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INTELLIGENTHEARTATTACKRISKASSESSMENT ANDHEARTDISEASEDETECTIONFROMRETINAL FUNDUS IMAGES USING AI AND DEEP LEARNING

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ABSTRACT

This paper presents an intelligent healthcare system for early heart attack risk assessment and heart disease detection using retinal fundus images and artificial intelligence techniques. The proposed system integrates deep learning, computer vision, and machine learning to improve prediction accuracy. Retinal fundus images are used as a non-invasive diagnostic source, where vascular patterns are analyzed using convolutional neural networks and Efficient Net to extract meaningful features related to cardiovascular conditions.

A machine learning layer further enhances prediction by incorporating clinical parameters such as age, blood pressure, and cholesterol levels. The system also includes a generative AI-based doctor module that provides personalized explanations and preventive suggestions, improving user understanding and engagement. Additionally, an emergency alert system is integrated to notify high-risk conditions for timely intervention.

The proposed framework combines image analysis, structured data processing, and intelligent assistance to deliver a scalable and efficient solution for early cardiovascular disease detection, contributing to improved healthcare outcomes

KEYWORDS: Heart Disease Detection, Retinal Fundus Imaging, Deep Learning, EfficientNet, MachineLearning, Risk Assessment

INTRODUCTION

Cardiovascular diseases are one of the leading causes of death worldwide, making early detection and risk assessment extremely important. Recent advancements in artificial intelligence have enabled the development of intelligent healthcare systems that can predict diseases at an early stage. The proposed system focuses on detecting heart disease using retinal fundus images. The retina provides a non-invasive way to observe blood vessels, and changes in these vessels can indicate cardiovascular abnormalities. This system uses deep learning models such as convolutional neural networks and Efficient Net to analyze retinal images and extract important features. These features are then combined with clinical data and processed using machine learning algorithms to predict heart disease risk. Additionally, the system includes a generative AI-based doctor module that explains results and provides preventive suggestions. An emergency alert mechanism is also included to ensure immediate action in high-risk cases.

MATERIALS AND METHODS:

The proposed system utilizes retinal fundus images as the primary data source, along with optional clinical parameters such as age, blood pressure, cholesterol levels, and lifestyle-related factors to improve prediction accuracy and provide a more comprehensive cardiovascular

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risk assessment. The collected images undergo preprocessing steps including resizing, normalization, contrast enhancement, and noise removal, which enhance image quality and improve the visibility of retinal blood vessels and other critical features. Feature extraction is carried out using advanced deep learning models such as Convolutional Neural Networks (CNN)and Efficient Net, which automatically learn and identify important patterns including vessel thickness, branching structures, and microvascular abnormalities associated with heart disease. The extracted features are then fed into machine learning classifiers such as Random Forest and Logistic Regression, which analyze the patterns and predict the likelihood of cardiovascular disease. Based on these predictions, the system categorizes individuals into low, medium, or high-risk groups, enabling effective prioritization and early intervention. Furthermore, an integrated generative AI module acts as a virtual doctor, providing personalized explanations, preventive recommendations, and lifestyle guidance tailored to the user's condition, thereby enhancing user understanding and engagement. In high-risk cases, the system activates an emergency response mechanism that generates alerts and notifies predefined emergency contacts to ensure timely medical assistance.

RESULTS

The proposed system achieved strong performance in heart disease prediction, demonstrating high effectiveness across multiple evaluation metrics. It attained an accuracy of 92.4%, along with an AUC-ROC score of 96.3%, indicating excellent discriminative capability. The model achieved a sensitivity of 93.5%, reflecting its ability to correctly identify high-risk patients, and a specificity of91.2%, showing reliable performance in correctly identifying low-risk cases. Furthermore, the model demonstrated good generalization across different datasets, highlighting its robustness and practical applicability. Visualization techniques, such as heat maps, further validated the model's decision-making process by confirming that it focuses on clinically relevant retinal regions.

DISCUSSION

The results demonstrate that combining retinal image analysis with clinical data significantly improves prediction accuracy compared to conventional approaches. The proposed model outperforms widely used architectures such as ResNet-50 and VGG16, while Efficient Net enhances feature extraction efficiency, contributing to improved overall performance. Furthermore, the hybrid approach, which integrates deep learning with traditional machine learning techniques, increases the robustness and reliability of the system. The inclusion of an AI-based explanation module also improves usability by providing interpretable insights and personalized recommendations, making the system more suitable for real-world healthcare applications. However, certain challenges remain, including variability in datasets, the need for large-scale validation to ensure generalizability, and difficulties associated with deployment in real clinical environments

CONCLUSIONS

The proposed system provides an efficient and intelligent solution for early heart disease detection using retinal images. By integrating deep learning, machine learning, and generative AI techniques, it significantly improves prediction accuracy, enhances interpretability through meaningful explanations, and enables early intervention for at-risk individuals. Owing to its ability to deliver reliable and accessible insights, the system demonstrates strong potential for real-world healthcare applications, particularly in resource-limited settings where advanced diagnostic facilities may be limited.

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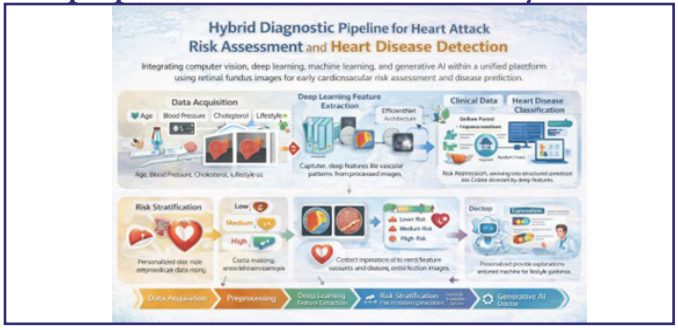
Tables and figures:

SYSTEM ARCHITECTURE

Fig.1: System architecture and workflow of the proposed heart disease detection system.



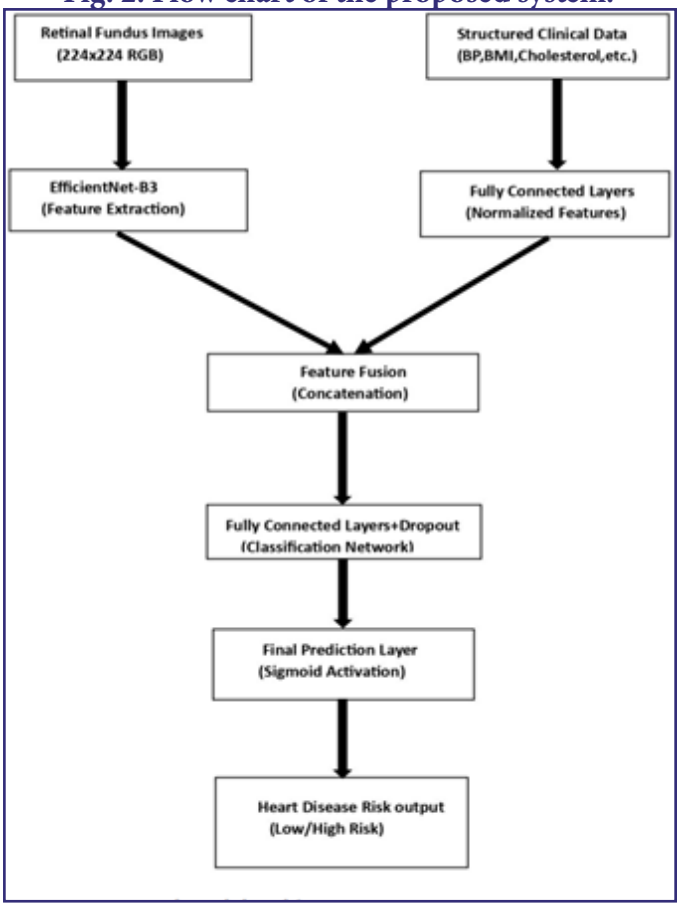
The system architecture consists of a multi-stage pipeline that integrates retinal image processing, deep learning, and machine learning for heart disease prediction. Initially, retinal fundus images and clinical data are collected as input. The images undergo preprocessing steps such as resizing, normalization, and contrast enhancement to improve quality.

The processed images are then passed through a deep learning model (CNN with Efficient Net) for feature extraction, where important vascular patterns are identified. These extracted features are combined with clinical parameters and fed into a machine learning classifier such as Random Forest or Logistic Regression.

The final output provides heart disease prediction along with risk levels (low, medium, high). Additionally, a generative AI module provides explanations, and an emergency alert system is triggered in high-risk cases

FLOWCHART

Fig. 2: Flow chart of the proposed system.



The flow of the system begins with data acquisition, where retinal fundus images and optional clinical data are collected. The input data is then preprocessed using normalization and enhancement techniques to improve image quality.

Next, the preprocessed images are passed to the deep learning model (CNN and Efficient Net) for feature extraction. The extracted features are combined with clinical data and processed using machine learning algorithms for classification.

The system then predicts the presence of heart disease and categorizes the risk level. Based on the prediction, the generative AI module provides recommendations, and in high-risk cases, an emergency alert is generated.

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