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DEEP LEARNING-BASED KIDNEY HEALTH DIAGNOSIS FROM CT SCANS

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Abstract: Tumors, cysts, and stones of the kidneys are among the serious problems in public health. It is critical to diagnose them early and accurately to achieve successful treatment. The current work aims to produce a web-based application for analyzing kidney CT scans by using deep learning techniques, based on a method known as CNN, in which the classification between Tumor, Cyst, Stone, or Normal occurs. The system makes further classification of renal cell images into predefined five classes in order to identify the malignancy level when a tumor is detected. The CNN model is trained based on a dataset 1 created from kidney CT scans sourced from Kaggle. The system designed by this approach offers an upload interface for images and provides diagnostic results in a very user-friendly manner. This project helps in diagnosing earlier and aids doctors to devise treatment planning which improves the management of kidney health care and the care of patients.

Index Terms - Kidney disease diagnosis, Convolutional Neural Network, CT scans, Deep Learning, Tumor classification, Kidney health management.

I. INTRODUCTION

The main contributing cause of serious health disorders in the general population is kidneyrelated health problems such as tumors, cysts, and stones. Early diagnosis and classification of such conditions become crucial factors in providing timely treatment and avoiding further complications. Kidney tumors, in particular renal cell carcinomas, pose great challenges due to the fact that early detection often occurs at advanced stages, with accompanying reduced survival rates. The proposed project addresses this problem statement through developing a system based on analyzing kidney CT scans using a class of deep learning models, known as Convolutional Neural Networks (CNNs), significantly proven to be of effective usage for applications involving image processing. It could classify the CT scans into four classes: Tumor, Cyst, Stone, or Normal. Additionally, it applies further classification techniques to analyze the renal cell images contained in scans with tumors into one of five classes that evaluate malignancy. This two-layered method ensures an elaborate diagnostic process. The system contains a web-based interface, through which users upload images from the CT scan and receive immediate online diagnostic results. Designing the application user friendly will make it more accessible both to medical practitioners and individuals to engage more in kidney health management.

II. LITERATURE SURVEY

[1] This study explains the potential use of machine learning models in forecasting kidney disease risk. The study focuses on using demographic and clinical data at an early stage for enhanced treatment planning of kidney-related conditions.
[2] This study concentrated on CNN models for the evaluation of medical imaging datasets with high accuracy in kidney conditions. It further establishes CNN to process large images of volumes meant for early diagnosis.
[3] The study presents methodologies on tumor classification based on datasets that comprised CT scans and histopathological images. It emphasizes that the combination of image processing with clinical features is crucial for diagnosis.
[4] This paper will discuss segmentation techniques in medical imaging towards the detection of kidney tumors and cysts, as if deep learning boosts the accuracy of diagnosis and helps in the clinical decision-making process.

III. SCOPE AND METHODOLOGY

Scope

The project will consist of designing a sound and user-friendly system for diabetes risk prediction, together with guiding people towards lifestyle changes based on the integration of AI into a chatbot. It encompasses a complete analysis of risks and exposes the factors associated with health, along with their recommendations aimed towards improving outcomes.

Methodology

The project starts with gathering an exhaustive dataset of kidney CT scans acquired from Kaggle. The dataset included images categorized into four groups: Tumor, Cyst, Stone, and Normal. For detected cases of tumors, more renal cell images are utilized in a separate database to classify the tumor into one of five classes for understanding their malignancy. The pre-processing aids the model's performance by resizing the images to uniform formats, normalizing pixel values, and over-sampling the dataset using techniques such as rotation, flipping, and scaling to avoid overfitting and have better generalization.

The core of the system is based on a Convolutional Neural Network. This CNN is trained to extract very important features from the CT scan images and to classify them accordingly into the predefined groups. To achieve optimal performance, the architecture of the network is fine-tuned through the adjustment of hyperparameters such as learning rate, batch size, and number of convolutional layers. Model training and validation are performed on a split of the dataset so that it assures the high accuracy and generalization of the system.

Development: The web application was built on Django; users could upload kidney CT scans to be analyzed by the system. When a user uploads an image, the system processes it using the trained CNN model and outputs the classification results. When there is evidence of a tumor, the application prompts the user to upload a renal cell image to further analyze, which will be classified under any of five classes that determine malignancy.

The CNN model is then tested by metrics like accuracy, precision, recall, and F1-score to evaluate the methodology. The whole system is designed in a way that encourages users to make its use smooth for early diagnosis and better management of kidney health. The user interface-friendly CNN model integrates everything in a very efficient and accessible diagnostic process.

IV. SYSTEM ARCHITECTURE

The data is obtained through publicly available kidney CT scans sourced from Kaggle. Users access the system via a web interface wherein kidney CT scans are uploaded for analysis purposes. The uploaded scans are processed using CNN-based models into one of four categories, namely, Tumor, Cyst, Stone, or Normal.

In case the tumor is detected, the application seeks to have a renal cell image uploaded for the purpose of further analysis. This second image is then processed utilizing a further CNN model, which classifies this image into one of five classes: Class 0 to Class 4.

This allows seamless integration of the two classification models such that it is able to provide users with real-time diagnostic results. The interface allows ease of navigation for the system and even gives actionable insights into individuals' kidney health. This efficient process of diagnostics allows users to make informed decisions about preventive or corrective health measures.

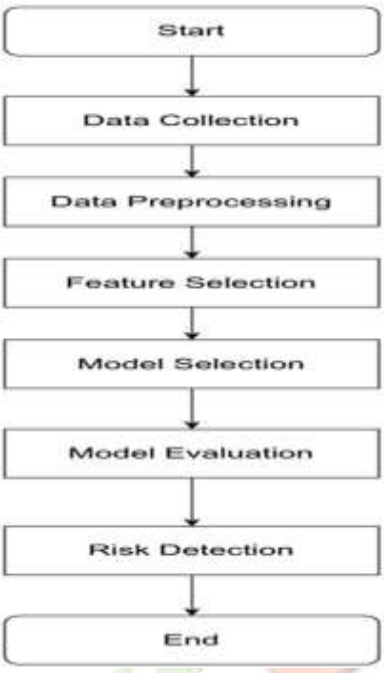

Figure 4.1:System Architecture

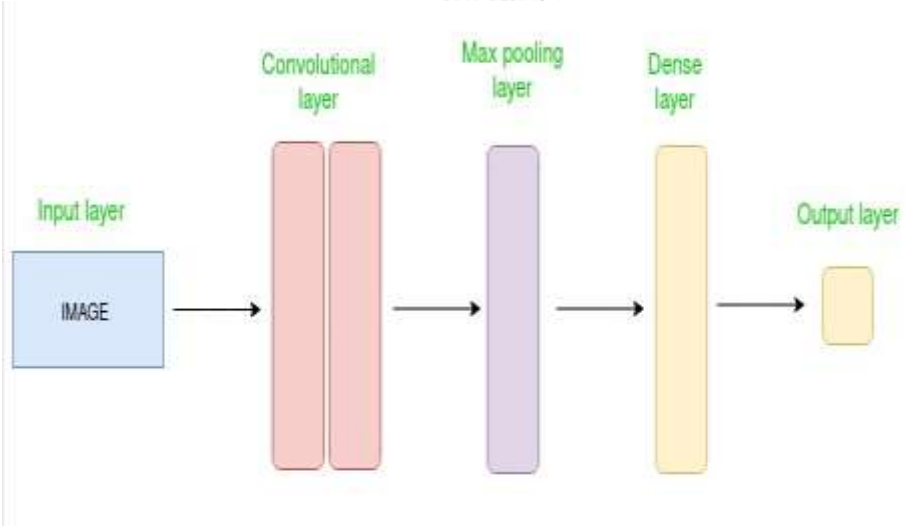

Figure 2:CNN Architecture

V. CONCLUSION

This paper presents a novel kidney health diagnosis system, which uses deep learning 3 techniques particularly CNNs to improve diagnostic accuracy and usability. System The proposed system efficiently identifies kidney-related conditions from CT scans, thus providing reliable and early diagnosis for users. Using CNNs, the kidney conditions are 2 classified into categories such as Tumor, Cyst, Stone, or Normal with high precision, thus enhancing the overall effectiveness of the diagnostic process. When ever the tumors are detected, then another auxiliary CNN model evaluates the renal cell images so that detailed insights about the user's condition will come out.

This is a feasible and scalable solution that would have immense potential to improve healthcare, primarily through the early detection and proactive health management that it enables. A user-friendly web application can be seamlessly integrated to allow users to take preventive or corrective action based on their results. This system makes meaningful contributions toward improving healthcare outcomes because of its innovative approach toward the diagnosis of kidney health.

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