International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Non-Contact Pulse Detector using Video Analytics

K. Swathi, R. Rahul, B. Phaninder

Abstract: ***Non-contact pulse detector used for heart beat measurement based on computer vision, where a standard color camera captures the plethysmographic signal and the heart rates are processed and estimated dynamically. It is important that the quantities are taken in a non-invasive manner, which is invisible to the patient. Presently, many methods have been proposed for non-contact measurement.***

The proposed method based on the computer vision technique is enhanced to overcome the above drawbacks and it requires low computational cost. *Many of the hospitals are using surveillance cameras, from these cameras we can monitor the video of the patients waiting in the queue.* ***The camera is attached in the patients' waiting room and the faces of the patients are monitored. Many factors are considered in the phases of image acquisition, as well as in the plethysmographic signal development, pre-processing and filtering. The pre-filter step uses numerical analysis techniques to cut the signal offset. The proposed method decouples the heart rate from the plethysmographic signal frequency. The proposed system helps in detecting the heart rate of a Patient who is waiting in queue for longer time. Based on the heart rate the seriousness of patient is identified and giving the preference to the patient and treatment will be started, with this the patient will be in safe side.***

Keywords: ***image processing, plethysmographic signal, non-invasive, Heart rate.***

I. INTRODUCTION

There are many different invasive and non-invasive methods of measurements in the context of Heart rate. Among the non-invasive techniques for heart rate monitoring, the universal standard, is the electrocardiograph (ECG). However, recording the electrical potential generated by the heart requires proper electrode placement, which may interfere with the patient movements. Still today, available disadvantaged areas still lack quality electrodes, complicating their placement, causing skin lesions. Furthermore, electrode misplacement may produce skin lesions if wrapped around a limb. These disadvantages can effect health of personnel who must revise the electrodes regularly.[1]

A plethysmography wave is used in the finger pulse oximeter, with it measures heart rate (HR) and oxygen saturation in the blood but can cause problems like the same caused by an ECG electrode including skin irritations. The heartbeat and breathing frequencies can be measured based on the piezoelectric effect and involves placing a sensor on the abdominal area [2]. These methods are the most commonly used for monitoring vital signs and require contact sensors to be placed on the patient, whereas new trends seek to allow non-contact monitorization.

The several methods available for measuring heart rates include thermal imaging analysis [3,4], observation of the Doppler effect [5], Doppler-camera hybrid [6]. The variations in light intensity are affected by the type of light source or flickering. These methods are called photo plethysmographic images (PPGI). After reviewing the principal PPGI methods, considering the suitability for monitoring a heart rate.

Face image analysis has the considerable attention in the computer vision research community. The evolution in emerging robust algorithms and technology to transfer face image analysis from theory to fruitful automated identification systems for various applications. Automatic face recognition remains an exciting task when presented with uncooperative users as well as in uncontrolled environments.

Discrete wavelet transforms (DWTs), which are multiresolution image analysis tool. Multiresolution property of DWT empowers one to efficiently compute a small-sized feature representation that is predominantly required for face recognition.[7] . Low frequency estimate sub band is suitable for face descriptor for recognition under precise illumination, but it is significantly affected by varying illumination. In other way, the detail sub bands (e.g., horizontal and vertical face features) are accurately hard-hitting against erratic lighting conditions, but they are affected by geometrical changes such as varying facial expressions and pose.

Comprehensive methods such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA) and the more recent 2-D PCA are used for facial analysis. In this paper using LBPH algorithm.

The paper is organized into 4 sections, in first section giving the information about introduction of the related work. In second section deals with the proposed methodology. In third section analyising the results. In the last and fourth section concluding the work.

Revised Manuscript Received on March 30, 2020.
* Correspondence Author
K.Swathi, Dept.Of IT,CBIT, Hyderabad, India.
R. Rahul, Dept.Of IT,CBIT, Hyderabad, India.
Email: aarutysu@gmail.com
B.Phaninder,Dept.Of IT,CBIT, Hyderabad, India.
Email: urstrulyphani17@gmail.com

II. PROPOSED FRAMEWORK

The proposed Framework mainly divided into two parts. They are

1. Recognize the face in the video
2. From the face grab the forehead to find the heart rate.

The complete framework is as follows

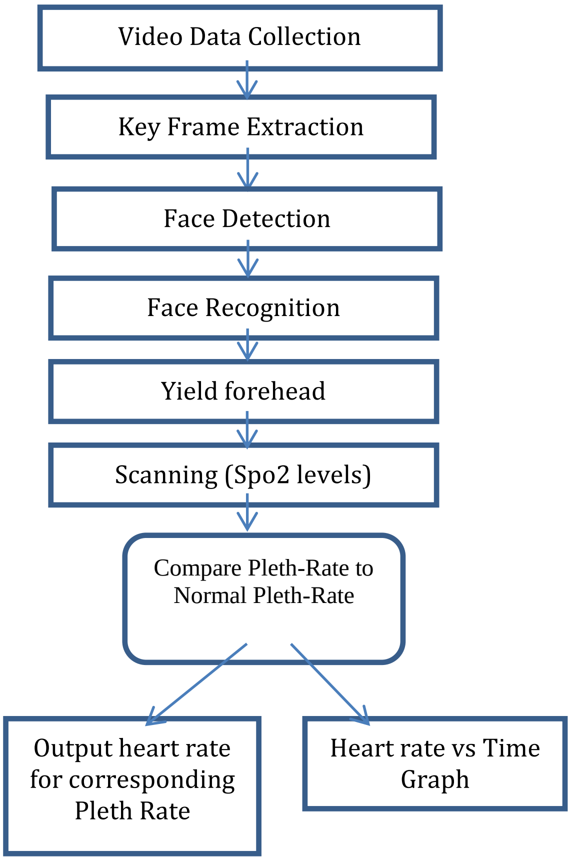

Fig 1: Proposed Framework

A. Video Data Collection

In hospitals at the sitting area of patient with the help of web cameras, collecting the video data of the patients. The main source for the video collection here is the cameras available in the hospitals.

B. Key Frame Extraction

Video key frame is the frame that can symbolize the salient content of a video shot. The use of key frames significantly reduces the amount of data necessary in video indexing and browsing and provides an organizational framework for dealing with video data. Key-frame-extraction techniques can be classified according to their various measurements of visual content complexity of a video shot or sequence. Current key-frame-extraction techniques can be classified according to their various measurements of visual content complexity of a video shot or sequence.

C. Face Detection

The face detection is mainly based on haarcascade features. A rectangular simple feature like Haar is used as an input feature for cascaded classifier in Fig. 2, some of the filters uses features like Haar. The filters are applying into one special area of the image, the pixel sums under white areas are subtracted from the pixel sums under the black areas. That is the weight of white and black area can be considered as "1" and "-1", respectively.[9]

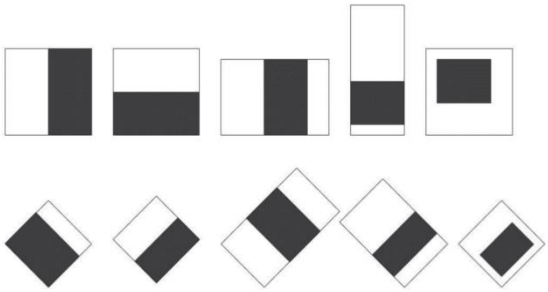

Fig 2: Different kinds of filters based on Haar-like feature.

D. Face Recognition

Face recognition technology is an important research project in the field of computer vision and pattern recognition, it can identify the identities and other information according to the visual features of face image, having a very broad prospect for development.

Face recognition is widely used in verification, criminal enquiry, video surveillance, robot intelligence and medical science and so on. It has wide application value and commercial value. As a biological feature, facial features have the characteristics of good, direct and convenient compared with other biological features. Therefore, face recognition is more acceptable for users.

The Local Binary Pattern Histogram algorithm is a simple solution on face recognition problem, which can detect both front face and side face. However, the detection rate of LBPH algorithm under the conditions of illumination variation, expression variation and attitude deflection is decreased. To solve this problem, a modified LBPH algorithm based on pixel neighborhood gray median is proposed.

E. Yield Forehead

After recognizing the face, the fore head part is recognized with the haar cascade classifier. The yield of this step is forehead part of the face is taken.

F. Scanning SpO2 levels

Good blood oxygenation is essential to supply the energy to our muscles need in order to function, which rises during a sports movement. If our SpO2 (blood oxygen saturation) value is below 95%, that could be a symptom of poor blood oxygenation, also called hypoxia. The scanning of SpO2 levels done plethysmography process.

Plethysmography measures variations in magnitudes in different areas of our body. It assesses these variations with blood pressure cuffs or other sensors. Plethysmography is particularly operative in spotting discrepancies caused by blood flow. It can help doctor to determine if there is a blood clot in arm or leg. It can also help to calculate the volume of air the lungs can hold. Plethysmographic signals were assessed tenuously (>1m)
using ambient light and a simple consumer level digital camera in movie mode. Heart and respiration rates could be computed up to several harmonics.

Retrieval Number: D2051029420/2020©BEIESP
DOI: 10.35940/ijitee.D2051.039520

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Although the green frequency featuring the toughest plethysmographic signal, similar to absorption peak by (oxygen) hemoglobin, the red and blue frequencies also delimited plethysmographic facts. The outcome gives the information that ambient light photo plethysmography may be useful for medical applications such as classification of vascular skin lesions (e.g., port wine stains) and remote sensing of dynamic signs (e.g., heart and respiration rates) for triage situations or sports purposes.

Pleth-rate(oxygen saturation levels) and heart rate are mutually inter related, if the pleth rate is normal ranging from 97-100% then the heart rate will be ranging from 70-90 beats per minute. Finally displaying heart rate as a graph.

III. ALGORITHM

The following algorithm basically we are using for this work

A) LBPH for face recognition

B) Spo2 algorithm

A. LBPH Algorithm

Step 1:- Initializing LBPH Parameters

Radius:- used to form the circular local binary pattern and embodies the radius round the central pixel. It is usually set to 1.

Neighbors:- the circular local binary pattern is formed by the sample points, normally the value is set to 8.

Grid X:- the horizontal direction cells. The 8 cells are accepting.

Grid Y:- the vertical direction cells. The 8 cells are accepting.

Step 2:- Training the Algorithm: First, we need to train the algorithm. Use a data set with the facial images of the individuals we want to distinguish.

Step3:- Applying the LBP operation:

LBPH is to create an intermediary image that defines the original image in a better way, by eminence the facial characteristics. The algorithm uses a concept of a sliding window, **radius** and **neighbors** are used as parameters.

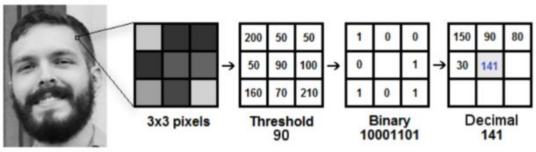

Fig 3: LBPH (comparing with threshold pixel value)

Step 4:- Extracting the Histograms

The image was divided into multiple grids as horizontally and vertically with respect to Grid X and Grid Y parameters.

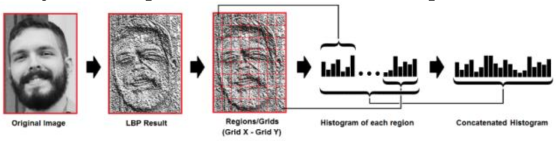

Fig4: Formation of Histograms

Step 5:-Performing the Face Recognition

The algorithm is already trained. Compare the histograms of trained and tested images and return the image with closest histogram. The approaches to compare the histograms are Euclidean distance**,** Chi-square**,** Absolute value.

B. Spo2 Calculation

Heart beat leads the flow of blood, or pulse rate in nature so the transmitted light changes with time. Red and Infrared lights are used, to estimate pulse oximetry and also the hemoglobin oxygen saturation of arterial blood. Visible and infrared (IR) light is absorbed by Oxyhemoglobin (HbO2) in a different way than deoxyhemoglobin (Hb), and the result is represented as bright red as opposed to the darker brown Hb. Absorption levels in the arterial blood is denoted by an A.C. signal which is overlaid on a D.C. signal signifying absorptions in other substances like pigment in tissue, venous, capillary, bone, and so forth. Cardiac-synchronized A.C. signal is approximately 1% of the D.C. level. This is denoted as the perfusion index %. The ratio of ratios 'R' is approximated in Equation 1. % SpO2 is calculated as follows:

$$R = \frac{AC_{rms}\ of\ RED / DC\ of\ RED}{AC_{rms}\ IR / DC\ of\ IR} \quad \text{---(1)}$$

Based on the empirical calibration precise %SpO2 is computed as ratio of ratios for the specific device

$$\%\,SpO2 = 110 - 25 \times R \quad \text{--- (2)}$$

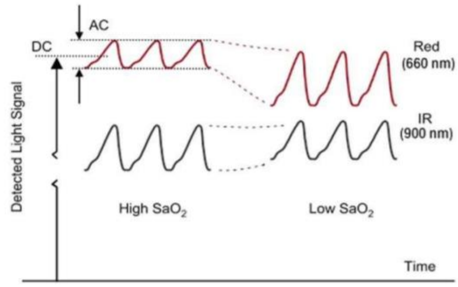

Fig 5: Cycling Blood modulation by Red and IR

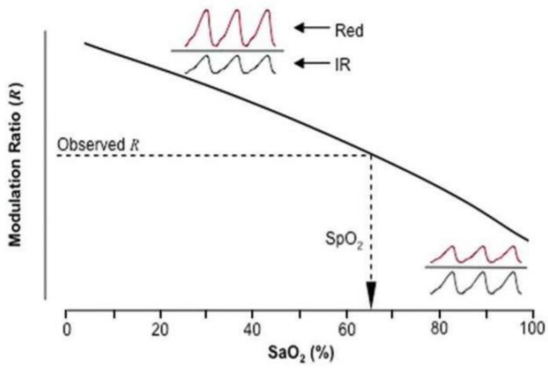

Fig 6: Modulation Ratio of Red/IR

IV. RESULT ANALYSIS

Face dataset program captures a video and gets the facial images of the person, here the video data may be taken from the standard dataset or from surveillance camera. The first task is to recognize the face in a video or image.

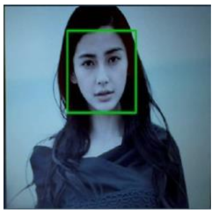

Fig 7: Face Recognition

Recognition of the person facial image will be done in face recognition program. This detects the face image if it is previously scanned and saved. Brightness is must for scanning the facial images.

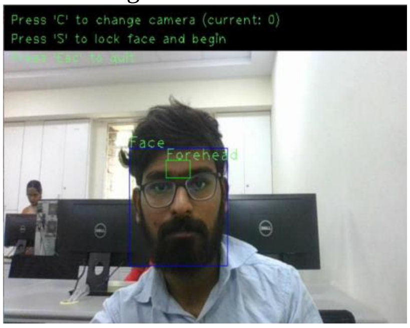

Fig 8: Face and Forehead detection

Face and the Forehead region are detected and scanned.

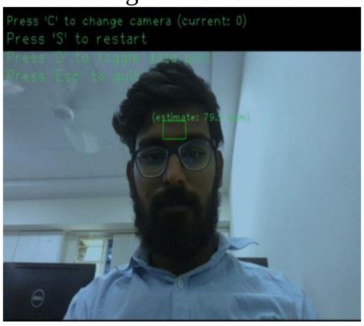

Fig 9: Detection of Heart rate.

After detecting the Face and Forehead of a person, from the extracted blood fluctuations and oxygen saturation levels, pleth rate and heart rate are detected as above.

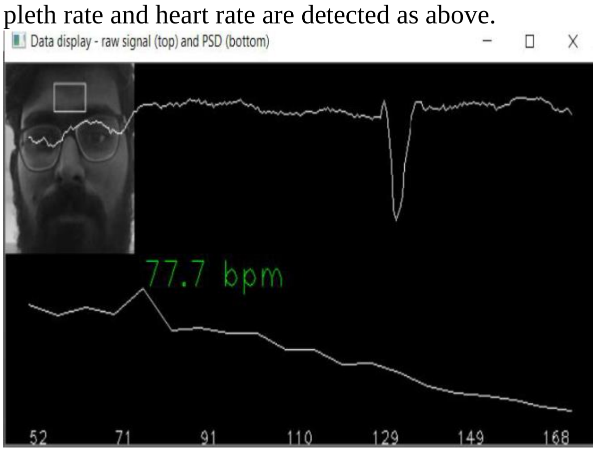

Fig 10: Plotting graph (beats per minute)

The overall output of non-contact pulse detector is shown in the above Fig 10.

V. CONCLUSION

The proposed system describes a methodology to register cardiac rates from video recordings by the surveillance camera. The proposed system is a relatively low-cost method for an independent analysis of cardiac rate, this method is imperceptible to the patient. The structure and algorithm of this system have not yet been tested online within a hospital setting. We have worked with face videos because hospital camera access is limited so as to avoid disturbing the patients. In order to estimate the robustness and lightweight of our algorithm, we have performed experiments to compare it with one of the most cited existing image photo plethysmography methods. The experiment proved that our method is tougher and computationally more efficient.

The proposed method would not work in the case of poor lighting or darkness. The system could be enhanced by dedicated illumination and optimal lighting conditions that would decrease or avoid shadows.

REFERENCES

1. Salas, G.; Satragno, D.; Bellani, P.; Quiroga, A.; Pérez, G.; Erpen, N.; Villalba, G.; Cortea, L.; Centeno, G.; Musante, R.; et al. Consenso sobre la monitorización del recién nacido internado. Parte 1: Monitorización no invasiva del recién nacido. Arch. Argent. Pediatr. **2013**, 111, 353–359.
2. Aminian, K.; Thouvenin, X.; Robert, P.; Seydoux, J.; Girardier, L. A piezoelectric belt for cardiac pulse and respiration measurements on small mammals. In Proceedings of the 14th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Paris, France, 29 October–1 November 1992;pp. 2633–2634.
3. Abbas, K.; Heimann, K.; Jergus, K.; Orlikowsky, T.; Leonhardt, S. Neonatal non-contact respiratory monitoring based on real-time infrared thermography. BioMed. Eng. OnLine **2011**, 10.
4. Ming, Y.; Liu, Q.; Turner, T.; Wu, Y. Vital sign estimation from passive thermal video. In Proceedings of the2008 IEEE Conference on Computer Vision and Pattern Recognition, Anchorage, AK, USA, 23–28 June 2008.
5. Mikhelson, I.V.; Lee, P.; Bakhtiari, S.; Elmer, T.W., II; Katsaggelos, A.K.; Sahakian, A.V. Noncontact millimeter-wave real-time detection and tracking of heart rate on an ambulatory subject. IEEE Trans.Inf. Technol. Biomed. **2012**, 16, 927–934.
6. Gu, C.; Wang, G.; Li, Y.; Inoue, T.; Li, C. A hybrid radar-camera sensing system with phase compensation for random body movement cancellation in doppler vital sign detection. IEEE Trans. Microw. Theory Tech. **2013**, 61, 4678–4688.
7. H. Sellahewa, "Wavelet-based automatic face recognition for constrained devices," Ph.D. dissertation, Univ. Buckingham, Buckingham, U.K., 2006.
8. H. Sellahewa and S. A. Jassim, "Illumination and expression invariant face recognition: Toward sample quality-based adaptive fusion," in *Proc.2nd IEEE Int. Conf. Biometrics, Theory, Appl. Syst.*, Sep. 2008, pp. 1–6.
9. Mohammad Mahdi Moghimi, Maryam Nayeri, Majid Pourahmadi, Mohammad Kazem Moghim ,"Moving Vehicle Detection Using AdaBoost and Haar-Like Feature in SurveillanceVideos", international journal of imaging and robotics, 2018, vol 18.
10. "Non-Contact, Simple Neonatal Monitoring by Photoplethysmography" Juan-Carlos Cobos-Torres, Mohamed Abderrahim and José Martínez-Orgado, Article in MDPI Sensors - Open Access Journal 10 Dec. 2018.

AUTHORS PROFILE

Ms K. Swathi, is an Assistant Professor in the Department of Information Technology, Chaitanya Bharathi Institute of Technology, Hyderabad. She has 13 years of teaching experience and her research concentrates on Machine Learning and Video Analytics. She taught various subjects like Discrete Structures, Computer Networks, Cryptography and network security, Artificial Intelligence, Social Media Analytics etc.

Mr. R.Rahul is a graduate student within the Information technology program at Chaitanya Bharathi Institute of Technology, Hyderabad. He will graduate with B.E. in Information Technology in 2021. His research concentrates on Image processing and Compute Vision.

Mr. B.Phaninder is a graduate student within the Information technology program at Chaitanya Bharathi Institute of Technology, Hyderabad. He will graduate with B.E. in Information Technology in 2021. His research concentrates on Machine Learning and Image processing.