Hasan "Motion Artifact Reduction from PPG Signals During Intense Exercise Using Filtered X-LMS" 978-1-4673-6853-7/17/$31.00 ©2017 IEEE
5. Thomas Wibmer, and Thomas Penzel,Christoph Fischer Benno D omer "An Algorithm for Real-Time Pulse Waveform Segmentation and Artifact Detection in Photo plethysmograms" VOL. 21, NO. 2, MARCH 2017
6. Salehizadeh, Yeonsik Noh, Jo Woon Chong, Duy Dao S,M.A Chae Ho Cho, Dave McManus,Chad E. Darling, Yitzhak Mendelson, and Ki H. Chon, Senior Member, IEEE"A "Robust Motion Artifact Detection Algorithm forAccurate Detection of Heart Rates From Photoplethysmographic Signals UsingTime–Frequency Spectral Features" VOL. 21, NO. 5, SEPTEMBER 2017
7. Yunfei Cheng, Wenwen He, Yalan Ye,Mengshu Hou, Member, IEEE, and Zhilin Zhang, Senior Member, IEEE "Combining Nonlinear Adaptive Filtering and Signal Decomposition for Motion Artifact Removal in Wearable Photoplethysmography" VOL. 16, NO. 19, OCTOBER 1, 2016
8. Mashhadi,Ehsan Asadi, Mohsen Eskandari,Mahdi Boloursaz Shahrzad Kiani, Student Member, IEEE,andFarokh Marvasti, Senior Member, IEEE "Heart Rate Tracking using Wrist-Type Photoplethysmographic (PPG) Signals during Physical Exercise with Simultaneous Accelerometry" VOL. 23, NO. 2, FEBRUARY 2016
9. Andriy Temko, Senior Member, IEEE "Accurate Heart Rate Monitoring During Physical Exercises Using PPG" 0018-9294 (c) 2016.

AUTHORS PROFILE

R.Valarmathi ,Completed B.E in ECE from MK university in the year 1999, M.E in Communication systems from anna university in the year 2010.

Dr.R.Ramesh, ,Completed B.E in ECE from MK University in the year 1999. M.E in Communication systems in the year 2001 and Phd completed in the year 2004.