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An ECG Measurement System for Vehicle Implementation and Classification of Heart Disease Based on Machine Learning

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ABSTRACT: Heart illness is among the leading causes of death in the modern world. The examination of clinical Data is among the most important problems with the forecast of cardiovascular disease. According to research, ML, or machine learning can efficiently assist in generating decisions and forecasts according to the massive according to the produced by the medical industry. Additionally, machine learning (ML) methods have been employed in recent developments in a figure of Web areas. The application of ML algorithms to predict heart illness is only partially understood by a few of studies. In this piece, we provide a new strategy founded on machine learning approaches to determine the important traits to raise the precision of cardiovascular disease prediction.

KEYWORDS: Machine Learning and Heart Disease Prediction.

I. INTRODUCTION

As the world's top cause of mortality, cardiovascular diseases (CVDs) present a serious public health concern. Mortality rates can be significantly decreased by early identification and ongoing monitoring of heart-related abnormalities. One of the most non-invasive ways to track cardiac activity is with electrocardiography (ECG). Traditional ECG monitoring systems, however, are usually only applicable in clinical settings, which limits their realtime application, especially for those who are constantly on the go.

Integrating health monitoring devices inside automobiles been a viable strategy recently to guarantee ongoing, instantaneous assessment of a driver's health. Apart from offering continuous heart monitoring, immediate evaluation of a ECG measurement equipment into automobiles is essential for averting collisions brought on by unexpected cardiac episodes. This strategy is particularly crucial for those who already have heart issues and for high-priced professional drivers of time behind the wheel.

By using machine learning (ML) techniques, these systems can automatically categorize heart conditions using the ECG data, increasing their usefulness. Proactive medical intervention is made possible by machine learning models' ability to learn from enormous volumes of data, identify intricate patterns, and make precise predictions about the presence and severity various cardiac conditions.

The arrangement of the paper is as follows: Section II outlines the preprocessing methods used to clean and normalize the signals in addition to the methodology for getting ECG information from existing datasets. The machine learningbased heart disease categorization system detection is as outlined in Section III, along with feature extraction, model training, and assessment methods. Experimental findings and performance comparisons of several classification models are presented in Section IV. The study is finally concluded with an overview of the primary conclusions and recommendations for further improvements in Section V.





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II. LITERATURE SURVEY

In recent years, a lot of research has been done on the idea of automatically detecting heart illness from ECG data. The foundation for the integrating machine learning methods for signal processing models for cardiovascular diagnostics was established by the work of Acharya et al. [1]. By maintaining both duration and regularity information, the wavelet transformation greatly increases classification accuracy when ECG signal features are extracted, as suggested by the writers in [2]. A work by Kiranyaz et al. [3] removed the necessity for manually created features by introducing a patient-specific deep learning model that might classify ECGs in real time.

Traditional methods of artificial intelligence have been the focus of several studies. K-nearest neighbours (KNN) and support vector machines (SVM) were employed by the authors in [4] to classify ECGs, demonstrating that feature selection and proper preprocessing have a major effect on performance. In order to simplify computations without compromising accuracy, the work in [5] investigated Principal component analysis is referred to as PCA and ICA independent component analysis, respectively for dimensionality reduction prior to applying classifiers. In the meantime, [6] provided a comparison of random forest, logistic regression, and decision tree methods using ECG datasets for the binary categorization of cardiac disorders.

There are two main stages to the study in this paper: 1) Preprocessing and Feature Extraction of ECG Signals; 2) Machine Learning-Based Classification of Heart Disease. In order to extract significant properties like RR intervals, heart rate variability, and waveform characteristics, the ECG signals must first be cleaned and normalized to eliminate noise and artifacts. A number of techniques for machine learning, such as logistic regression, random forest, and assist vector machines, are taught and assessed to categorize whether heart disease is present or not during the classification stage. The strategy seeks to offer a software-based, effective, real-time solution that can be included into automotive systems for ongoing cardiac health monitoring.

III. METHODOLOGY

A software-based method for the identification and categorization of cardiac illness using ECG data is presented in this paper; it may find use in automobile settings for ongoing driver health monitoring. Gathering information, preprocessing signals, and extracting features and selection, and machine learning-based categorization the four main steps of the methodology



Figure 1: System Architecture

ECG signals are initially obtained from clinically validated and publically accessible datasets, including the Arrhythmia of MIT-BIH Database. These datasets provide annotated ECG recordings that form the basis for the creation and assessment of models. Preprocessing is necessary to guarantee clean and trustworthy data since raw noise may be present in ECG signals and artifacts from muscle movements, electrode motion, or other external disturbances. Filtering techniques are used at this level to eliminate baseline drift and noise. Low-frequency drift and high-

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frequency noise are suppressed using high-pass and band-pass filters, respectively. To enable uniform feature extraction, the signals are also standardized to a standard scale.

Following preprocessing, pertinent features are retrieved from the signals to record the ECG's morphological and temporal aspects. Heart rate variability (HRV), QRS complex duration, and RR intervals are important time-domain characteristics. Mean, variance, and skewness are statistical measures that offer further information on signal behaviour. In order to find periodic patterns that are difficult to see in the time domain, frequency-domain features are also obtained utilizing transformations like wavelet transforms or the Fast Fourier Transform (FFT). Employing techniques such as Principal Component Analysis (PCA) or Recursive Removal of Features (RFE), which preserve the key characteristics for categorization, dimensionality reduction is conducted in order to improve model efficiency and prevent overfitting.

In the final phase different models of supervised machine learning for the categorization of heart disease are trained using the chosen features. Among the algorithms used is Random Forest, K-Nearest Neighbours (KNN), Vector Machine Support, Decision Tree, and Logistic Regression. To provide robustness and generalizability, k-fold cross-validation is used for both training and evaluation of these models. Standard assessment measures such as recall, accuracy, and precision, F1-score, and the Area Under the ROC Curve (AUC-ROC) are used to assess the system's performance. For real-time ECG-based cardiac disease detection in vehicle-integrated software systems, the top-performing model is determined to be the most appropriate.

IV. EXPERIMENTAL RESULTS

Twelve photos have undergone testing for this system, which include displayed in the figures below. The outcome demonstrates that the system operates with accuracy.







Figure 3. Algorithms for learning machines

The graphic displays a bar graph that evaluates the precision of seventeen distinct models for machine learning. 16





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AdaBoost, Random Forest, Gradient Boosting, Gaussian Decision trees, deep learning, naive bayes, and SVM, or support vector machine are several the models symbolized by the x-axis. The precision figures, which vary from 0 to 1, are displayed on the y-axis.

From the chart, Gradient Boosting emerges as the most accurate model, achieving close to 0.9 accuracy, followed closely by Random Forest and AdaBoost Gaussian Naive Bayes and Deep Learning models perform moderately, with accuracies around 0.8 and 0.55 respectively. Decision Tree and SVM show comparatively lower performance, with accuracies near 0.7 and 0.65. This comparison highlights the superior performance of group techniques such as Gradient Boosting and Random Forest in this particular task corresponding to human.





V. CONCLUSION

Early identification of irregularities in conditions of the heart and long-term lifesaving will be aided by recognizing the unprocessed medical data processing connected to the heart. In this work, the unprocessed data was handled using machine learning techniques to create a fresh and innovative diagnosis of cardiac condition. Heart disease prediction is difficult yet crucial in the field of medicine. However, if the condition is identified early and preventative measures are implemented as soon as feasible, the death rate can be significantly reduced. It would be ideal if this study could be expanded further to focus on real-world datasets rather than merely theoretical methods and simulations. The characteristics of the Linear Method (LM) and Random Forest (RF) are combined in the suggested hybrid HRFLM technique. When it came to forecast cardiac disease, HRFLM showed to be highly accurate

This research can be conducted eventually utilizing a different approaches to machine learning to enhance prediction methods. To increase the effectiveness of cardiac conditions prediction, new feature selection methods that can be developed to obtain a wider perspective of the important information.

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