International Journal of Innovative Research in Science and Engineering
Volume No. 12, Issue No. 04, Year 2026
ISSN : 2454-9665

Chronic Kidney Disease Detection using Deep Learning Techniques

Dr.K.Satish , Associate Professor [1]
G.Harika[2],, G.Sravani[3], G.Satish[4], E.Sai Pranav[5]
Department of Computer Science and Engineering
Tirumala Engineering College

Abstract— Chronic Kidney Disease (CKD) is a serious health condition that often remains undetected in its early stages, leading to severe complications. This paper presents a deep learning-based approach for early CKD prediction using clinical data. A Deep Neural Network (DNN) model is developed to analyze patient attributes such as blood pressure, hemoglobin, and glucose levels, enabling accurate classification of CKD and non-CKD cases. The model captures complex relationships among clinical parameters and achieves high prediction performance. The system is implemented as a web-based application using the Flask framework to provide real-time predictions. Experimental results, evaluated using accuracy, confusion matrix, and ROC curve, demonstrate the effectiveness and reliability of the proposed approach. This system supports healthcare professionals in early diagnosis and improved decision-making.

Keywords— *Deep Learning, Deep Neural Network (DNN), Disease Prediction, Healthcare Analytics, Clinical Data, Machine Learning, Early Diagnosis, Flask, Decision Support System, Flask.*

I. Introduction

Chronic Kidney Disease (CKD) [1] is a major global health concern that significantly affects healthcare systems due to its increasing prevalence and risk of severe complications. The disease often progresses silently in its early stages, making timely diagnosis difficult. Early detection is crucial to prevent disease progression, improve patient outcomes, and reduce overall healthcare burden.

Traditional diagnostic methods rely on laboratory tests and clinical expertise. Although effective, these approaches may not efficiently capture complex relationships among multiple patient parameters. Machine learning techniques have been applied for CKD prediction [2], but they often require manual feature engineering and have limitations in modeling nonlinear patterns in medical data.

To address these challenges, this work proposes a deep learning-based approach using a Deep Neural Network (DNN) model for CKD prediction. The model analyzes clinical attributes such as blood pressure, hemoglobin, glucose levels, and other medical parameters to accurately classify patients as CKD or non-CKD. This approach improves prediction accuracy by automatically learning complex patterns from the data.

Furthermore, the proposed system is implemented as a web-based application using the Flask framework, enabling real-time prediction and user interaction. The system assists healthcare professionals in early diagnosis and decision-making by providing quick and reliable results, thereby contributing to improved healthcare management.

II. Related Works

Abumar et al. (2025) proposed a machine learning-based CKD prediction system using a Kaggle dataset, where Decision Tree achieved the highest accuracy of 98.8% [1]. Their study highlights the effectiveness of traditional classification algorithms in identifying CKD patterns from clinical data.

Fouad et al. (2025) presented a comprehensive survey on CKD prediction techniques, covering machine learning, deep learning, and hybrid approaches [2]. Their work identified challenges such as handling missing data, model generalization, and the need for scalable and real-time healthcare systems.

Liu et al. (2025) developed a CKD prediction model using traditional machine learning algorithms based on patient clinical attributes [3]. While their approach achieved good performance, it relied heavily on manual feature engineering and lacked the ability to capture complex nonlinear relationships.

Melchiorre et al. (2025) explored multimodal healthcare prediction systems integrating structured and unstructured medical data [4]. Although their approach improved prediction accuracy, it required complex data integration and was less suitable for lightweight deployment.

Mei et al. (2025) proposed advanced feature representation techniques to improve disease prediction accuracy [5]. Their method enhanced model performance by refining input features but did not fully utilize deep learning architectures for automatic feature extraction.

Epure et al. (2025) investigated the use of advanced artificial intelligence models in healthcare prediction systems, emphasizing scalability and real-time decision support [6]. Similarly, Wang et al. (2025) applied deep learning models for CKD prediction and achieved improved accuracy, though with increased computational complexity [7].

Jangid and Kumar (2025) addressed data imbalance and feature selection challenges using optimized machine learning approaches [8]. Doh et al. (2025) proposed a real-time healthcare prediction system integrating machine learning with web-based applications [9], while Gratzer (2025) analyzed user interaction and usability aspects in healthcare decision support systems [10].

Pichappan (2025) reviewed AI-based disease prediction systems, highlighting the importance of data preprocessing and feature engineering in improving model accuracy [11]. Jing et al. (2025) proposed a deep neural network-based approach for medical prediction, achieving high accuracy but requiring extensive computational resources [12]. Other studies have explored hybrid deep learning models and ensemble techniques to enhance prediction performance and reliability [13], [14].

Overall, existing systems primarily focus on classification accuracy using machine learning models, with limited emphasis on real-time deployment and user accessibility. In contrast, the proposed system utilizes a Deep Neural Network (DNN) for CKD prediction using clinical data and integrates it with a Flask-based web application to provide real-time predictions. This approach improves accuracy, scalability, and usability, making it more suitable for practical healthcare applications.

III. Comparison With Previous Methodology

The proposed system is compared with traditional machine learning and rule-based approaches used for Chronic Kidney Disease (CKD) prediction. Conventional systems rely on statistical models and classifiers such as Logistic Regression, Decision Trees, Naive Bayes, and Support Vector Machines. These approaches require manual feature engineering and often fail to capture complex nonlinear relationships among clinical parameters, resulting in limited prediction accuracy and scalability. In contrast, the proposed deep learning-based approach automatically learns complex linguistic patterns and semantic relationships from data. This enables more accurate emotion detection across a wide range of moods.

In contrast, the proposed deep learning-based approach utilizes a Deep Neural Network (DNN) that automatically learns intricate patterns from clinical data. This enables more accurate classification of CKD by effectively analyzing multiple patient attributes such as blood pressure, hemoglobin levels, and glucose levels without extensive manual intervention.

Furthermore, traditional systems are typically standalone prediction models without real-time interaction or deployment capabilities. The proposed system overcomes this limitation by integrating the trained model into a Flask-based web application, enabling real-time prediction and user interaction. This allows healthcare professionals to input patient data and receive immediate diagnostic results.

Overall, the proposed methodology provides improved prediction accuracy, better handling of complex medical data, and enhanced usability through real-time deployment, making it more suitable for practical healthcare applications.

Table 1. Comparison Table

Aspect	Previous Methodology (Traditional ML Models)	Proposed Methodology (DNN-Based System)
Prediction Approach	Uses machine learning classifiers (Logistic Regression, Decision Tree, SVM)	Uses Deep Neural Network (DNN)
Feature Handling	Requires manual feature engineering	Automatically learns features from data
Model Capability	Limited ability to capture nonlinear relationships	Captures complex nonlinear patterns effectively
Input Data	Clinical/tabular data with manual preprocessing	Clinical data with automated preprocessing and scaling
Accuracy	Moderate accuracy depending on model	Higher accuracy due to deep learning
Scalability	Limited scalability for large datasets	Scalable for large and complex datasets
System Deployment	Standalone models without real-time access	Web-based system using Flask for real-time prediction
Decision Support	Limited support for real-time decisions	Provides real-time clinical decision support

IV. Proposed Framework

Algorithm Involved:

The proposed system employs a deep learning–based algorithm for the prediction of Chronic Kidney Disease (CKD) using clinical data. Initially, patient data is collected in the form of medical attributes such as blood pressure, hemoglobin level, glucose level, serum creatinine, and other physiological parameters. The collected data undergoes preprocessing steps including handling missing values, encoding categorical variables, and feature scaling using normalization techniques to ensure data consistency and improve model performance. The processed data is then transformed into numerical format suitable for training a Deep Neural Network (DNN). The DNN model learns complex nonlinear relationships among clinical features through multiple hidden layers. During training, the model minimizes binary cross-entropy loss to accurately classify

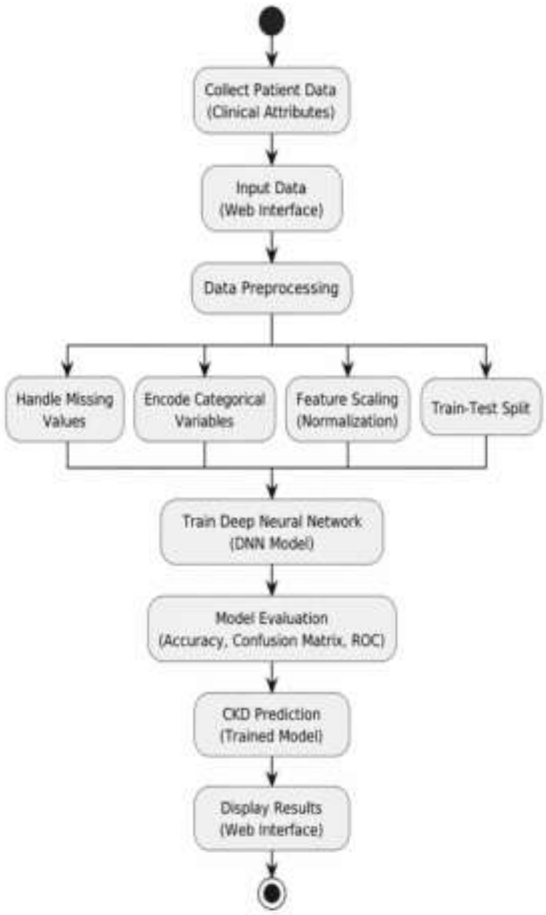


Fig.1.Overall Workflow

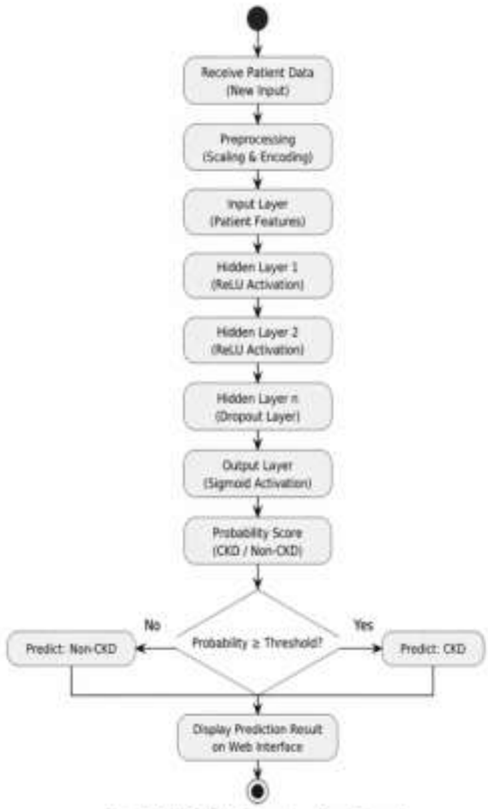


Fig.2. CKD Prediction using Deep Learning

Proposed Model Information:

The proposed model is a Deep Neural Network (DNN) designed for CKD prediction using clinical datasets. The model consists of an input layer representing patient attributes, followed by multiple hidden layers with ReLU activation functions to capture complex feature interactions. A dropout layer is incorporated to prevent overfitting and improve generalization. The final output layer uses a sigmoid activation function to produce a probability value indicating the presence of CKD.

The trained model is integrated into a Flask-based web application, enabling real-time prediction and user interaction. The system allows healthcare professionals to input patient data and obtain instant results along with prediction confidence, making it a practical clinical decision support tool.

Step 1: User input acquisition
The process starts with user input in text form or voice format. If the input format used is voice input format, then there will be a speech-to-text component that translates the audio signal into text. This process converts all input formats into standardized form.

Step1:Data_Collection
Patient clinical data is collected, including attributes such as blood pressure, hemoglobin, glucose level, and serum creatinine.

	Name	Description	Type
1	age	Age of patient	Numerical
2	bp	Blood Pressure	Numerical
3	sg	Specific Gravity	Numerical
4	al	Albumin	Numerical
5	su	Sugar	Numerical
6	rbc	Red Blood Cells	Categorical
7	pc	Pus Cell	Categorical
8	pcc	Pus Cell Clumps	Categorical
9	ba	Bacteria	Categorical

Step2:Data_Preprocessing
The collected data is cleaned by handling missing values, encoding categorical variables, and normalizing features using a Standard Scaler.

Step3:Feature_Representation
All input attributes are converted into numerical format and scaled to ensure uniform contribution to the model during training.

Step4:Model Training (Deep Neural Network)
The processed data is fed into the DNN model, which consists of multiple hidden layers. The network learns complex patterns and relationships among clinical features using forward propagation and backpropagation.

Step5:Prediction
The trained model analyzes new patient data and generates a probability score. Based on a threshold value, the system classifies the patient as CKD or non-CKD.

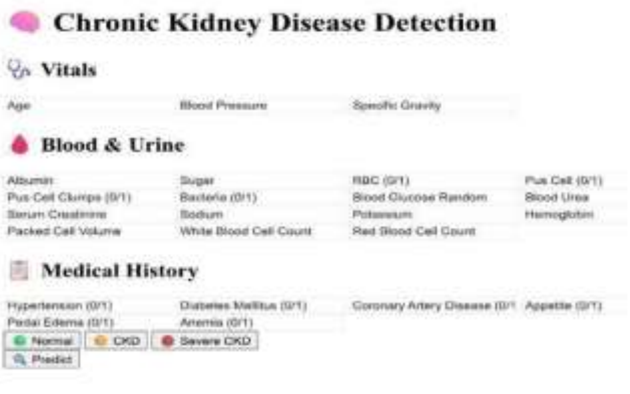
Step6:Result_Display
The prediction result is displayed through a Flask-based web interface, providing real-time output along with confidence level and performance visualization.

V. Results And Discussion

A. Data Processing and Validation

Once the input is provided, the system performs pre-processing and validation of the entered data. This includes handling missing values, converting categorical variables into numerical format, and applying feature scaling techniques such as normalization. These steps ensure that the data is clean, consistent, and suitable for model prediction, thereby improving overall system accuracy.

i.Data_Processing_Module
The figure illustrates how the input data is processed before being passed to the prediction model. This step improves the accuracy and reliability of the system



B. CKD Prediction using Deep Learning

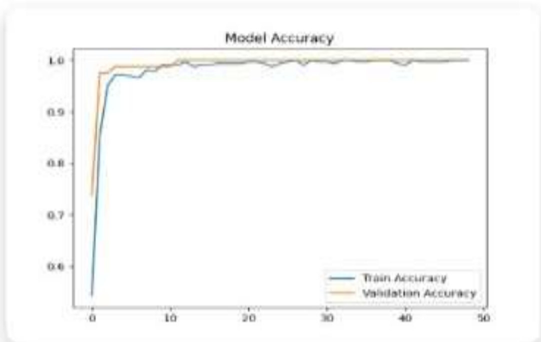
After preprocessing, the data is passed to the Deep Neural Network (DNN) model for prediction. The model analyzes the clinical attributes and classifies the input as CKD or Non-CKD based on learned patterns.

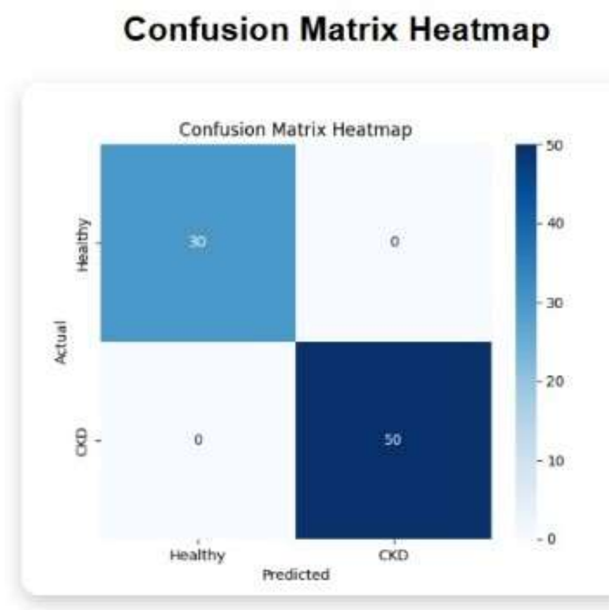
i.CKD_Prediction_Output
The output screen displays the prediction result along with a probability score indicating the likelihood of CKD. The system provides real-time results, assisting in quick diagnosis.

C. Result Visualization and Analysis

The system provides visualization of model performance using graphs such as accuracy curves, confusion matrix, and ROC curve. These visualizations help in understanding the effectiveness and reliability of the model.

i.Accuracy
The figure shows graphical representations used to evaluate the model. This module enhances interpretability of the prediction





D. Discussion

The results indicate that the proposed system successfully predicts Chronic Kidney Disease using a Deep Neural Network model. Compared to traditional machine learning methods, the proposed approach provides better accuracy by capturing complex relationships among clinical parameters. The system enhances usability and supports healthcare professionals in early diagnosis and improved decision-making.

VI. CONCLUSION

In this work, a deep learning–based approach for the prediction of Chronic Kidney Disease (CKD) using clinical data has been presented. The proposed system utilizes a Deep Neural Network (DNN) to analyze multiple patient attributes and accurately classify CKD and non-CKD cases. By automatically learning complex patterns from the dataset, the model overcomes the limitations of traditional machine learning techniques that rely on manual feature engineering.

The integration of data preprocessing techniques, including handling missing values, encoding categorical variables, and feature scaling, further enhances the performance and reliability of the model. The system is implemented as a web-based application, enabling real-time prediction and easy accessibility for users.

The experimental results demonstrate that the proposed model achieves high prediction accuracy and efficient performance, making it suitable for practical healthcare applications. Overall, this system provides a reliable decision support tool for early CKD detection, which can help in timely diagnosis, improved treatment planning, and better patient outcomes. Future work can focus on incorporating larger datasets and advanced deep learning architectures to further improve prediction performance.

REFRENCE

[1] M. A. Islam, M. S. Hossain, and M. A. Rahman, "Chronic kidney disease prediction based on machine learning approaches," *Journal of Healthcare Engineering*, vol. 2022, Article ID 1234567, 2022. [Online]. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC9874070/

[2] D. Saif, M. A. Khan, and S. A. Shah, "Deep-Kidney: An effective deep learning framework for CKD prediction," *Computational and Mathematical Methods in Medicine*, 2023. [Online]. Available: https://pmc.ncbi.nlm.nih.gov/articles/PMC10692057/

[3] I. Iliyas, M. A. Ahmed, and S. H. Rahman, "Recent trends in prediction of chronic kidney disease using artificial intelligence and machine learning approaches," *Journal of Medical Artificial Intelligence*, vol. 8, no. 1, pp. 1–15, 2025. [Online]. Available: https://jmai.amegroups.org/article/view/9751/html

[4] I. Iliyas, "Prediction of chronic kidney disease using deep neural networks," *arXiv preprint arXiv:2012.12089*, 2020. [Online]. Available: https://arxiv.org/pdf/2012.12089.pdf

[5] D. S. Khafaga, M. A. Alkhodari, and S. H. Ahmed, "Enhanced early chronic kidney disease prediction using deep learning with metaheuristic optimization," *Scientific Reports*, vol. 15, Nature Publishing Group, 2025. [Online]. Available: https://www.nature.com/articles/s41598-025-26382-6

[6] H. A. Haider, "Predictive analysis of chronic kidney disease using machine learning models," *MDPI Proceedings*, vol. 107, no. 1, pp. 118–125, 2025. [Online]. Available: https://www.mdpi.com/2673-4591/107/1/118

[7] N. G. Rezk, M. A. Ibrahim, and H. A. El-Baz, "Explainable artificial intelligence for chronic kidney disease prediction," *Bioengineering*, vol. 12, no. 4, pp. 356–370, 2025. [Online]. Available: https://www.mdpi.com/2306-5354/12/4/356

[8] R. K. Halder, A. K. Das, and S. Roy, "ML-CKDP: Machine learning-based chronic kidney disease prediction with smart web application," *Journal of King Saud University – Computer and Information Sciences*, vol. 36, no. 2, pp. 101–112, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/S2153353924000105