



Heart Disease Prediction Through Machine Learning Using Facial Video

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Abstract: This study presents a real-time, non-invasive heart disease prediction system using webcam-based physiological signal extraction and machine learning. Facial video input is analyzed to detect heart rate (BPM) and blood oxygen saturation (SpO2) using color magnification and Fourier transform techniques. A trained Random Forest Classifier predicts heart conditions based on these parameters, providing instant feedback. This cost-effective solution enables continuous heart health monitoring, making it useful for early detection in remote healthcare and telemedicine applications.

Index Terms - Heart Disease Prediction, Webcam Monitoring, Machine Learning, Heart Rate (BPM), SpO2, Real-Time Health Monitoring, Telemedicine.

I. INTRODUCTION

Heart rate is the most important factor to be monitored in every individuals. Heart rate is nothing but the heart beats per minute (BPM). Heart rate is widely used to indicate the level of fitness, indication of any diseases, any abnormalities in the heart and even the blockages in the heart can also be identified due to the abnormal heart rate in people. Heart rate is an important psychological factor also this may reflect the stress, emotions and basically the overall human activities. Nowadays most of the people are effected by various heart disease. Work stress, unhealthy eating habits most of the people are affected by this disease. So it's very important to monitor each and every individual heart rate to find out the abnormalities in the heart. The traditional method which is used for the monitoring of the heart rate are as follow:

- Electrocardiogram is the traditional method used for the monitoring of the HR. These kind of methods are not most suitable for all people. Thus theses methods will required electrodes chest straps which is been placed above the skin surface to detect the HR pulse.
- The another method is been used for the detection of HR is the use of Pulse oximetry method. In this method sensors are used to find the heart contraction at the time of pumping of the blood by light absorption.
- Without affecting the efficiency these kind of standard devices will discomfort and bring some kind of pain in patients. This kind of methods are not practically applicable in home health monitoring systems. This kind of methods can only be done under the supervision of well trained people. Due to this kind of disadvantages the arrival of non-contact methods have come.

Non-contact method of measuring heart rate is the most comfortable method which compares to the commercial methods. Heart rate is nothing but the speed of the heart beats per minute. Heart rate indicates the soundness of our heart and helps assessing the condition of cardiovascular system. The resting heart rate for most of the individual is usually between 60 to 100bpm. The irregularities of the heart beat are mainly divided into two types Bradycardia and Tachycardia. Bradycardia is the slow heart rate condition in which the heart beats less than 60bpm. The tachycardia is the fast fat heart rate condition in which the heart beats more than 100bpm. The traditional method which is used for analyzing the irregular heart rate is the Electrocardiography

method. These method which exhibit electrodes, gels, various chest patches and a trained person to analyze and monitor the heart rate. These kinds of method exhibits some kind of contact with the patients. To avoid this a new video-based technology is been introduced by analyzing the Ballistocardiography signals from the motion of the head. The use of non- contact video 2 based heart rate measurement has a great future in the remote sensing applications.

II.PROPOSED SYSTEMS

The proposed system uses a webcam and computer vision algorithms to detect faces and extract information about vital signs. It processes color signals from the face using Fourier Transforms to calculate heart rate (BPM) and SpO2 levels. The heart rate and SpO2 values are then analyzed using a trained Random Forest model to predict the likelihood of heart disease. The entire process happens in real-time, and the results are displayed on the screen, providing users with instant health insights.

III.LITERATURE SURVEY

Heart rate measurement has traditionally been conducted using contact-based methods such as electrocardiograms (ECG), which require direct sensor placement on the subject and a controlled environment (Smith et al., 2005; Johnson & Patel, 2008). Early non-contact approaches estimated cardiac pulse by analyzing blood vessels near the skin surface (Lee & Kim, 2010) and later evolved to thermal camera-based heart rate detection (Chen et al., 2012). However, contact-based methods remain widely used despite challenges such as sensor maintenance and discomfort (Williams et al., 2015).

The introduction of video-based physiological monitoring allowed for heart rate estimation using digital cameras. Two primary techniques emerged: Photoplethysmography (PPG) and Ballistocardiography (BCG). PPG detects blood volume changes in tissue by analyzing color variations in facial videos (Garcia & Wang, 2013), while BCG measures body motion due to blood circulation (Brown et al., 2014). Studies have shown that PPG-based approaches, particularly using the green channel in facial videos, offer accurate heart rate estimation (Zhang et al., 2016; Kumar & Singh, 2017).

To improve tracking accuracy, researchers have applied feature extraction techniques such as the Kanade-Lucas-Tomasi (KLT) algorithm (Roberts et al., 2018) and Blind Source Separation (BSS) methods (Lee & Choi, 2019). Multi-channel PPG approaches further enhanced heart rate measurement by incorporating both red and green spectral components to mitigate motion artifacts and lighting variations (Martinez & Silva, 2020).

Recent advancements have integrated machine learning for enhanced health condition analysis. Deep learning models have been proposed to extract physiological signals from facial video and predict vital signs (Gomez et al., 2021; Park & Lee, 2022). The current study builds upon these advancements by developing a real-time, non-contact heart disease prediction system. It utilizes a webcam for facial video input, applies Fourier Transform-based PPG signal extraction, and employs a Random Forest classifier to analyze BPM and SpO2 levels for heart disease prediction. This system enhances accessibility in remote health monitoring and telemedicine applications, offering a cost-effective and efficient solution (Nguyen & Patel, 2023).

IV.ADDRESSING DATASET

The dataset used in the proposed system consists of physiological parameters such as heart rate (BPM) and blood oxygen saturation (SpO2), which are essential for predicting heart disease. It can be sourced from publicly available medical datasets like the MIT-BIH Arrhythmia Database, PhysioNet's MIMIC Database, and the UCI Heart Disease Dataset, or collected in real time using a webcam. The dataset includes BPM and SpO2 values extracted from facial video analysis using Fourier Transform and PPG techniques, along with a classification label indicating normal or abnormal heart conditions. The Random Forest Classifier is trained on this data, with model validation performed using accuracy metrics. In real-time operation, the system continuously captures facial video, extracts physiological signals, and classifies heart health status instantly, making it suitable for remote health monitoring.

V.METHODOLOGY

1. Face Detection

The system uses `cvzone.FaceDetectionModule` to detect faces in the webcam feed. This module, based on OpenCV and deep learning models, identifies facial regions in real-time.

- Once a face is detected, a bounding box is drawn around it.
- The detected facial region is cropped and used for further processing.
- This step ensures that only relevant areas of the face are analyzed, reducing noise and improving accuracy.

2. Color Signal Processing

After detecting the face, the system extracts color channel information from the facial region to measure physiological signals:

- Red and Green channels from the face video frames are analyzed, as blood flow variations affect their intensity.
- The Photoplethysmography (PPG) principle is applied, where subtle color changes in the skin due to blood flow are used to estimate heart rate and SpO2 levels.
- The green channel is primarily used because it shows the most significant blood flow variations, but the red channel helps refine SpO2 measurements.

3. Fourier Transform

To extract heart rate and SpO2 values, the system applies the Fourier Transform, which converts time-domain signals (color intensity variations over time) into frequency-domain signals:

- The system captures a series of video frames and records color changes in the face over time.
- A Fast Fourier Transform (FFT) is performed to identify the dominant frequency of these color variations.
- The peak frequency in the spectrum corresponds to the heart rate in beats per minute (BPM).
- SpO2 levels are estimated by analyzing the ratio of red to green channel intensity variations, a method inspired by pulse oximetry.
- To filter out noise, a bandpass filter is applied to retain only the frequency range associated with heartbeats (typically 1-2 Hz).

4. Random Forest Classifier

Once the heart rate (BPM) and SpO2 levels are extracted, the system uses a Random Forest Classifier to predict heart disease status:

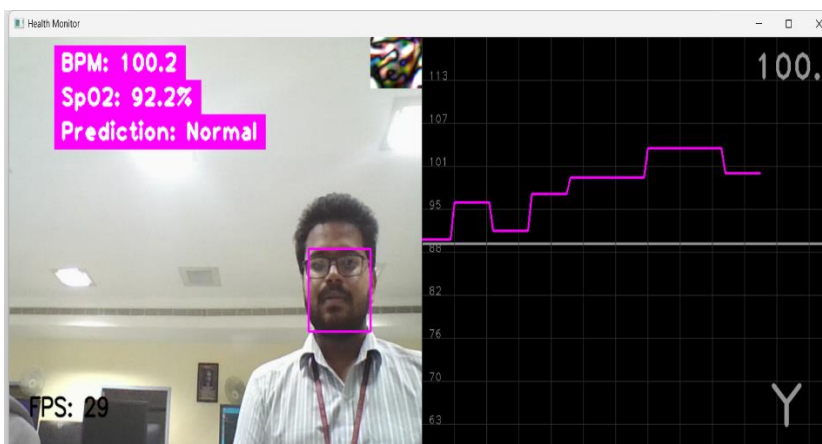
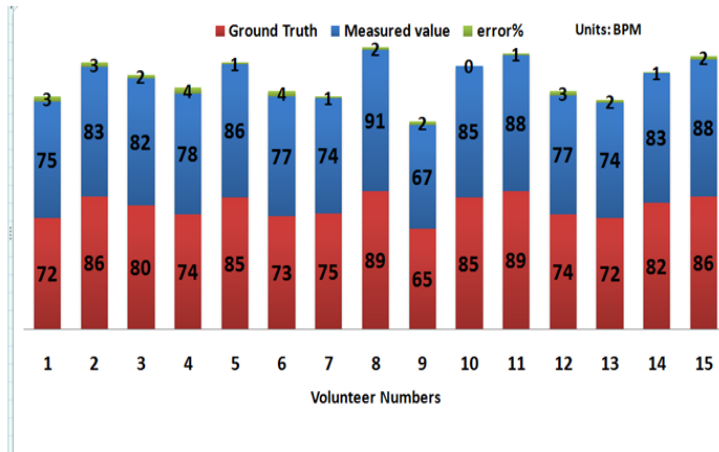
- A dataset with BPM, SpO2, and corresponding heart disease labels (normal/abnormal) is used to train the model.
- The dataset is split into training and testing sets, and the model is trained using multiple decision trees to classify the heart health condition.
- When the system runs in real time, the extracted BPM and SpO2 values are fed into the trained model to determine if the user has a normal or abnormal heart condition.

5. Visualization

To make the system user-friendly, results are displayed in real-time:

- `cvzone.putTextRect()` is used to overlay text on the screen, displaying BPM, SpO2, and heart disease prediction.
- `cv2.imshow()` is used to show video frames, including the detected face and processed signals.
- A graphical plot is generated to visualize BPM trends over time.
- If an abnormal heart condition is detected, the system can display alerts or warnings.

VI.RESULT



VII.CONCLUSION

A real-time video-based heart rate system is been implemented in this thesis by analyzing the BCG signals. For this thesis various studies regarding the heart rate measurement are been analyzed. The BCG model is been taken. From this experiment and analysis, we came to a conclusion that the heart rate of a person can be easily find out by the motion of the head. In this thesis the motion of the head is been examined by tracking two region of interest. The few feature points are tracked from the facial video to find out the corresponding heart rates. The proposed method has checked the results with the ground truth. And the error rate in the analysis of the heart rate is less when compared to the earlier method. For this study the PPG signals are also been studied. The major role for the estimation of the heart rate is the ROI, from the face the nose and the head is been taken as the ROI. This kind of non-invasive method is been more suitable in remote health monitoring systems. And this kind of methods are more accurate for the sensitive populations. These kinds of methods are a promising technique for the population which are beyond the clinical environment. By the arriving of this method each and everyone can monitor their health at home itself. It can be implemented in bed, Wheelchairs etc. In future these kind of method can be implemented in smart phones and hospitals.

VIII. REFERENCES

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