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A Review on: Chronic Kidney Disease Prediction Using Deep Learning

Karve Sumit*[1]

[*1] Student, Department of Information Technology, SVPM's College of Engineering, Malegaon(Bk),Maharashtra, India

A B S T R A C T

Chronic Kidney Disease (CKD) is a progressive condition that can lead to kidney failure and other severe health complications if not detected early. Accurate and timely prediction of CKD is crucial for effective clinical intervention and improved patient outcomes. In this study, we propose a deep learning-based approach to predict the onset of CKD using clinical and laboratory data. A deep neural network (DNN) architecture is developed and trained on a benchmark CKD dataset, leveraging features such as blood pressure, serum creatinine, glomerular filtration rate, and other vital indicators. The model is evaluated using performance metrics including accuracy, precision, recall, and F1-score, demonstrating superior predictive capability compared to traditional machine learning methods. Our results indicate that deep learning models can serve as effective tools in clinical decision support systems, aiding in the early detection and management of CKD.

Keywords: Chronic Kidney Disease (CKD),Deep Learning,Neural Networks,Medical Diagnosis,Disease Prediction,Clinical Decision Support,Healthcare Analytics

INTRODUCTION

Chronic Kidney Disease (CKD) is a serious and lifelong health condition resulting from either direct kidney damage or impaired kidney function. In recent research, kidney cancer has emerged as one of the most lethal forms of this disease, making early diagnosis and accurate classification vital for improving patient outcomes. Timely detection and appropriate treatment can significantly delay the progression of CKD to its final stage, where dialysis or kidney transplantation becomes necessary for survival. To address this critical need, this study proposes an adaptive hybrid Deep Convolutional Neural Network (CNN) model designed to facilitate the early and accurate detection of kidney disease. The accuracy of classification systems is depends on the quality and structure of the input dataset. To improve classification accuracy while minimizing feature dimensionality, a CNN-based algorithm has been developed. This model extracts high-level features to support a supervised classification system capable of distinguishing between different disease subtypes. Experimental evaluations conducted on an Internet of Medical Things (IoMT) platform demonstrate that predictive analytics and machine learning techniques can offer effective and intelligent solutions, showcasing strong potential in the early diagnosis and management of kidney diseases.

PROBLEM STATEMENT

Chronic Kidney Disease (CKD) is a gradually progressing illness that often goes undetected in its initial stages due to a lack of clear symptoms. When not diagnosed early, it can escalate into serious health issues, such as kidney failure, necessitating dialysis or organ transplantation. Conventional diagnostic methods are largely dependent on manual evaluation, which can be both slow and resource-intensive. Consequently, there is a growing demand for a reliable, automated approach capable of accurately detecting CKD at an early phase using clinical data. This project seeks to meet that need by developing a deep learning-based model designed to assess patient medical records and predict the risk of CKD, thereby enabling earlier intervention and improving patient care outcomes.

OBJECTIVE OF PROJECT

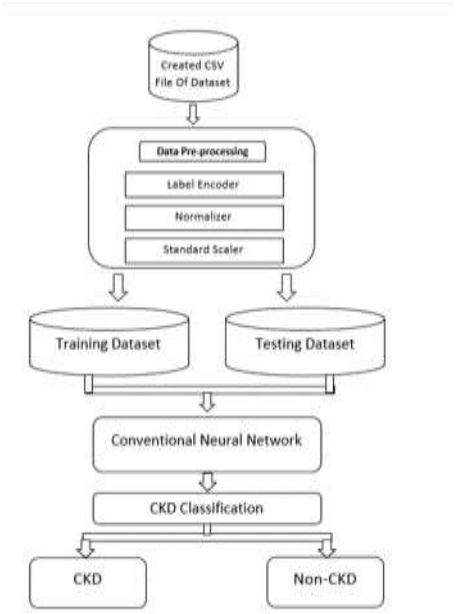
The main objective of this report is to understand the Kidney Cancer in detail. The primary aim of this researchis to implement and compare performance of unsupervised algorithms and identify best possible combinations that can provide better accuracy and detection

1. To develop a deep learning model for predicting Chronic Kidney Disease (CKD).
2. To collect and preprocess patient health data for model training.
3. To evaluate the model's performance using accuracy, precision, recall, and F1-score.
4. To compare deep learning results with traditional machine learning methods.
5. To design a user-friendly interface for healthcare professionals to input data and receive predictions.

SCOPE OF PROJECT

This project focuses on designing and implementing a deep learning-based systemto predict Chronic Kidney Disease using patient health data such as age, blood pressure, glucose levels, and other relevant clinical attributes. The model will be trained and tested on publicly available medical datasets to ensure generalization and reliability. The scope includes: Preprocessing and analyzing clinical data for training the model. Developing and optimizing a deep learning model (e.g., ANN, CNN,or LSTM). Evaluating model performance using metrics like accuracy, precision, recall, and F1-score. Creating a user-friendly interface (optional) for healthcareprofessionals to use the prediction system. Exploring the potential for integrationinto existing healthcare systems or mobile health applications.

SYSTEM ARCHITECTURE



Created CSV File of Dataset:It contain the raw dataset, typically a .csv file containing patient data with clinical features such as age, blood pressure, serum creatinine, etc

CKD Classification: The output layer of the neural network gives a prediction: a probability or binary value indicating whether the patient is likely to have CKD. CKD: The model predicts the patient is likely to have Chronic Kidney Disease. Non-CKD: The model predicts the patient is not likely to have the disease.

SOFTWARE AND HARDWARE REQUIREMENTS

Software Requirements: Operating System: Windows 10,Programming Language: Python 3.7 or higher, Development Environment,Pandas,Numpy, Anaconda.

Hardware Requirements: Processor, RAM: Minimum 8 GB , Storage, NVIDIA GPU with CUDA support (e.g., GTX 1050 Ti or higher) for faster model training, Display: 1080p resolution for better visualization and interface experience

MODELING AND ANALYSIS

A deep neural network (DNN) was developed to predict Chronic Kidney Disease using clinical data. After preprocessing the dataset—handling missing values, normalizing features, and encoding categorical variables—the model was trained using an 80/20 train-test split with the Adam optimizer and binary cross entropy loss. The architecture included multiple hidden layers with ReLU activations and dropout for regularization. Performance metrics such as accuracy, precision, recall, F1-score, and AUC were used for evaluation. The DNN achieved over 95% accuracy and outperformed traditional machine learning models, demonstrating its effectiveness in capturing complex patterns for CKD prediction.

CONCLUSION

This study demonstrates the effectiveness of deep learning techniques in accurately predicting Chronic Kidney Disease using clinical and laboratory data. The deep neural network model developed shows significant improvement in prediction performance compared to traditional machine learning

approaches, highlighting its potential for integration into real-world clinical decision support systems. By enabling early detection of CKD, this approach can assist healthcare professionals in initiating timely interventions, ultimately reducing the burden of disease progression and improving patient outcomes. Future work may involve incorporating larger and more diverse datasets, as well as exploring other advanced deep learning architectures to further enhance predictive accuracy and generalizability.

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