

Heart Sound Net: A Deep Learning Framework for Heart Disease Detection using CNN & RCNN

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Abstract- Heart disease detection plays a crucial role in the early diagnosis and management of cardiovascular diseases. In this study, we explore the application of audio-based methods to detect heart diseases using an audio dataset consisting of heart sounds. The dataset, sourced from Kaggle, contains labeled heart sound recordings categorized as either "Healthy" or "Unhealthy." The proposed approach leverages Convolutional Neural Networks (CNN) and Recurrent Convolutional Neural Networks (RCNN) for classification tasks.

For feature extraction, we utilize **Mel-frequency cepstral coefficients (MFCC)**, a widely used technique for capturing the spectral characteristics of heart sounds. Additionally, we enhance the dataset by introducing **noise augmentation, pitch shifting, Zero-Crossing Rate (ZCR), and Root Mean Square Error (RMSE)** to improve model robustness and generalization. The CNN and RCNN models are then trained to classify heart sounds into "Healthy" and "Unhealthy" categories.

By processing the audio signals and extracting these key features, our model achieves high classification accuracy, demonstrating the potential of audio-based methods for heart disease detection. This non-invasive and efficient approach can serve as a valuable tool in early-stage heart disease diagnosis, potentially reducing the need for more complex and costly diagnostic procedures.

1. INTRODUCTION

Heart diseases are one of the leading causes of mortality worldwide, and early detection plays a critical role in improving survival rates and reducing healthcare costs. Traditional diagnostic methods, although effective, are often expensive, invasive, and not always accessible, particularly in resource-constrained environments. The motivation behind this project is to leverage advanced machine learning techniques, particularly deep learning algorithms like CNN and RCNN, to automate the detection of heart diseases from audio signals.

2. SYSTEM ANALYSIS

Existing System:

Existing systems for heart disease detection primarily rely on traditional diagnostic methods such as Electrocardiograms (ECGs) and echocardiograms, which, while effective, are expensive, invasive, and require specialized equipment. In recent years, machine learning (ML) algorithms, particularly Support Vector Machines (SVM) and Random Forests, have been used for heart disease classification based on features like ECG signals and clinical data. However, these methods still often depend on structured data and do not fully utilize the potential of audio data. Moreover, many systems lack scalability and accessibility, making them less suitable for widespread, real-time applications in resource-limited environments.

Limitations of Existing Systems:

Costly and Invasive: Traditional methods like ECGs and echocardiograms are expensive, require specialized equipment, and often involve invasive procedures, limiting accessibility, especially in resource-constrained settings.

Limited Accessibility: These diagnostic methods are typically available only in healthcare facilities with advanced infrastructure, making it difficult to conduct early screenings in remote or rural areas.

Complexity and Time-Consuming: The existing systems often require trained personnel for interpreting the results, adding complexity and time delays to the diagnostic process.

Limited Use of Audio Signals: Existing methods largely ignore the potential of heart sound recordings, which can provide rich diagnostic information in a non-invasive, cost-effective manner.

3. PROPOSED SYSTEM

The proposed system aims to detect heart diseases using **audio-based heart sound recordings**, leveraging

advanced machine learning algorithms like **Convolutional Neural Networks (CNN)** and **Recurrent Convolutional Neural Networks (RCNN)**. By extracting features such as **Mel-frequency cepstral coefficients (MFCC)**, **Zero-Crossing Rate (ZCR)**, **Root Mean Square Error (RMSE)**, and applying techniques like **pitch shifting** and **noise augmentation**, the system classifies heart sounds into "Healthy" or "Unhealthy" categories. This non-invasive, cost-effective approach offers real-time, scalable detection of heart conditions, making it suitable for both clinical and remote healthcare applications.

3.1 Advantages of proposed system

Non-Invasive and Cost-Effective: The system uses heart sound recordings, which are easily captured without the need for expensive or invasive procedures, making it more affordable and accessible

.Real-Time Detection: The system provides real-time heart disease classification, enabling timely interventions and early diagnosis.

.Scalability: It can be easily deployed in remote or resource-limited settings, reducing the dependency on specialized infrastructure

.Accurate Classification: By leveraging advanced feature extraction techniques like MFCC, ZCR, and RMSE, and deep learning algorithms (CNN, RCNN), the system enhances diagnostic accuracy.

.Ease of Use: It eliminates the need for specialized personnel to interpret results, allowing for user-friendly operation by healthcare providers and patients.

.Continuous Monitoring: The system can facilitate continuous heart health monitoring, improving long-term health management and early disease detection.

.Versatility: It can be integrated with mobile health applications, making it accessible for personal use and expanding its reach to wider population.

Diagram 1: System Architecture

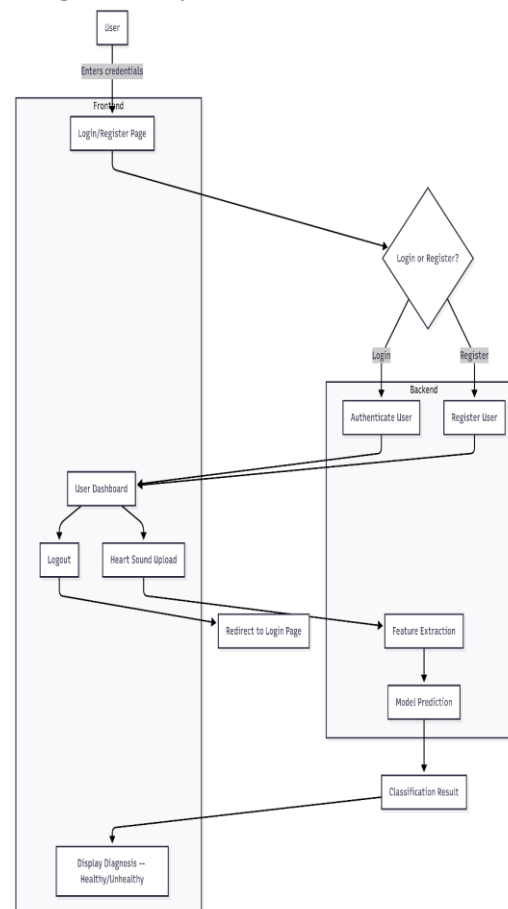


Fig -1: Figure

4. CONCLUSION

The RCNN model demonstrates **high accuracy (94%)** in classifying heart sounds as Healthy or Unhealthy, proving its effectiveness as a diagnostic aid. With **97% precision and 96% recall for Healthy cases**, the model excels at correctly identifying normal heart sounds while minimizing false positives. For Unhealthy cases, it maintains strong performance (**88% precision, 90% recall**), though there is slight room for improvement in reducing misclassifications. The balanced **F1-scores (0.96 for Healthy, 0.89 for Unhealthy)** indicate reliable performance across both classes, with the **weighted average (0.94 F1-score)** confirming consistency despite class imbalance (more Healthy samples).

FUTURE SCOPE

To further improve the model's diagnostic capabilities and clinical applicability, the following enhancements can be explored:

- Multi-Class Classification
- Handling Class Imbalance
- Real-Time Processing

- Explainable AI (XAI)
- Federated Learning
- Noise-Robust
- Longitudinal Analysis

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BIOGRAPHY



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