AcouHeart Diagnostics

Project Guide : Ms.Divya John

Abhijith M(FIT21CS002)
Alen V Thomas (FIT21CS018)
Diya Chandra (FIT21CS048)
Gopika Jayaram (FIT21CS057)

Federal Institute of Science and Technology

07/04/2025

ABSTRACT

- This study presents an AI framework for heart disease classification using audio signals.
- Using PASCAL Challenge datasets, the framework integrates Mel-Frequency Cepstral Coefficients (MFCCs) and models like Multilayer Perceptron (MLP) and 1D Convolutional Neural Networks (Conv1D).
- The MLP model achieved 95.65% accuracy, highlighting the potential of audio signal analysis.

Introduction

- Cardiovascular Disease (CVD) is a leading cause of death globally, responsible for 17.9 million deaths annually, particularly in low- and middle-income nations.
- Early detection is vital to reducing its impact. Abnormal heart sounds, such as murmurs, often indicate serious conditions and can be identified through cardiovascular auscultation.
- However, access to skilled physicians is limited in many areas. Traditional diagnostic methods like angiography are costly and time-intensive, creating barriers in resource-limited settings.

Problem statement

- Cardiovascular disorders are a leading cause of mortality, requiring reliable and efficient diagnostics.
- Using advanced models, audio feature extraction, and data augmentation, heart disease classification accuracy, offering a cost-effective alternative to traditional methods.

Objectives

- Develop an Innovative Framework: Propose a novel approach that integrates audio data augmentation techniques with machine learning and deep learning methodologies.
- Design a Feature Ensembler: Develop a feature ensembler by combining multiple audio feature extraction methods.
- Evaluate and Compare Models: Implement and test multiple ML and DL models and achieve significant improvements in heart disease detection.

Social relevance

- Early detection of heart anomalies through non-invasive methods can prompt timely interventions, reducing the progression of CVDs.
- using AI and readily available audio signals, this approach minimizes the need for costly and invasive diagnostic procedures, making healthcare more affordable for patients and providers.

Overview of the Literature Review

Title	Methodology	Advantage	Disadvantage
[4]	Multilayer Perceptron (MLP) , 1D- CNN	High accuracy robustness , enhanced feature extraction	Potential overfitting on training data, computational ly intensive.
[8]	SNR	Comprehen sive dataset, improved SNR quality	Limited real- world noise scenarios
[9]	Random Forest	High accuracy ,robust feature selection	Requires detailed pre- processing and feature selection; performance drops without feature reduction .
[10]	Recurrent Neural Network	Highest accuracy, Avoids overfitting	High computational cost, less effective
[1]	CNN,SVM	Robust feature extraction, High sensitivity	Lower performance, Limited improvement.
[7]	Hybrid ML Framework	High specificity,accuracy	Processing time more, Requires significant computational resources.
[2]	SVM	Accuracy	Limited exploration of hybrid models.
[6]	SVM,AdaBoost	Employs multiple machine learning classifier, Utilizes feature selection techniques .	Limited exploration, Dependence on specific datasets.
[5]	CNN,RNN	provides systematic review	training inefficiencies and high computational requirements
[3]	CNN,SVM,RNN	High accuracy,Robust	Computationally expensive

System Architecture

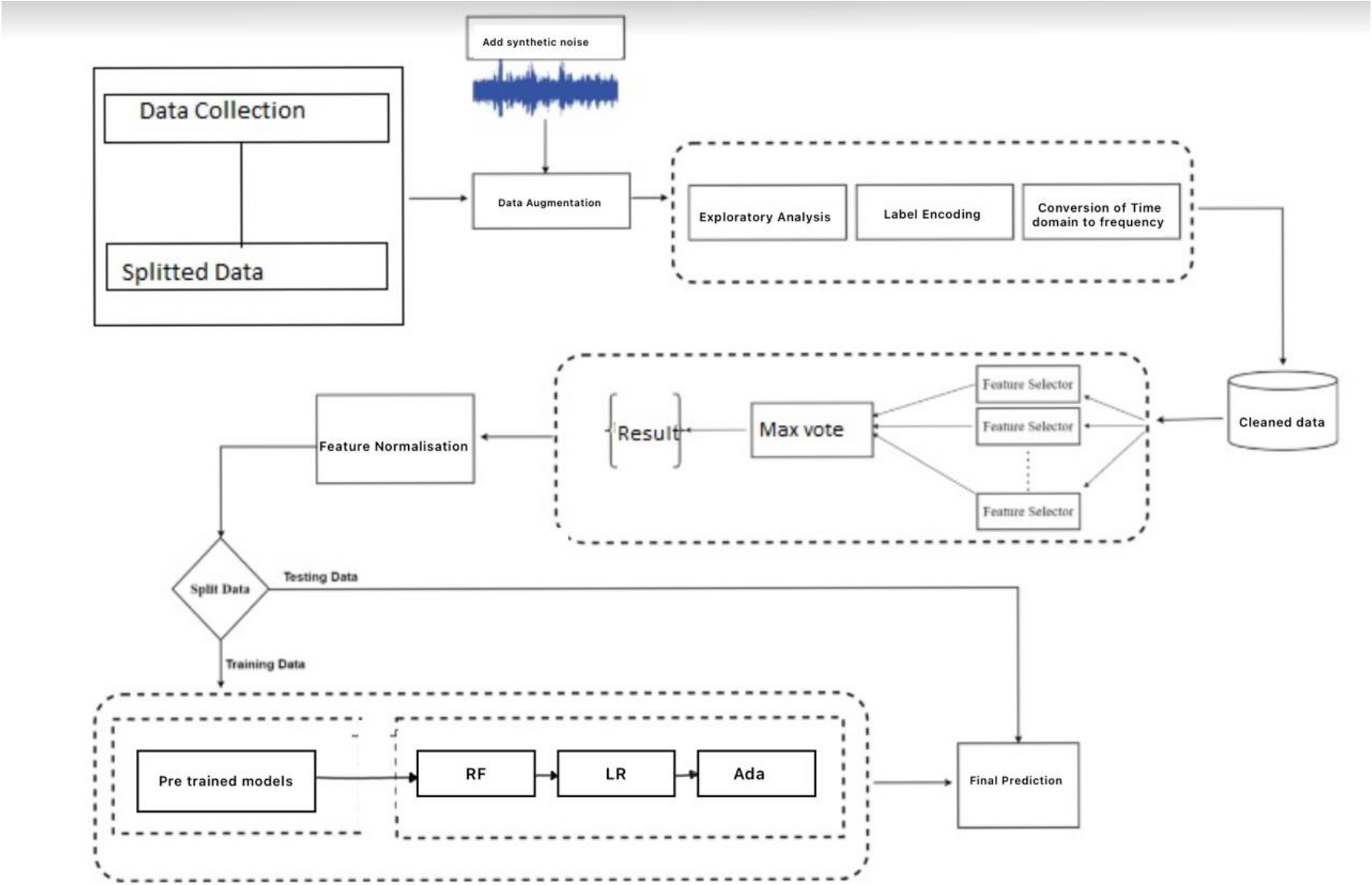
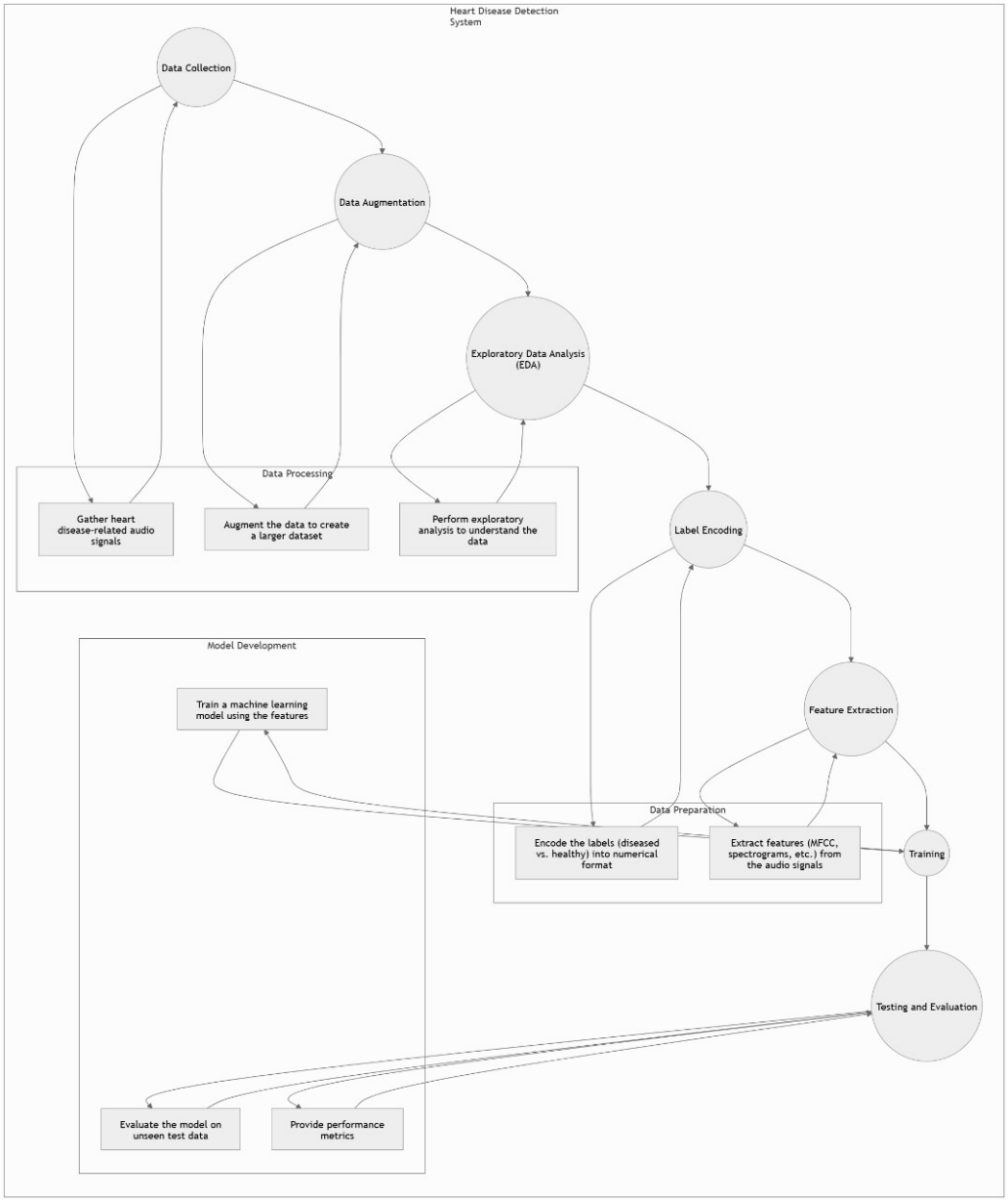


Figure: System Architecture

Modules

- Data Collection : Collect heart disease-related audio signals.
- Data Augmentation : Increase the size and variability of the dataset by augmenting the audio signals.
- Exploratory Data Analysis : Analyze the dataset to understand the distribution, trends, and relationships in the data.
- Label Encoding : Encode the labels (heart disease status) into a machine-readable format.
- Feature Extraction : Extract meaningful features from the audio signals that can be used by machine learning models.
- Training : Train a machine learning model on the processed audio features to predict heart disease.
- Testing and Evaluation : Test the model on unseen data and evaluate its performance.

Flowchart


Heart Disease Detection System
Data Collection
Data Augmentation
Exploratory Data Analysis (EDA)
Data Processing
Gather heart disease-related audio signals
Augment the data to create a larger dataset
Perform exploratory analysis to understand the data
Label Encoding
Model Development
Train a machine learning model using the features
Feature Extraction
Data Preparation
Encode the labels (diseased vs. healthy) into numerical format
Extract features (MFCC, spectrograms, etc.) from the audio signals
Training
Testing and Evaluation
Evaluate the model on unseen test data
Provide performance metrics

UML Diagram

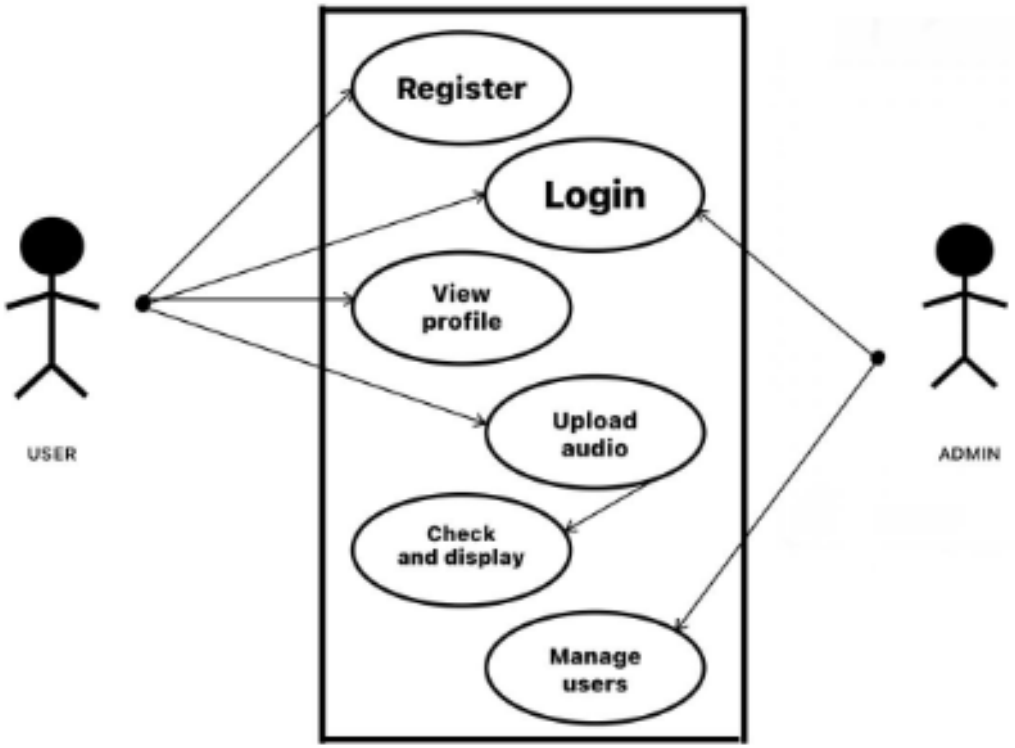


Figure: Use Case Diagram

Implementation - Tech Stack

Programming Language -
Python, used for machine learning, data processing, and backend development.

Backend Development -
Django (Python Framework) – Manages the web application and API for user interactions.

Machine Learning Data Processing -
Scikit-learn – Implements machine learning models (Random Forest, AdaBoost, Logistic Regression).

Librosa –
Extracts audio features (MFCCs, Spectrograms, Zero-Crossing Rate) for classification.

Tech Stack

NumPy Pandas –
Handles numerical computations and data management.

SQLite –
Manages structured data such as user uploads and metadata.

Frontend Development -
HTML, CSS, JavaScript, for building a user-friendly interface.

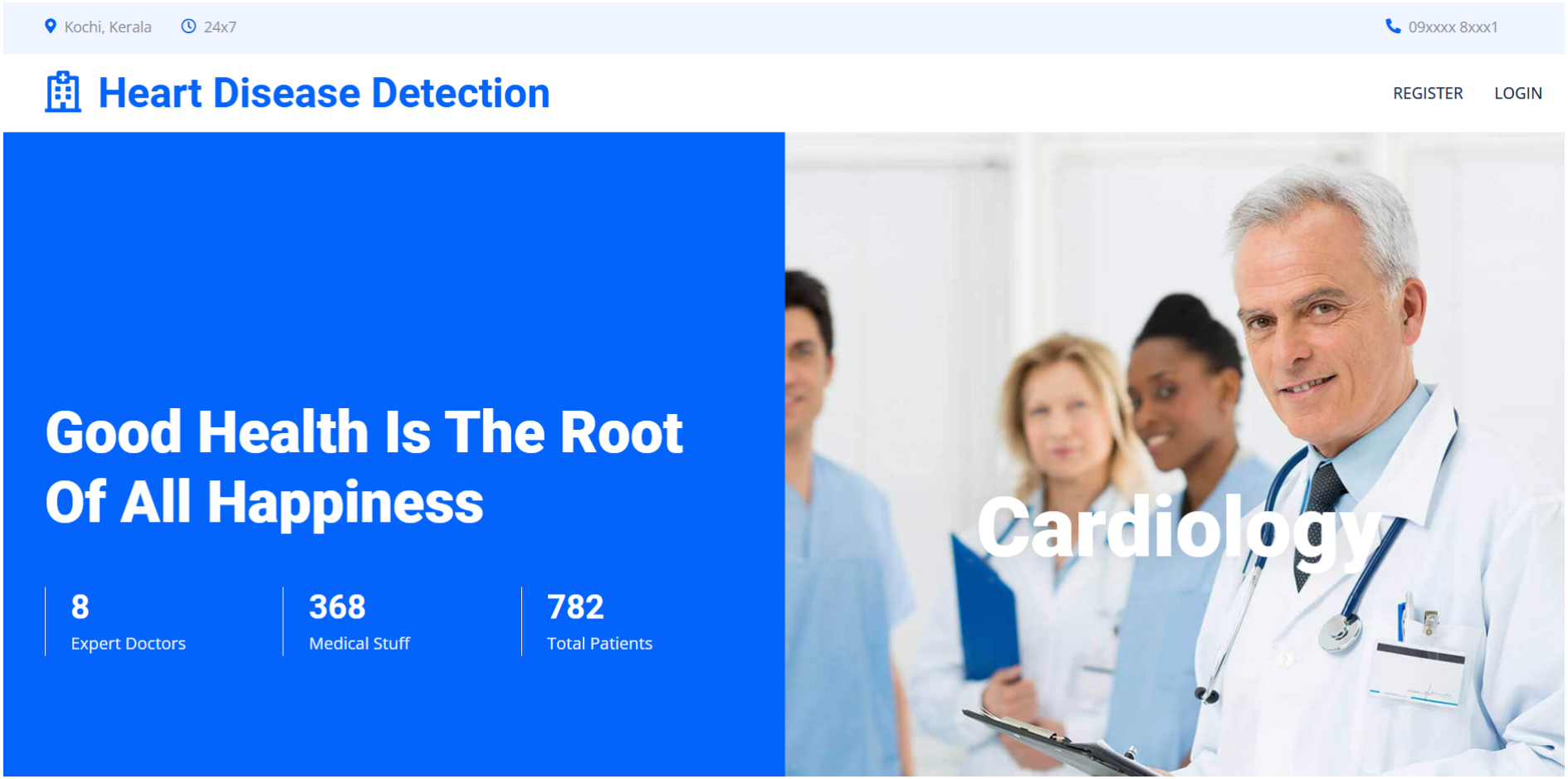
Result

Heart disease detection using audio signals is emerging as a promising alternative to traditional diagnostic methods. Compared to ECG and Holter monitors, which are highly accurate for detecting electrical abnormalities, audio-based detection offers a more accessible and cost-effective solution.

In contrast, AI-powered audio signal analysis enables early screening and continuous monitoring without the need for invasive procedures.

The current AI analysis technique has an 80% accuracy and future scope focuses on improving the accuracy and expanding availability.

Front End


Kochi, Kerala
24x7
09xxxx 8xxx1
Heart Disease Detection
REGISTER
LOGIN
Good Health Is The Root Of All Happiness
8
Expert Doctors
368
Medical Stuff
782
Total Patients
Cardiology

Conclusion

- During this stage of the project, significant progress has been made in developing the foundation for a heart disease prediction model using audio signals.
- The frontend design focuses on providing a user-friendly interface.
- Meanwhile, the backend development has successfully established a robust database structure, enabling efficient data storage and retrieval.

Bibliography

[1]Tschannen, M., Kramer, T., Marti, G., Heinzmann, M. Wiatowski, T. Heart sound classifcation using deep structured features. In 2016 Computing in Cardiology.

[2] Huang, J.-D. et al. Applying artifcial intelligence to wearable sensor data to diagnose and predict cardiovascular disease: A review. Sensors 22, 8002 (2022).

[3] A. Raza, A. Mehmood, S. Ullah, M. Ahmad, G. S. Choi, and B.-W. On, "Heartbeat Sound Signal Classification Using Deep Learning,"Sensors, vol. 19, no. 21, p. 4819,Nov. 2019,

[4] J.-D. Huang, J. Wang, E. Ramsey, G. Leavey, T. J. A. Chico, and J. Condell, "Applying Artificial Intelligence to Wearable Sensor Data to Diagnose and Predict Cardiovascular Disease: A Review,"Sensors, vol. 22, no. 20, p. 8002, Oct. 2022

[5]Md. Imam Hossain et al., "Heart disease prediction using distinct artificial intelligence techniques: performance analysis and comparison,"Jun. 2023

Contribution

- Abhijith.M: Implemented the backend development
- Alen V Thomas: Collected the data and done pre-processing
- Diya Chandra:Designed and implemented the frontend.
- Gopika Jayaram: Implemented the machine learning models

Thank you!