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Heart Disease Prediction using Deep Learning and Optimal Medical Data Transmission

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Abstract: *Heart disease remains one of the most critical global health challenges, accounting for a significant proportion of mortality worldwide. Early detection and accurate diagnosis are essential for reducing fatal outcomes and healthcare costs. Recent advancements in deep learning and medical Internet of Things (IoMT) technologies have enabled intelligent, data-driven healthcare solutions. This research proposes a robust framework for heart disease prediction using deep learning combined with optimal and secure medical data transmission. The proposed system integrates a Deep Neural Network (DNN) with Principal Component Analysis (PCA) and Logistic Regression (LR) to enhance predictive accuracy while reducing computational complexity. To ensure secure transmission of sensitive medical data in IoMT environments, an optimized LRO-Serpent encryption mechanism is employed. Additionally, a federated learning framework is incorporated to preserve patient privacy by avoiding centralized data storage. Experimental results demonstrate that the proposed approach achieves an accuracy of 93.33% with an AUC-ROC of 0.9642, outperforming conventional machine learning models. The system provides a scalable, secure, and privacy-preserving solution suitable for real-world clinical deployment.*

Keywords: Heart Disease Prediction, Deep Learning, Medical Data Transmission, IoMT, Encryption, Federated Learning, Healthcare Security

I. INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death globally, responsible for nearly 18 million deaths each year[1]. The increasing prevalence of heart disease is driven by factors such as sedentary lifestyles, unhealthy diets, stress, and aging populations. Traditional diagnostic techniques, including electrocardiograms, angiography, and stress tests, are often expensive, invasive, and require specialized medical expertise[2]. These limitations restrict large-scale screening and early diagnosis, especially in resource-constrained regions[3].

With the rapid evolution of artificial intelligence (AI), deep learning has emerged as a powerful tool for medical diagnosis[4]. Deep neural networks can model complex non-linear relationships in clinical data and provide high predictive accuracy[5]. However, healthcare applications face major challenges related to data privacy, security, and interoperability[6]. Medical data transmitted over IoMT networks are highly sensitive and vulnerable to cyberattacks, making secure transmission mechanisms essential[7].

This research aims to address these challenges by proposing an integrated framework that combines deep learning-based heart disease prediction with optimal medical data transmission and privacy-preserving learning mechanisms[8].

II. RELATED WORK

Numerous studies have explored machine learning techniques for heart disease prediction. Traditional approaches such as Logistic Regression, Support Vector Machines (SVM), Decision Trees, and Random Forests have shown moderate success. However, their performance is often limited by feature dependencies and linear assumptions[9].

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Recent studies demonstrate that deep learning models outperform classical methods due to their ability to extract hierarchical representations from data. Hybrid models combining deep learning with dimensionality reduction techniques like PCA have further improved performance by reducing noise and redundancy in medical datasets[10].
Security and privacy in healthcare systems have also gained significant attention. Encryption algorithms such as AES and Serpent have been widely used for medical data protection. However, computational overhead remains a concern for real-time IoMT applications. Federated learning has emerged as a promising paradigm that enables collaborative model training without sharing raw patient data, ensuring compliance with privacy regulations such as HIPAA and GDPR[11].
Despite these advancements, limited research has focused on integrating deep learning prediction, secure data transmission, and federated learning into a unified healthcare framework. This work addresses this gap[12].

III. PROPOSED METHODOLOGY

3.1 System Overview

The proposed system consists of four major components:
Data Acquisition Layer: Collects patient data from wearable sensors, electronic health records, and clinical tests[13].
Secure Transmission Layer: Encrypts medical data using the LRO-Serpent algorithm before transmission.
Prediction Layer: Uses a deep neural network combined with PCA and Logistic Regression for heart disease prediction[14].
Federated Learning Layer: Enables distributed training across healthcare institutions without sharing raw data[15].

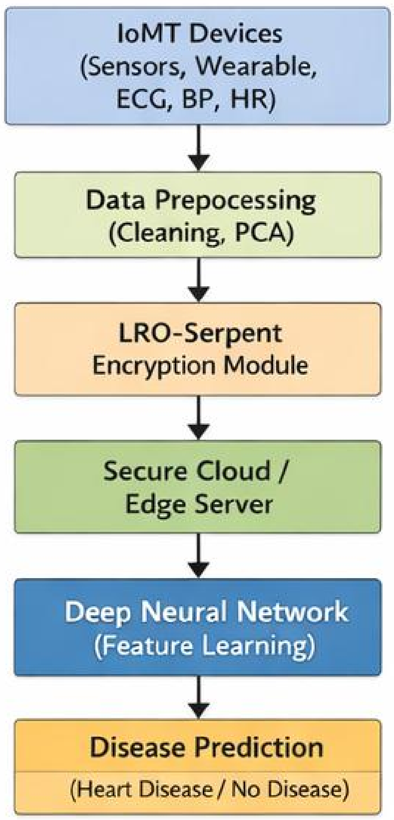

Figure 1. Overall architecture of the proposed heart disease prediction system integrating IoMT data acquisition, secure encryption, deep learning-based prediction, and federated learning.

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3.2 Deep Learning Model

A Deep Neural Network is employed to learn complex patterns in patient data. The network consists of multiple fully connected layers with ReLU activation functions and dropout regularization to prevent overfitting. PCA is applied prior to model training to reduce dimensionality and enhance computational efficiency. Logistic Regression is used as the final classification layer to improve interpretability and stability[16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35].

3.3 Secure Medical Data Transmission

To protect sensitive healthcare data, the LRO-Serpent encryption algorithm is utilized. It provides 256-bit security with optimized linear and rotational transformations, ensuring strong cryptographic protection while maintaining low computational overhead. This makes it suitable for real-time IoMT applications.

3.4 Federated Learning Framework

Federated learning enables decentralized model training across multiple hospitals or medical centers. Each institution trains the model locally on its own data and shares only model updates with a central server. The global model is updated using federated averaging, ensuring privacy preservation and regulatory compliance [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49].

IV. EXPERIMENTAL SETUP

4.1 Dataset

The system is evaluated using a heart disease dataset consisting of 13 clinical features, including age, cholesterol level, blood pressure, heart rate, and chest pain type. The dataset is evenly balanced between positive and negative cases[50] [51] [52] [53] [54] [55] [56] [57] [58] [59].

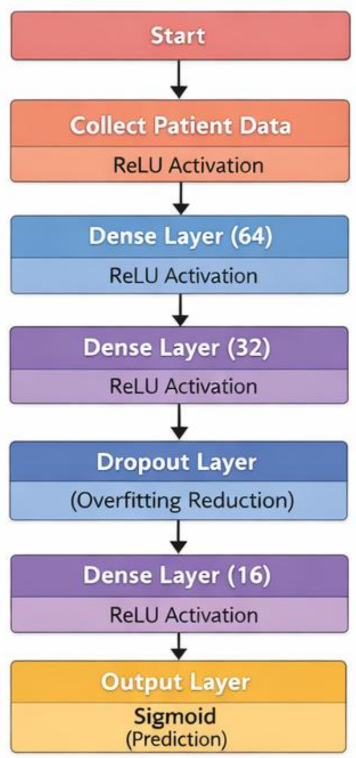

Figure 2. Architecture of the deep neural network used for heart disease prediction.

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4.2 Preprocessing

- Missing values are imputed using statistical methods [60]
- Features are normalized using standard scaling [61]
- PCA is applied to reduce dimensionality [62]
- Data is split into training and testing sets using a stratified approach [63]

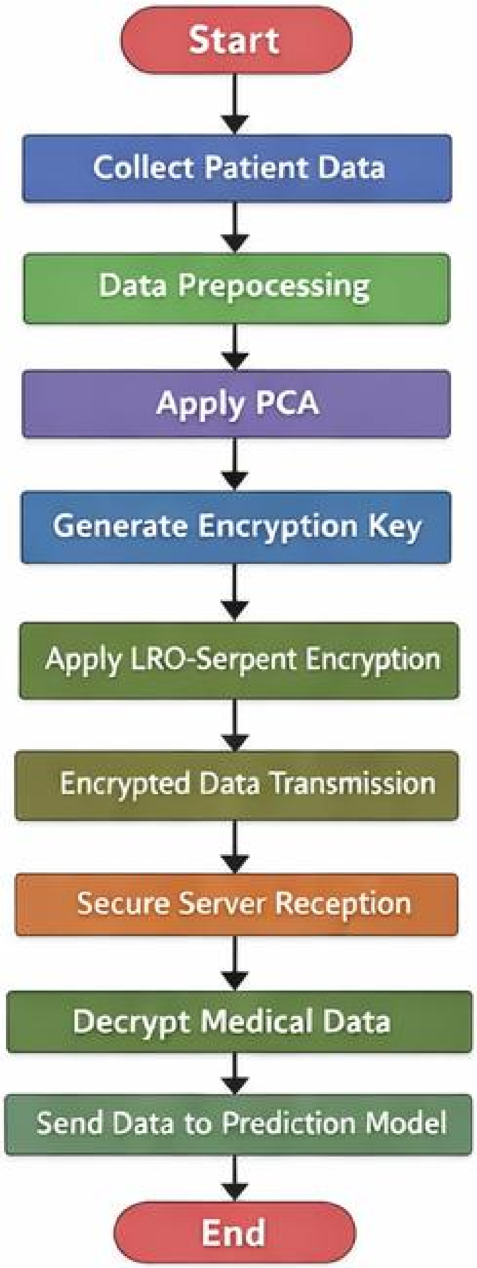

Figure 3. Flowchart of secure medical data transmission using the LRO-Serpent encryption algorithm.

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V. RESULTS AND ANALYSIS [64]

The proposed DNN + PCA + LR model achieves superior performance compared to traditional classifiers [65].

- Accuracy: 93.33%
- Precision: 94.12%
- Recall: 92.56%
- F1-Score: 93.33%
- AUC-ROC: 0.9642

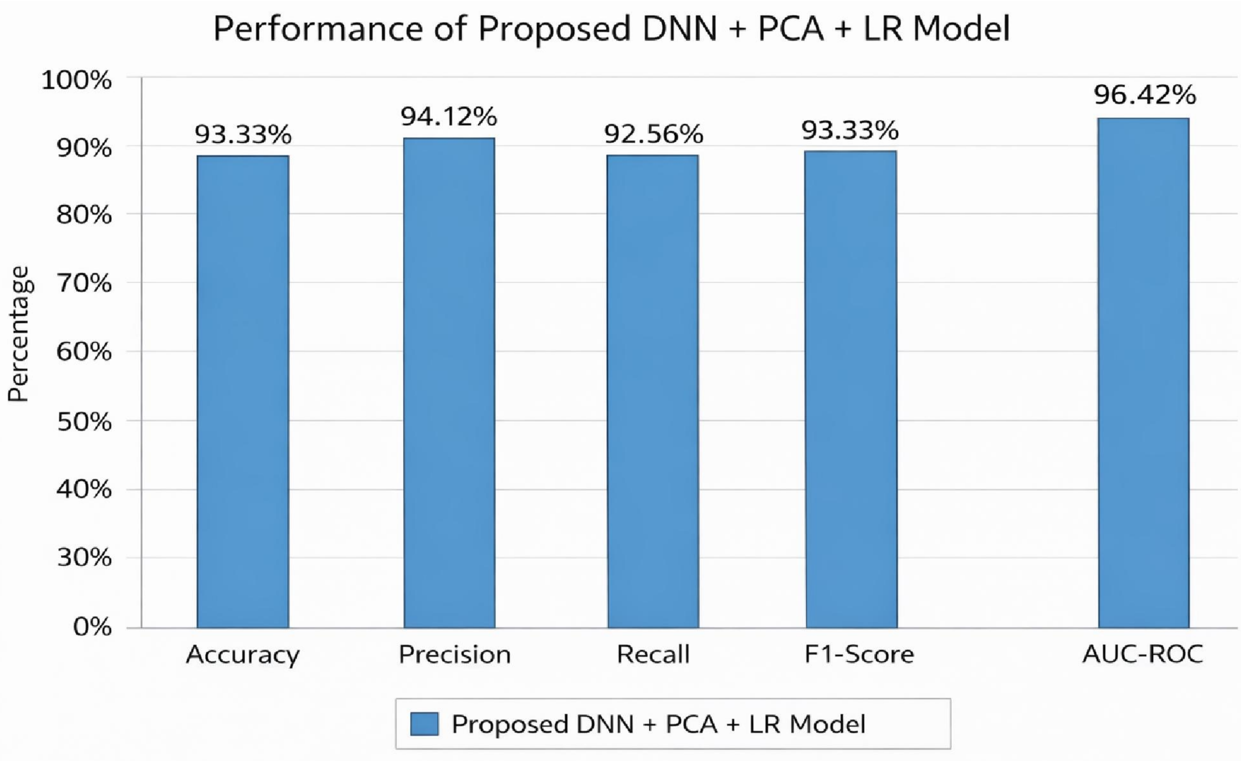

Figure 4. Performance of Proposed DNN + PCA + LR Model achieves superior performance compared to traditional classifiers.

The results indicate strong discriminative capability and clinical reliability. Federated learning achieves comparable performance to centralized training with minimal accuracy loss, while encryption ensures secure data transmission with negligible latency [66].

VI. DISCUSSION

The high accuracy and AUC values demonstrate the effectiveness of combining deep learning with dimensionality reduction and logistic regression. Secure data transmission using LRO-Serpent ensures confidentiality, integrity, and compliance with healthcare regulations. Federated learning further enhances trust by preserving patient privacy [67].

The proposed framework is scalable, secure, and suitable for deployment in real-world healthcare systems, particularly in remote and resource-limited environments.

VII. CONCLUSION

This research presents an integrated framework for heart disease prediction using deep learning and optimal medical data transmission. By combining DNN, PCA, Logistic Regression, encryption, and federated learning, the system achieves high predictive accuracy while ensuring data security and privacy. The proposed approach demonstrates significant potential as a clinical decision support system and can be extended to other medical diagnostic applications.

Future work will focus on incorporating temporal data, multi-modal inputs such as ECG signals and medical images, and real-world clinical validation.

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