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Heart health care: Heart beat rate from face video and detecting cardiac diseases from ECG images

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Abstract: Non-invasive heart rate prediction has gained significant interest in various domains. Traditional methods utilizing external gadgets with the intention of of estimating heart rate through electrocardiogram **(**ECG)sensors often require direct skin contact, limiting comfort and utility. Recent developments in computer vision techniques have shown their capability to extract physiological data from facial videos through the detection of the forehead region The proposed real-time system employs OpenCV for facial recognition and tracking, ensuring with good lighting and minimal motion artifacts. Additionally, the study explores recognizing various physiological waveforms from raw data streams to enhance health monitoring capabilities. Shifting focus to image reports of ECGs, the research employs machine learning to digitize and analyses ECG paper records automatically. The transformation of ECG data into 1-D signals facilitates the extraction of P, QRS, and T waves, aiding in measuring heart electrical activity using diverse techniques. We employ dimension reduction techniques for feature extraction, and multiple classifiers such as ensemble, logistic regression, support vector machine (SVM), and k-nearest neighbors (KNN) are used for diagnosis. The resulting model demonstrates diagnostic potential, accurately identifying ECG records to interpret various cardiac conditions, such as myocardial infarction, arrhythmias, and normal heart function.

I. INTRODUCTION

Accurate and non-invasive heart rate prediction have tremendous interest in a variety of areas, including healthcare, fitness tracking. Historically, there have been external gadgets employed to estimate heart rate using electrocardiogram (ECG) sensors. This need regularly requires direct touch with the skin; however, this restricts their usefulness and comfort over time. Recent advances have exhibited considerable potential for extracting physiological information from video of a human face. This research proposes a system that predicts heart rate from a facial video by accurately detecting the average optical intensity in the forehead region. The forehead is chosen as the target area because of its near proximity to the skin's surface and high vascularization, which makes it appropriate for capturing minute changes in blood flow. The system can automatically recognize and track the user's face in real-time by utilizing OpenCV's face detection capabilities, providing continuous heart rate monitoring. This study's main goal is to determine in situations with good lighting conditions and minimal motion artifacts. As a way to enhance the system's capacity for health monitoring, the research also investigates the possibility of recognizing additional physiological waveforms, from the raw data stream. The capacity is to manage many individuals simultaneously in the camera's image stream, enabling heart rate for numerous users. There is a wide range of algorithms accessible to recognize and detect cardiac problems from clinical records. But here the study, the emphasis is largely on identifying and extracting patterns from image reports of electrocardiograms (ECG or EKG). Digitizing ECG records can eliminate the need for time-consuming manual analysis to interpret the report. The electrocardiogram (ECG) is most popular devices for identifying cardiovascular issues. Although the test itself is rather straightforward, it takes a lot of training to read the ECG charts. The most of ECG records were formerly preserved on paper. Therefore, manually reviewing and rereading the ECG paper records can frequently be a tedious, time-consuming and difficult operation. ECG recordings can be digitally digitized for automated analysis and diagnosis. The aim of this project is to transform paper ECG records into a 1-D signal using machine learning.

The P, QRS, and T waves that are present in ECG data can be extracted in order to demonstrate using a different of techniques to measure the heart electrical activity. There are several ways used, such as dividing the original ECG report into 13 Leads, employing threshold and scaling the signal was extracted and converted, the results were smoothed, and the output was converted to binary images. After feature extraction the data undergoes exploration using Principal Component Analysis (PCA) and other dimension reduction techniques to aid in making sense of the information. Numerous classifiers are used, that is the voting-based ensemble classifier, logistic regression, support vector machine (SVM), and k-nearest neighbour (KNN). The model will determine whether the model meets the necessary criteria for accuracy, precision, recall, f1-score, and support. This final model will assist in the diagnosis of cardiac disorders by determining whether a patient has/had myocardial infarction, an irregular heartbeat, or is in good condition by reading the ECG records.

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II. LITERATURE SURVEY

[1] The determination of cardiac rate from face video recordings has been the subject of various research publications that have examined non-invasive and remote health monitoring applications. Liu et al. looked into the application of color magnification techniques to amplify the minute color changes caused by blood flow in specific facial regions. This non-invasive technology's capability for heart rate estimation suggested its viability for use in in remote health monitoring.

[2] A real-time a technique for estimating cardiovascular activity from movies of faces was created in a separate study by Wang et al. This system used temporal averaging and spatial filtering technique store cover color variations according to changes in blood flow. Astonishingly, our real-time technology accurately determined heart rates despite difficult circumstances including motion artifacts and differences in lighting.

[3] Zhang et al. demonstrated cutting-edge techniques for remote heart rate detection based on digital signal processing (DSP). Through the use of the fast Fourier transform (FFT) and adaptive filtering, they created a method to extract data on heart rates from video sources. This technique demonstrated good accuracy when determining heart rate remotely, making it suitable for integration into a range of devices to enable continuous health monitoring.

[4] Zhang et al.'s heart rate measuring investigation also utilized face video data. In order to separate facial regions, the researchers used face detection. After tracking regions of interest (ROI), they were able to compute blood volume pulse signals. These face video data-derived blood volume pulse signals provide a dependable and practical way to estimate heart rate, offering possibilities for use in physical activity and health checking.

[5] Wang et al. used an innovative method to detect cardiac rate from video data. To make heart rate assessment easier, they isolated and combined several facial regions. They also tested several methods for combining this data. Compared to single-region techniques, the multi region technique showed improved robustness in heart rate estimate. This thorough method of merging face regions for heart rate estimate solves possible drawbacks of depending on single regions and makes the measurement process more accurate.

[6] Utilizing machine learning methods to cardiac disease identification and real-time cardiovascular condition monitoring is the main topic of this research. The Support Vector Machine (SVM) model
consistently outperforms the competition in term of precision, recall, sensitivity, accuracy, and misstate, as shown by the results.

[7] This investigation investigates cardiac disease prediction machine learning techniques. While models created using Random Forest and Naive Bayes classifiers showed significant predictive ability, decision trees performed less well than ideal. Additionally, the Support Vector Machine (SVM) emerged as a trustworthy option, highlighting the exciting possibilities of machine learning in predicting of cardio vascular medical condition.

[8] The primary aim of this research is to" determine the algorithm that is most effective at detecting heart disease and assessing its efficacy for future health problems. In terms of accuracy, the Support Vector Machine (SVM) emerged as the preferable approach. It's crucial to remember that this technique utilizes artificial intelligence techniques for predictive purposes cardiac illness rather than to explicitly identify it.

III. PROPOSED WORK

By Applying face video analysis, the suggested cardiac rate prediction system calculates cardiac rates from the user's forehead area. OpenCV is used to recognize faces, making it possible to automatically extract the forehead region. On the basis of the temporal fluctuations in the color of the forehead induced by blood flow, the system gathers optic intensity data over time, calculates the average intensity, and calculates the user's heart rate. By producing a real-time face variation linked to the heart rate, the device further improves the user experience by enabling a visibly coordinated pulsating highlight on the forehead. The proposed strategy for predicting cardiovascular disease (CVD) Utilizing ECG image technology combined with a Python Flask algorithm seeks to get around a few of the disadvantages of the current method and offer an objective, rapid, and precise detection of CVD. These algorithms have been taught on a various range of ECG pictures and associated diagnoses, which allows them to detect patterns in the data. Python programming language and Flask framework, which offers a flexible and lightweight web application development framework, are used in the system's construction. Medical practitioners can input ECG images and receive the appropriate CVD diagnosis via the system's web-based user interface. Specified System The outcomes are immediate and without any lag time. The ecg data can be verified without seeing a doctor. The patient may consult a specialist doctor after the initial findings. It can be utilized in distant places of the world where finding doctors is difficult and time-consuming.

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IV. METHODOLOGY

A. The methodology of this research encompasses two core areas: non-invasive estimating heart rate through facial video analysis. and automated analysis of electrocardiogram (ECG) records. To predict heart rate from facial video, innovative computer vision algorithms are harnessed to extract physiological information. Leveraging the optical absorption properties of hemoglobin, the research centers on the forehead region due to its proximity to the skin's surface and pronounced vascularization. Utilizing OpenCV's face detection capabilities, real-time facial recognition and tracking ensure continuous monitoring. For multi-user feasibility, the system is designed to concurrently estimate heart rates of numerous individuals.

B. In the context of ECG analysis, the project strives to transform paper-based ECG records transforming into digital data streams designed for automated interpretation. The conversion of analog data into 1-D digital signals enables the extraction of critical features like P, QRS, and T waves, crucial for measuring heart electrical activity. Principal Component Analysis and dimension reduction techniques aid in feature extraction, while multiple classifiers encompassing ensemble methods, logistic regression, support vector machines (SVM), and k- nearest neighbors (KNN) are employed for diagnostic purposes.

C. By integrating these methodologies, the study endeavors to deliver a comprehensive solution for heartrate prediction and cardiac disorder diagnosis. The predictive potential from facial video and the automated analysis of ECG records collectively contribute to advancing non-invasive monitoring and diagnose is capabilities, handling a wide variety of applications in healthcare and human interaction domains

V. CONCLUSION

Tracking heart rate is crucial since atypical cardiovascular system changes might aid with diagnosis. The non-contact heartbeat monitoring techniques are seen to be most helpful for everyday use and IoT applications. The method we've described makes a mobile implementation possible while resolving the problem of multiple-subject heart rate monitoring. A single webcam may be used to evaluate the HR of upto4 persons, although in this case, just a low-resolution laptop camera was chosen. The technique employs both facial recognition and monitor of objects, which result in a shorter computation time. In conclusion, the suggested system for Predicting Cardiovascular Disease utilizing ECG pictures has shown effective outcomes employing Python Flask technology and algorithms like SVM, KNN, Logistic regression, and XGBoost. The system was created with the aim to give a precise and effective diagnosis of cardiovascular disorders while overcoming the limitations of current technologies. The suggested method offers plenty of benefits, such as a user-friendly interface, the capacity to process an enormous number of ECG pictures, and the high accuracy and efficiency with which it can forecast cardiovascular disorders. The suggested approach still has significant drawbacks, though, which have to be solved through in further study.

FUTURE ENHANCEMENT

In the future, we suggest researching the relationship between camera quality and the total number of faces that can be recognized as well as the maximum distance between the camera and the subject. Additionally, we plan to use Android and other platforms to create the HR measurement algorithm. In order to create tracking of several people and their HR using numerous cameras, this is being done. The study's relatively small dataset may have restricted how broadly the findings could be applied. Further study is required to see how well the system performs with other sorts of medical imaging as it was only evaluated on ECG images.

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