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Kidney Stone Detection Using Image Processing and Convolutional Neural Networks

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Abstract:- Renal calculi, often known as kidney stones, are solid masses made mostly of crystals. Detecting the perfect and correct site of urinary calculus is essential for surgical procedures. Because CT pictures include greater speckle noise, manually detecting urinary calculi is difficult, hence automated systems for detecting kidney stones in CT images are necessary. CT imaging is one of the imaging modalities available for diagnosing kidney abnormalities, which can include changes in shape and position, as well as swelling of the limb; other kidney abnormalities include the creation of stones, cysts, urine obstruction, congenital defects, and malignant cells. This research presents a new method for detecting kidney stones. This project is divided into two parts: kidney CT image classification and kidney stone detection. For renal CT image classification, VGG16 convolutional neural networks are employed, and for kidney stone identification, Fuzzy c means clustering is used. Filtering and processing of kidney CT scans removes undesired noise and enhances the image. Using complicated techniques such as the Convolutional Neural Network (CNN) model, classify the image using the SoftMax classifier algorithm, and ultimately detect the kidney stone using FCM. This technology will produce more accurate findings and will do it faster than the previous way.

Keywords:- *Kidney Stones, Image Processing, CT image, CNN.*

I. INTRODUCTION

Kidney stones are tough composite of salts and minerals along with calcium and urine that shape internal your kidney. Body fluid content material is chargeable for the formation of those kidney stones. It takes time for our body to become dehydrated and waste products to accumulate. When the nutrient minerals in the urine become supersaturated, stone crystals form. Kidney stones usually spread with urine through the urethra to the bladder, but can also enter the bladder and come out large. Stones are regularly found by CT scans, x-rays, and ultrasound. The most common symptoms of kidney stones are low back pain, rib pain, and abdominal pain. In addition to urinary tract infections, severe pain can also cause odorous nausea and hematuria. The intensity of the pain varies and there are waves. Excessive urination, pollakiuria, and chills are all symptoms and symptoms of caution.

II. LITERATURE SURVEY

According to the method proposed in [7], the superiority of self-stated KS records become decided the usage of NHANES weights and layout variables. An important position in this study is the increasing predominance of kidney stones in adult males as well as females. Women of childbearing age have achieved the highest growth.

Deep learning technologies and applications are the subject of the papers in the [17] special area. Deep learning is a type of neural network with more layers allowing for greater abstraction and better data predictions.

Dayanand Jamkhandikar and his collaborators This approach converts images to grayscale and extracts features. Brute pressure matchers test the traits of the database and go back the results.

According to[1] the study was based on a cross-sectional examination of NHANES responses from 2007 to 2014. Data from four NHANES cycles (2007–2014) were used to examine KS prevalence patterns in adults of various ages. For the analysis, SAS version 9.4 was employed.

III. SYSTEM ANALYSIS AND DESIGN

Segmentation is essential in medical image processing. Traditional segmentation methods, such as thresholding and edge-based segmentation, are still in use, however they do not produce adequate segmentation results for medical images (Kidney Stone CT images).

Machine gaining knowledge of strategies aren't as correct as deep gaining knowledge of strategies. Nevertheless, gadget gaining knowledge of strategies are used for category purposes.

IV. PROPOSED SYSTEM

The proposed system has following steps:

- The CT images for the kidney are taken for the public database.
- Image analysis relies heavily on preprocessing. Removing undesirable factors and additives from the renal CT image is the pre-processing stage. Therefore, you can make better decisions. To do this, we advise a method in which we use a median filter to clear noise and use adaptive histogram equalization to enhance picture quality.
- After preprocessing, the VGG16 CNN network is utilized in getting to know a step to classify kidney CT images into regular and abnormal classes.
- Finally, to detect kidney stones in abnormal kidney CT images, we employed fuzzy c-means clustering(FCM) and level set segmentation.

V. IMPLEMENTATION

➢ *Modules*

Kidney stone detection done by following modules,

A. Image Acquisition
B. Preprocessing
C. Classification
D. Kidney Stone Detection

➢ *Module Description:*

A. Image Acquisition:

- Image acquisition is the process of collecting an image from a source, often a hardware-based source, so that it may be processed later using whatever techniques are required.
- In image processing, image capture is always the first step in the workflow, as processing is impossible without images. The resulting image is not completely processed and is the result regardless of the equipment used to make it; this can be vital in some industries where having a consistent foundation to work from is critical.
- The CT images for the kidney are taken for the public database.

B. Preprocessing:

- The second stage of kidney stone detection is pretreatment, including noise reduction, contrast enhancement, and image scaling.
- The noise reduction part of preprocessing is a stage where the noise from the renal CT image is done using the median filter.
- Rectification is used to enhance the contrast of kidney CT image via way of means of the use of Adaptive Histogram Equalization (AHE).

C. Classification:

- After pretreatment of the transfer learning model Vgg16, CNN is used to extract features and classify CT images of the kidney.
- The VGG16 network learns all of the info from a massive quantity of images. VGG16 is a 16-layer convolutional neural network. The image provided as input to the VGG network must be 224x224 pixels.
- After defining the network structure, you need to select alternative training. For training purposes, the length ought to be among 5 and 500. Network training makes use of layer based architecture, schooling data, and schooling parameters to classify the renal CT images.
- Finally, using the proposed vgg16 CNN model, test CT kidney images are categorized into two types, normal and pathological, based on their very rich function.

D. Kidney Stone Detection:

- Kidney stones are discovered following the categorization stage. In the kidney CT image, the FCM and level set segmentation techniques are employed to find the stone location.
- The technique of dividing the accumulated records or gadgets into special subsets is known as as clustering analysis
- The partition should have two properties:
  Cluster homogeneity: To achieve cluster homogeneity, data from the same cluster must be as identical as feasible.
  Data heterogeneity: To achieve data heterogeneity, data from different clusters must be as different as possible.
- The fuzzy c-means method (fuzzy c-means) is a classification strategy that is based on the fuzzy optimization of an aquadratic classification criterion. The approach requires previous knowledge of the number of classes and creates them iteratively using objective function minimization.
- As a result, each pixel is allocated a degree of zone membership, resulting in a fuzzy image division. Finally, in a clustered picture, the level set is employed to recognise just the stone region

VI. SYSTEM ARCHITECTURE

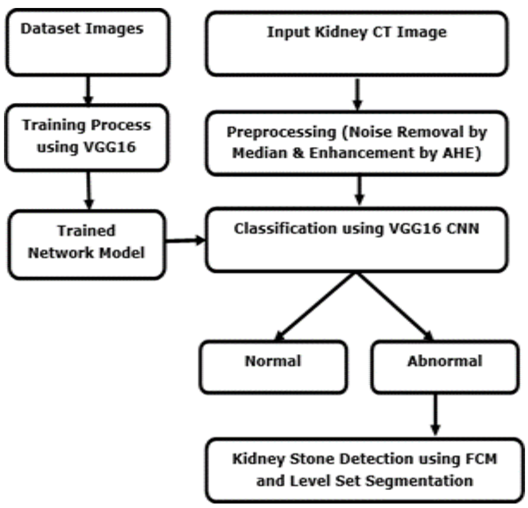

Fig 1:- System Architecture

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VII. OUTPUT

A. Normal Condition:

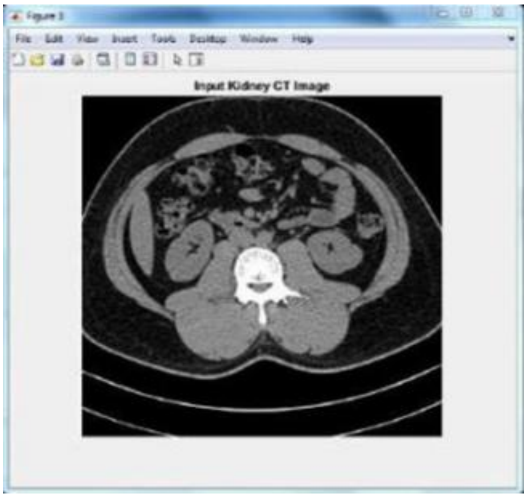

Fig 2.1:- Input CT image

Fig 2.2:- Noise Removal Using Median Filter

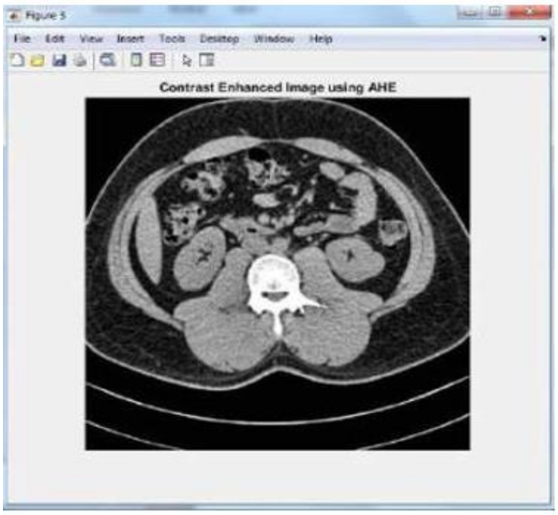

Fig 2.3:- Contrast Enhanced Using AHE

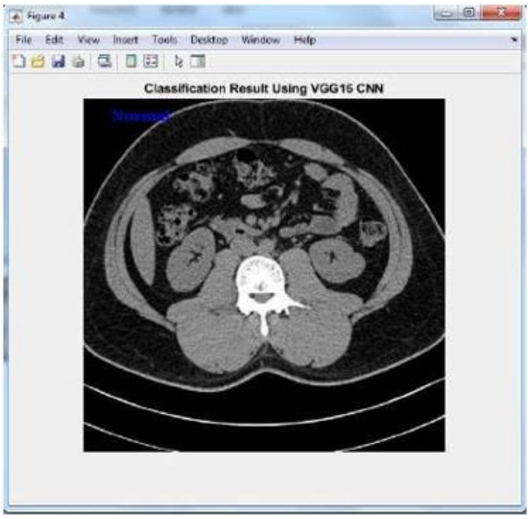

Fig 2.4:- Classification Using VGG16 CNN

Fig 2.5:- Output for a Normal Kidney

B. Abnormal Condition:

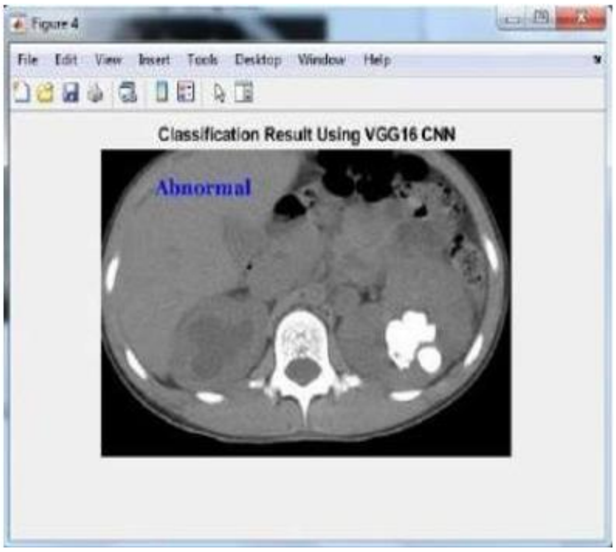

Fig 3.1:- Classification of an abnormal kidney

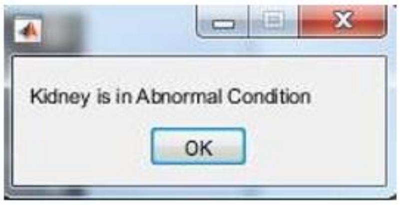

Fig 3.2:- Output for an abnormal kidney

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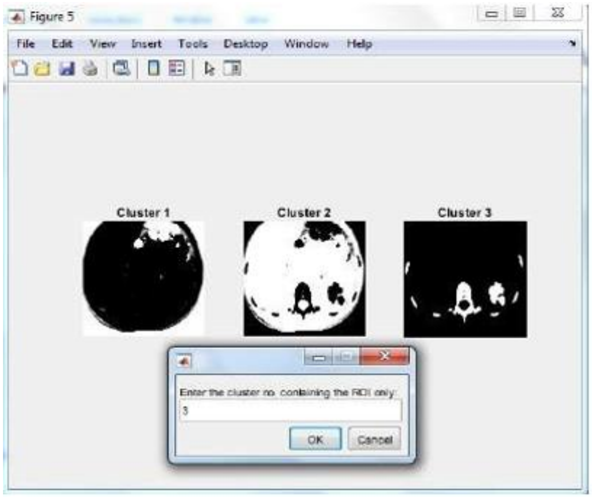

Fig 3.3:- Clustering of the Abnormal Kidney Image

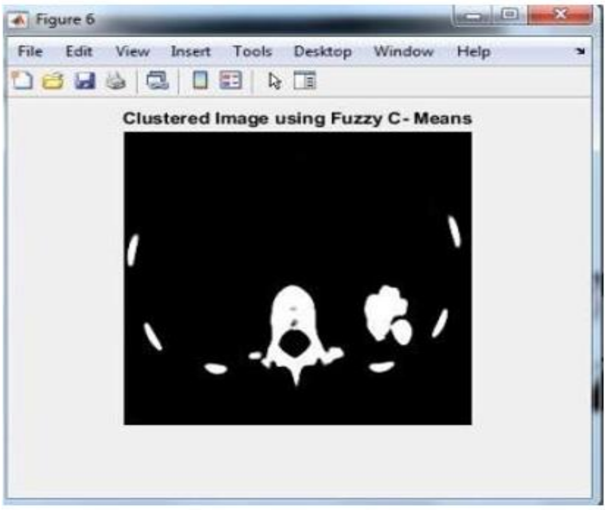

Fig 3.4:- Clustered CT Image using Fuzzy C Means

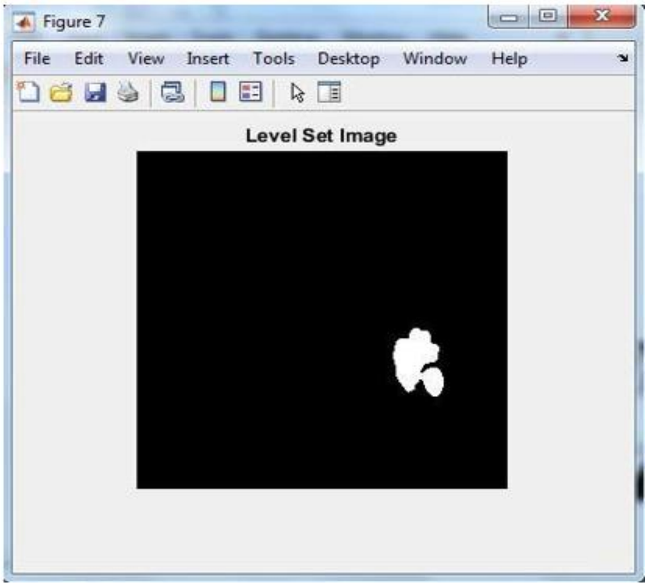

Fig 3.5:- Level Set Segmentation

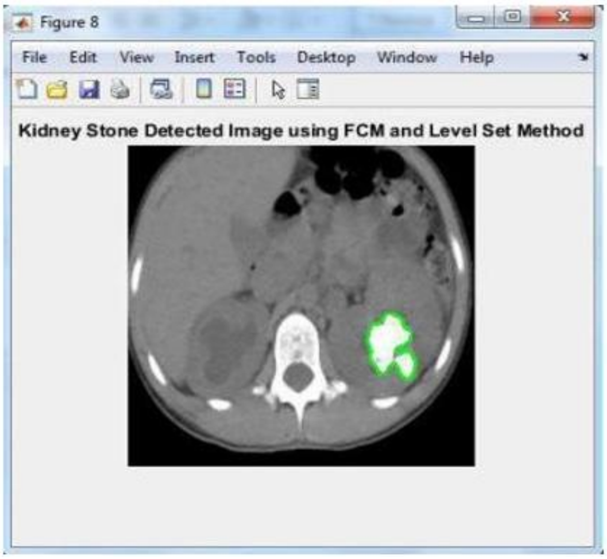

Fig 3.6:- Detected Kidney Stone Image

VIII. CONCLUSION

This research describes two innovative algorithms for categorising renal CT images and diagnosing kidney stones: the VGG16 CNN transfer learning model and Fuzzy C-means clustering. The primary purpose is to utilise Vgg16 CNN to classify normal and abnormal kidney CT images, as well as to detect kidney stones in abnormal kidney CT images using fuzzy c-means clustering and level set segmentation. Modules for image capture, preprocessing, classification, and kidney stone diagnosis are included in the study. The suggested approach may distinguish between two types of kidney CT pictures (normal/abnormal). Finally, the experimental findings showed that the unique method beat traditional tactics significantly.

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