

DETECTION OF RENAL CALCULI USING ARTIFICIAL INTELLIGENCE

Submitted in partial fulfillment of the requirements for the award of
Master of Technology degree in Medical Instrumentation

By

Afreen Banu. F (41440002)



**DEPARTMENT OF BIOMEDICAL ENGINEERING
SCHOOL OF BIO AND CHEMICAL ENGINEERING**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade "A" by NAAC
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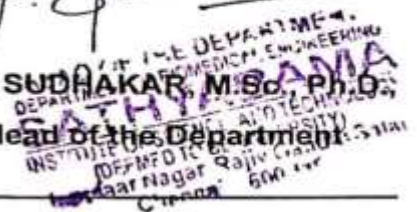
This is to certify that this project report is the bonafide work of **Afreen Banu. F** (Reg. No. **41440002**) who carried out the project entitled "**Detection of Renal calculi using Artificial Intelligence**" under our supervision from **November 2022 to April 2023**.

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Submitted for Viva-voce Examination held on **05-05-2023**

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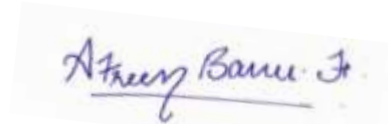
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DECLARATION

I, **Afreen Banu. F** (Reg. No. **41440002**) hereby declare that the project report entitled "**Detection of Renal calculi using Artificial Intelligence**" done by me under the guidance of Dr. **J. Bethannee Janney**, M.E., Ph.D., Department of Biomedical Engineering is submitted in partial fulfillment of the requirements for the award of **Master of Technology** degree in **Medical Instrumentation**.

DATE: 05.05.2023

PLACE: Chennai.

A handwritten signature in blue ink that reads "Afreen Banu. F." with a horizontal line underneath the name.

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Artificial Intelligence (AI) is used in the diagnosis of numerous nephrological and urological conditions such as glomerulonephritis and glomerular diseases, urolithiasis, renal transplant, and many more. According to the current state of study, renal illness is becoming more common disease every year. A lot of people confess to emergency department with unbearable pain due to kidney stones, which are a widespread illness around the world. The diagnosis of kidney stone illness involves the use of many imaging modalities. For the entire diagnosis and interpretation of these images, specialists are required. The practical methods that can be employed as supplemental tools to aid physicians in their diagnosis are computer-aided diagnosis system. Kidney stones are a common complaint worldwide, causing many people to admit to emergency rooms with severe pain. Various imaging techniques are used for the diagnosis of kidney stone disease. Specialists are needed for the interpretation and full diagnosis of these images. Computer-aided diagnosis systems are the practical approaches that can be used as auxiliary tools to assist the clinicians in their diagnosis. In this study, an automated detection of kidney stone (presence / absence of stone) using Computed Tomography (CT) images is proposed with Deep Learning (DL) technique which has recently made significant progress in the field of artificial intelligence. This study shows that recently popular Deep Learning methods that can be employed to address other challenging problems in urology.

Keywords: *Artificial Intelligence, Computed Tomography, Deep Learning, Urology, Convolutional Neural Network.*

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LIST OF ABBREVIATIONS

AI	- Artificial Intelligence
BUN	- Blood Urea Nitrogen
CHPD	- Calcium Hydrogen, Phosphate Dehydrate
CNN	- Convolutional Neural Network
COM	- Calcium Oxalate Monohydrate
CT	- Computed Tomography
CTC	- Computed Tomography Colonography
DL	- Deep Learning
MAPH	- Magnesium Ammonium Phosphate Hexahydrate
MRI	- Magnetic Resonance Imaging
PIL	- Python Imaging Library
RGB	- Red, Green, Blue
SGD	- Stochastic Gradient Descent
UA	- Uric Acid

CHAPTER 1

INTRODUCTION

Kidneys are the filtering organs of the body. It's located at the sides of abdomen, it's responsible for purification of blood through nephrons, also produce urine as a waste by product.

Kidney stone disease is also called as nephrolithiasis or urolithiasis or renal calculi. The stone is a crystallopathy where a solid piece of material developed in the urinary track. Kidney stone typically form in the kidney and leave the body in the urine stream. A small stone may pass without causing symptoms. If a stone grows more than 5mm then it may cause impasse in the ureter. The formation of kidney stone can arise at any age, gender, and race. It's more common in men's when compared to women. Usually, stones formation occurs under the age group of 20 – 50 years or in premature infant. Diet, excess body weight, lack of physical activity and also eating habits are among the many causes of kidney stones. (Smiti Tripathy et al., 2021). The most common reason for stone formation is chronic disease such as blood pressure, diabetes and obesity might affect the stone formation. If the kidney stone is treated also there are high chances of becoming chronic kidney disease, it depends on the person's health and their diet plans. Kidney stones can affect any part of the urinary tract i.e. from kidney to bladder. Often, kidney stone form when the urine becomes concentrated, allowing minerals to crystallize and stick together.

Prevention of kidney stone formation and recurrence is still a significant problem for human health. Weakening of kidney function due to development of kidney stone endangers human life. Consequently, early diagnosis of kidney stones is critical. A sample kidney stone image is shown in fig 1.



Fig. 1.1: Image of stone present in the kidney

Types of kidney stones depending on the minerals and salts.

1. Calcium oxalate stones – most of the kidney stones are calcium stones. These types of stones are formed because the urine contains high amount of calcium oxalate and low level of citrate. Majority of the kidney stone is due to this calcium oxalate. Oxalate is a substance made daily by liver or absorbed from diet. Certain fruits and vegetables, as well as nuts and chocolate, have high oxalate content. Dietary factors, high doses of vitamin D, intestinal bypass surgery and several metabolic disorder can increase the concentration of calcium or oxalate in urine.
2. Calcium phosphate stones – calcium stones may also occur in the form of calcium phosphate. Calcium phosphate stones are formed due to the malfunction of the urinary system. This type of stone is more common in metabolic conditions, such as renal tubular acidosis. It's often present with calcium oxalate stones.
3. Struvite stones – Struvite stones forms due to infection in urinary tract. These stones grow quickly and become quite large, sometimes with few symptoms or little warning. These stones are also called as the stag horn calculi when they form hefty enough. These are most commonly found in women.
4. Uric acid stones – These stones are formed due to insufficient intake of water, also forms in people who lose too much fluid because of chronic diarrhea or malabsorption, and those who eat a high – protein diet and those with diabetes or metabolic syndrome or can develop after chemotherapy. Uric acid stones are most commonly found in men. Certain genetic factors also may increase the risk of uric acid stones.
5. Cystine stones – These stones form in people with a hereditary disorder called cystinuria that causes the kidney to excrete too much amount of a specific amino acid. These can result in stone formation at any part of the urinary tract (kidney, bladder, and urethra). (Smiti Tripathy et al., 2021).

Symptoms – A kidney stone usually won't cause any symptoms until it moves around within the kidney or passes into one of the ureters. If a kidney stone becomes lodged in the ureters, it may block the flow of urine and causes the kidney to swell and the ureter to spasm, which can be very painful. At that point these symptoms appears

-severe, sharp pain in the side and back, below the ribs. Pain that radiates to the lower abdomen and groin, pain or burning sensation while urinating. Other common symptoms are – pink, red or bloody urine. Cloud or foul-smelling urine, a persistent need to urinate, urinating more often than usual or urinating in small amounts, nausea and vomiting, fever and chills if an infection is present. When the size is small, no symptoms or pain would be visible. Proper hydration more consumption of citrate juices, oxalate food and low intake of animal protein are few ways to prevent the formation of kidney stone. If the kidney stones are not treated, they can cause hematuria, kidney infection and loss of kidney function. (Vishnu Prasad et al., 2022).

Detection of kidney stones can be done in several ways: urinalysis, BUN (blood urea nitrogen) and creatinine to diagnose urinary tract function, test for calcium, electrolytes and phosphorus in blood stream. The other methods for detecting kidney stone by non-invasive methods, such as Ultrasound Imaging of kidney, X-ray and Computerized Tomography (CT) of the abdomen, Magnetic Resonance Imaging (MRI) of a kidney and abdomen. (Farheen Sultana et al., 2020).

In this paper, various imaging technique and their output are used for identifying the presence of stone. Furthermore, the proposed Artificial Intelligence (AI) based approach for detection and classification of kidney stone is presented.

Review of Imaging Techniques

The most commonly used imaging techniques used in the medical field for diagnosis are X-ray imaging, Ultrasound Imaging, Computerized Tomography scans (CT), Magnetic Resonance Imaging (MRI) techniques etc.

X-ray Imaging

A beam of energy is pointed at the body part where the diagnosis is done. A plate behind the body part captures variation of the energy beams after it passes through the skin, bone, muscle and other tissue. In abdominal X-ray, the location of kidney stone can be identified that are present in the urinary tract. Not all the stones are visible on abdominal X-rays.

Ultrasound Imaging

Ultrasound technology uses sound waves to create images of kidneys and bladders. Ultrasound imaging is a non-invasive test, also it is fast and simple to carry

out. Hence urologist use ultrasound for pediatric and pregnant patients, it's widely accepted diagnostic tool.

Computerized Tomography (CT)

CT scans take a fast series of X-rays images, which are put together to create images of the area that was scanned. CT scans of kidneys can provide more specified information about the kidneys. CT scan can show the size and location of kidney stone.

Magnetic Resonance Imaging (MRI)

An MRI uses strong magnetic fields to take images of the inside of the body. A major advantage of MRI is the ability to produce 3D imaging without radiation. But MRI costs about 3 times more than a CT scan.

Summary

CT scans are most commonly used for diagnosis because CT scans may reveal even tiny stones. During a CT scan, the patient is exposed to ionizing radiation so, the image is accurate. Low dose of radiation used in CT scan does not cause a long term harm, while at high dose, there may be a small increase in the risk of cancer. MRI scans which doesn't use any radiation are not used to evaluate kidney stone. But, it helps in the safety diagnosis of kidney stone in pregnant women. (Daniel Elton. C et al., 2022).

Fig.1.2, Describes the different types of stones. They are Calcium Oxalate Monohydrate (COM), Uric Acid (UA), Magnesium Ammonium Phosphate Hexahydrate (MAPH), Calcium Hydrogen, Phosphate Dehydrate (CHPD) and Cystine stones.



Fig. 1.2: Types of Kidney Stone

CHAPTER 2

LITERATURE SURVEY

Caglayan Alper et al., (2022) designed a deep learning model-assisted detection of kidney stones on computed tomography. The 455 patients who underwent CT scanning for kidney stones between January 2016 and January 2020 were included in this retrospective investigation; of them, 405 had kidney stones, and 50 did not. Patients were divided into groups 1, 2, and 3 based on their kidney stone sizes: 0-1 cm, 1-2 cm, and >2 cm. 2,959 CT scans from 455 patients were examined by two radiologists in three planes. A deep learning algorithm was then used to assess these CT pictures. The deep learning model's accuracy rate, sensitivity, specificity, and positive and negative predictive values were calculated.

Daniel Elton. C et al., (2022) created a deep learning system for automated kidney stone detection and volumetric segmentation on noncontrast CT scans. They employed a dataset consisting of 89 CTC scans without kidney stones and 91 CT colonography (CTC) scans with kidney stones that had been manually tagged. Half of the data was used for training and testing in order to compare to earlier research. As an external validation set, 6185 CTC scans from a different institution's patients were employed. These scans included patient- level labelling. The kidneys were divided using a 3D U-Net model, and then thresholding, region-growing, and gradient- based anisotropic denoising were applied. Following that, a 13 layer convolutional neural network classifier was used to separate false positive regions from kidney stone-containing regions.

Eliyas, Sherin et al., (2022) designed an equipment for Kidney Stone Prediction Using Neural Network Classifier. The Dual- Tree Complex (DTCWT) Wavelet transforms, which provide a framework for decomposing images, with each stage corresponding to a coarser judgement band. The CT photo readability is also increased by the Median Filter to observe a clear image free of noise. The image is extracted using

the gray-level co-occurrence matrix (GLCM), then using neural network classifiers, it is classified as being affected or not.

Farheen Sultana et al., (2020) developed a system for detecting kidney stone using CNN. It utilizes a multi-clustering model and morphological technique to identify the Stone from MRI-scanned medical pictures. The division of a digital image into several pieces is referred to as segmentation. Filters are used to remove the noise from the kidney MRI, and then spatial correction is implemented. Clustering approach for the segmentation of MRI kidney images is known as fuzzy C. The Stone region will be isolated from the noisy background using the morphological technique. For telemedicine use, the segmented primary and secondary regions are compressed employing hybrid approaches.

Fuzhe et al., (2020) designed a system for detection and diagnosis of chronic kidney disease using deep learning-based heterogeneous modified artificial neural network. The early kidney stone detection is essential because renal damage might endanger life. To undertake surgery to remove a kidney stone, the location of the kidney must be determined. It is challenging to discern kidney anomalies from normal kidneys since the ultrasound pictures of the kidneys have low contrast and are speckled. This could make it challenging for medical professionals to recognize tiny kidney type and stones. In order to solve this problem, the energy levels of stone have been extracted using the proposed sub-bands of wavelets and the HMANN classification algorithms of SVM and MLP-BP.

GP. Vishnu Prasad et al., (2022) developed a system for predicting kidney stones using machine learning based on coronal computed axial tomography (CT) scans were used to automatically detect kidney stones using the Deep Learning (DL) technique, which has made great advancements in the field of computers. With Python and the Keras deep learning framework, they are employing convolutional neural networks (particularly, the Xception Model) that have been pre-trained on the ImageNet database.

Lalith Vikas et al., (2021) published a work on kidney Stone Detection Using Image Processing and Neural Networks. The Back- Propagation Network (BPN) is utilized. Features are extracted using GLCM, and subsequently they are categorized using BPN. This study segments computed tomography images in order to identify kidney stones in their early stages using the Fuzzy C-Mean (FCM) clustering technique.

Pavithra S et al., (2022) obtained kidney stone detection using image processing and convolutional neural networks. For the public database, kidney CT pictures are taken. The preprocessing step is crucial to image analysis. Pre-processing involves removing unwanted elements and additives from the renal CT image. As a result, you can choose more wisely. To achieve this, they suggest a technique in which we remove noise with a median filter and improve picture quality with adaptive histogram equalization. Following preprocessing, the kidney CT images are divided into normal and pathological classes using the VGG16 CNN network. Last but not least, they used level set segmentation and fuzzy c-means clustering (FCM) to detect kidney stones in aberrant kidney CT images.

Shobana. S et al., (2022) designed a system for detection of kidney stones using machine learning. They proposed using coronal computed tomography (CT) scans to automatically detect kidney stones using the deep learning (DL) technique, which has significantly advanced artificial intelligence. Because it is a low-cost, dependable, and non-invasive method, the development of imaging techniques and the diagnosis utilizing Computed Tomography (CT) pictures have gained broad use. For these images, feature extraction, analysis, and pattern recognition algorithms are utilized to look for abnormalities like tumors, cysts, stones, etc.

Surya. V et al., (2021) developed a system for kidney stone detection using machine learning algorithm. The two types of systems employed in the identification of kidney stones are the Back propagation network (BPN) and the GLCM features, on which our suggested method is based using the two suggested approaches, we can quickly diagnose kidney stones. For the classification of kidneys, they are extracting features using GLCM features and a back propagation network (BPN).

CHAPTER 3

AIM AND SCOPE

3.1 AIM

The aim of this present work is to develop a website to detect the kidney stone and highlight the stone area using CT images with deep learning. Many people are admitted in hospitals due to sudden pain in abdomen region i.e., formation of kidney stone. This kidney stone early diagnosis is not possible & accuracy of the stone composition is imperfect for some people. In order to overcome this crisis a website is developed where the kidney stone is predicted and identified.

3.2 EXISTING SYSTEM

According to the research, many ideas and systems were developed based on detection of kidney stone in either Ultrasound images or Magnetic Resonance (MR) Images using either Machine Learning or Deep Learning Algorithms. But they are more complex and prediction is not accurate also some sort of system errors may occur.

3.3 PROPOSED SYSTEM

The development of technology, a lot of computer-aided systems has been evolved for diagnosing the presence of disease with an important emphasis on system accuracy. In proposed system, we develop an automated detection of kidney stones using computed tomography (CT) images was proposed with deep learning (DL) technique which has made significant progress in the field of artificial intelligence. Further, more accuracy of the algorithm and effective diagnosis is obtained.

3.4 SCOPE

The development of imaging techniques, diagnosis using computed Tomography (CT) images has become widespread because of its low cost, reliable and Non-invasive procedure. Feature extraction, analysis and pattern recognition techniques for these images are used for finding the abnormality like a tumor, cyst, stone etc.

CHAPTER 4

MATERIALS AND METHODS

4.1 BLOCK DIAGRAM

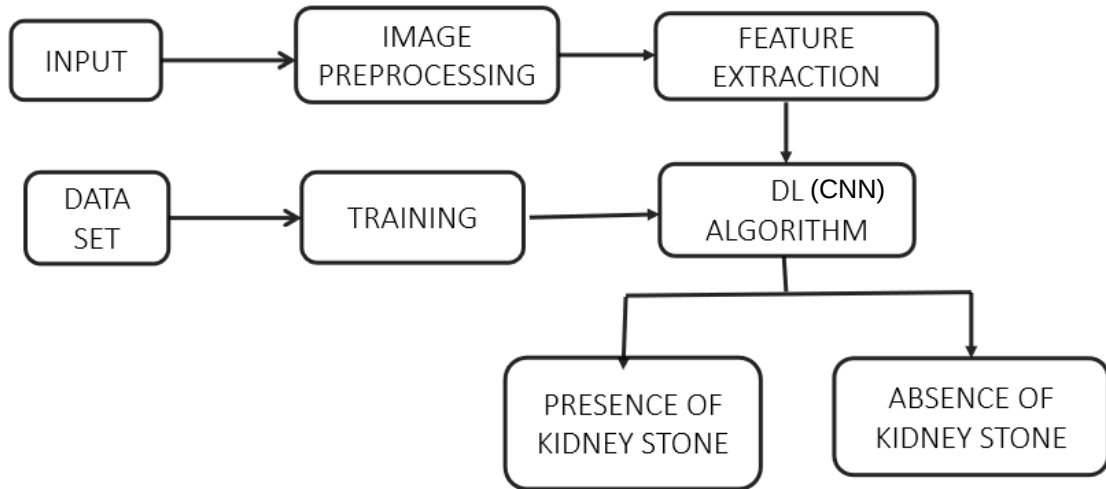


Fig. 4.1: Block Diagram of Kidney Stone Detection

4.2 COLLECTION OF DATASETS

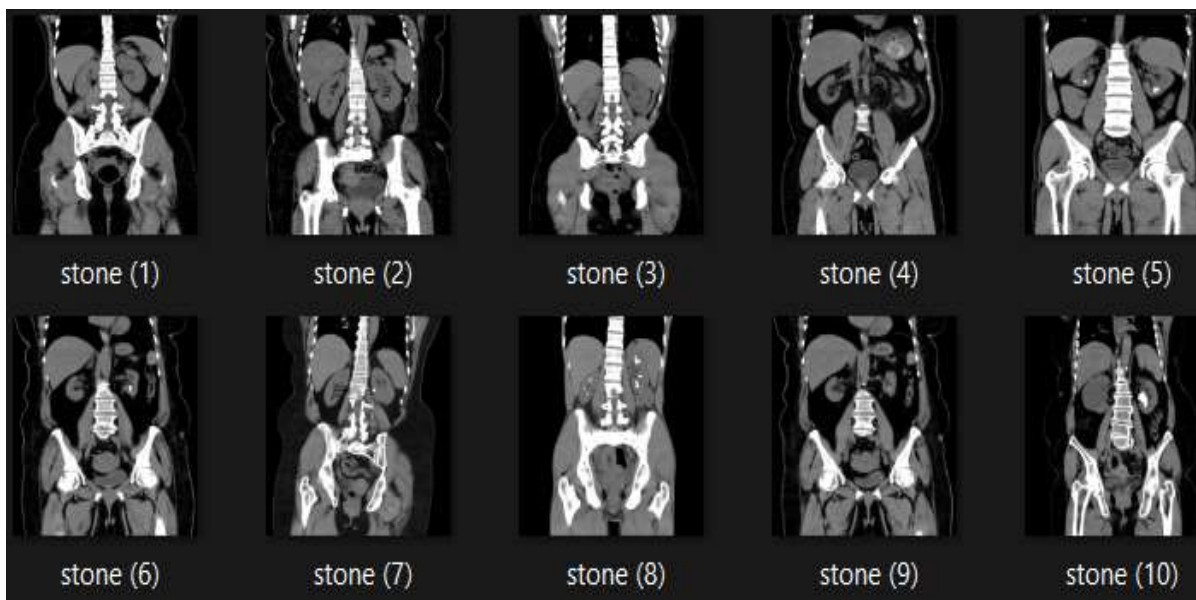


Fig. 4.2: Images of kidney stone presence

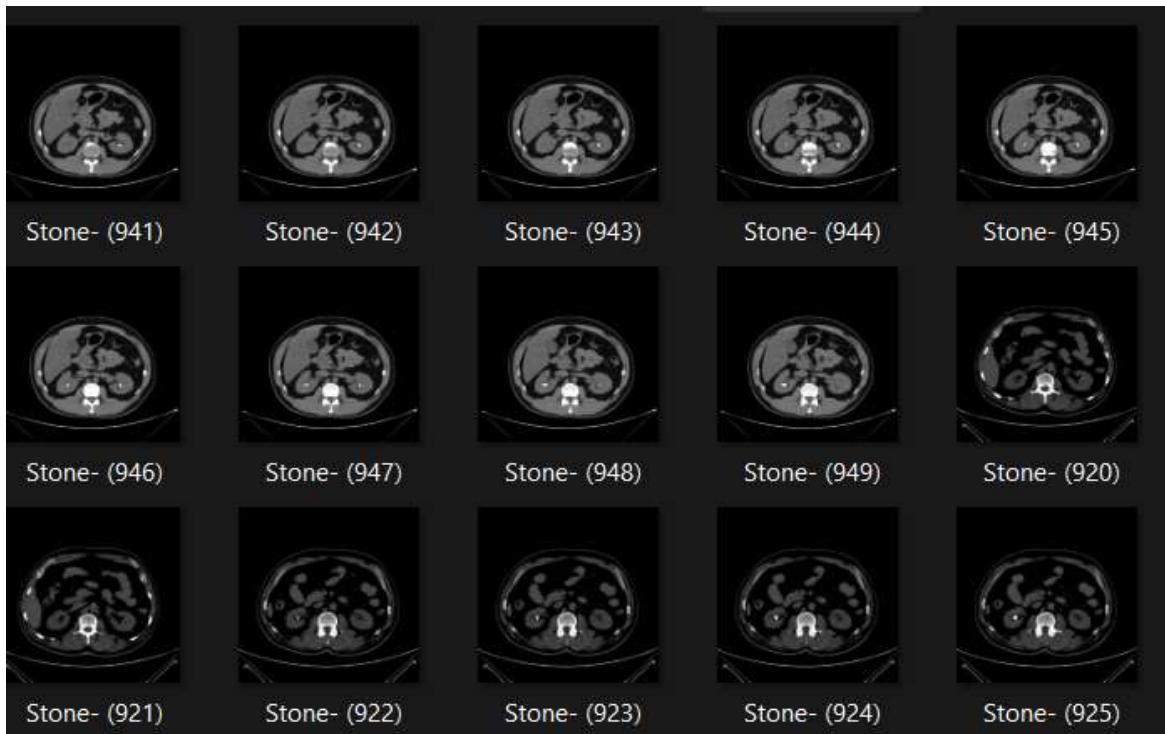


Fig. 4.3: Images of Kidney Stone Presence



Fig. 4.4: Images of Normal Kidney

4.3 PRE-PROCESSING

The images in the database are exposed to the pre-processing stage where the resizing task is carried out to maintain the uniform dimensions among the images.

4.4 TRAINING

Training data is the initial dataset you use to teach a deep learning application to recognize patterns or perform to the criteria, while testing or validation data is used to evaluate your model's accuracy. Here we are using Convolutional Neural Network (CNN) to train the data.

4.5 DEEP LEARNING

Deep learning is a subfield of machine learning concerned with algorithms inspired by the structural and functional of the brain called artificial neural network. It is used in Image Recognition, Fraud Detection, News Analysis, Stock Analysis, Self-driving cars, Healthcare like cancer image analysis, etc. By inputting more data in the network the layers get trained very well. They can be classified into Supervised, Semi-Supervised and Unsupervised categories. Each layer is known for extracting information specifically. For example, in Image recognition, the first layer will find the edge, lines, etc. second layer like eye, ear, nose, etc. In Image processing and deep learning may identify the concepts relevant to human such as digital image.

4.5.1 Convolutional Neural Network (CNN)

In deep learning, a convolutional neural network (CNN/ConvNet) is a class of deep neural networks, most commonly applied to analyze visual imagery. Now when we think of a neural network, we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. Now in mathematics convolution is a mathematical operation on two functions that produces a third function that expresses how the shape of one is modified by the other. But we don't really need to go behind the mathematics part to understand what a CNN is or how it works. Bottom line is that the role of the ConvNet is to reduce the images into a form that is easier to process, without losing features that are critical for getting a good prediction.

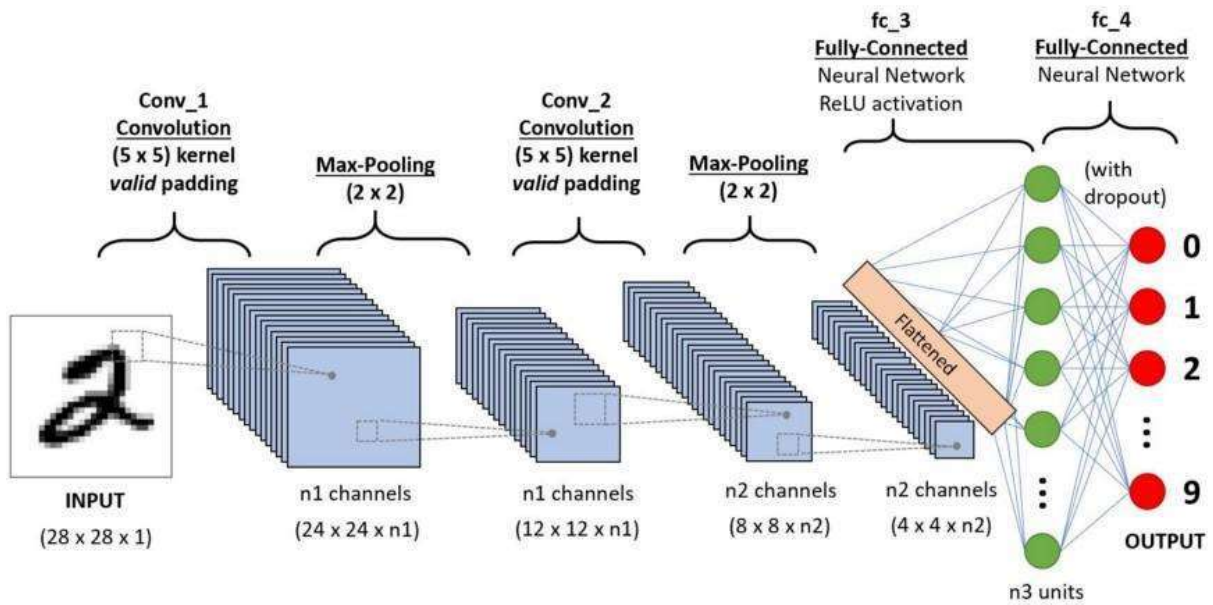


Fig. 4.5: A CNN sequence to classify handwritten digits

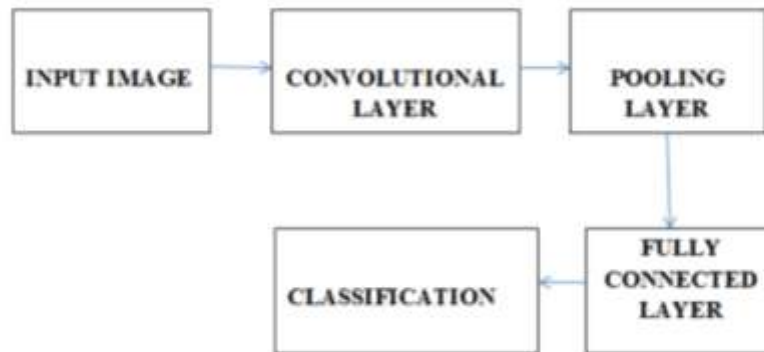


Fig. 4.6: Classification of CNN Layers

4.5.2 Working of CNN

Before we go to the working of CNN's let's cover the basics such as what is an image and how is it represented. An RGB image is nothing but a matrix of pixel values having three planes whereas a grayscale image is the same but it has a single plane. Take a look at this image to understand more.

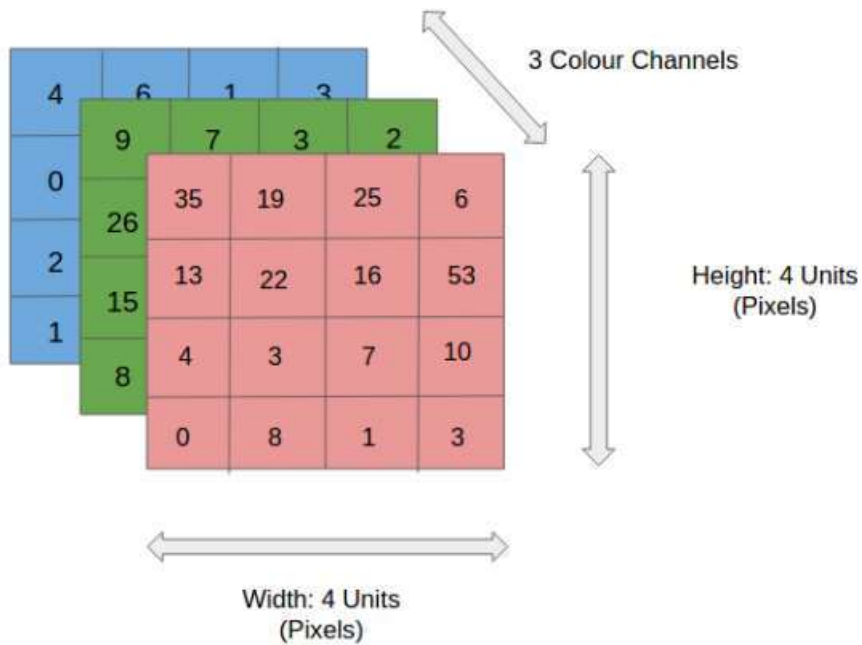


Fig. 4.7: 4*4*3 RGB Image

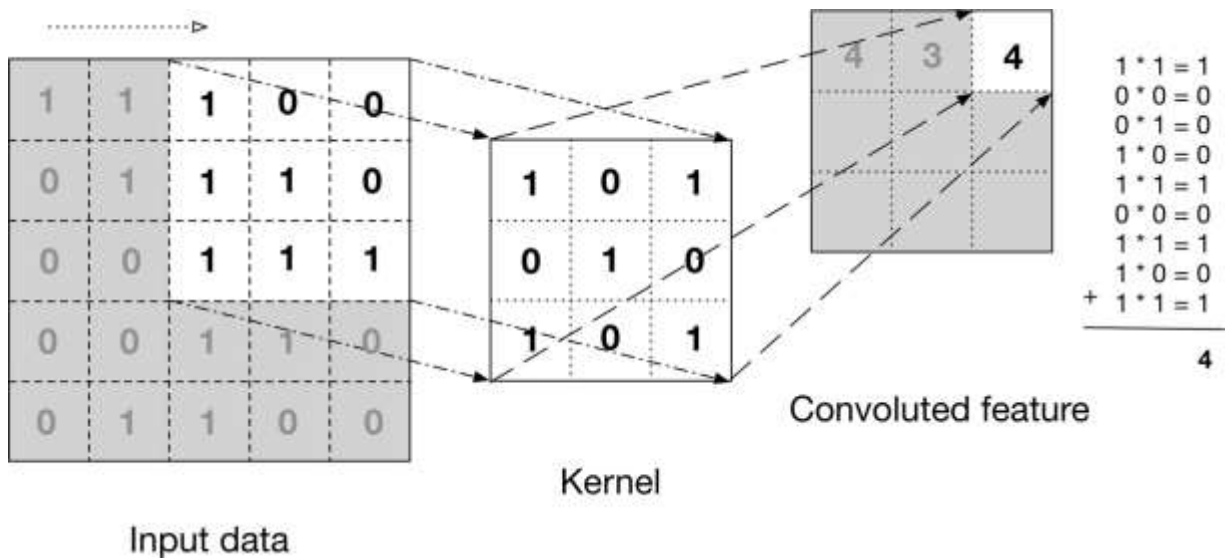


Fig. 4.8: Convolution applied for gray scale images

For simplicity, let's stick with grayscale images as we try to understand how CNNs work. The above image shows what a convolution is. We take a filter/kernel (3×3 matrix) and apply it to the input image to get the convolved feature. This convolved feature is passed on to the next layer.

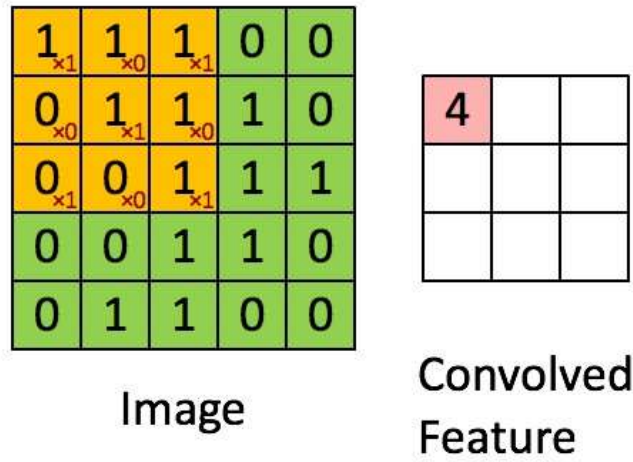


Fig. 4.9: Convolution applied to RGB Image

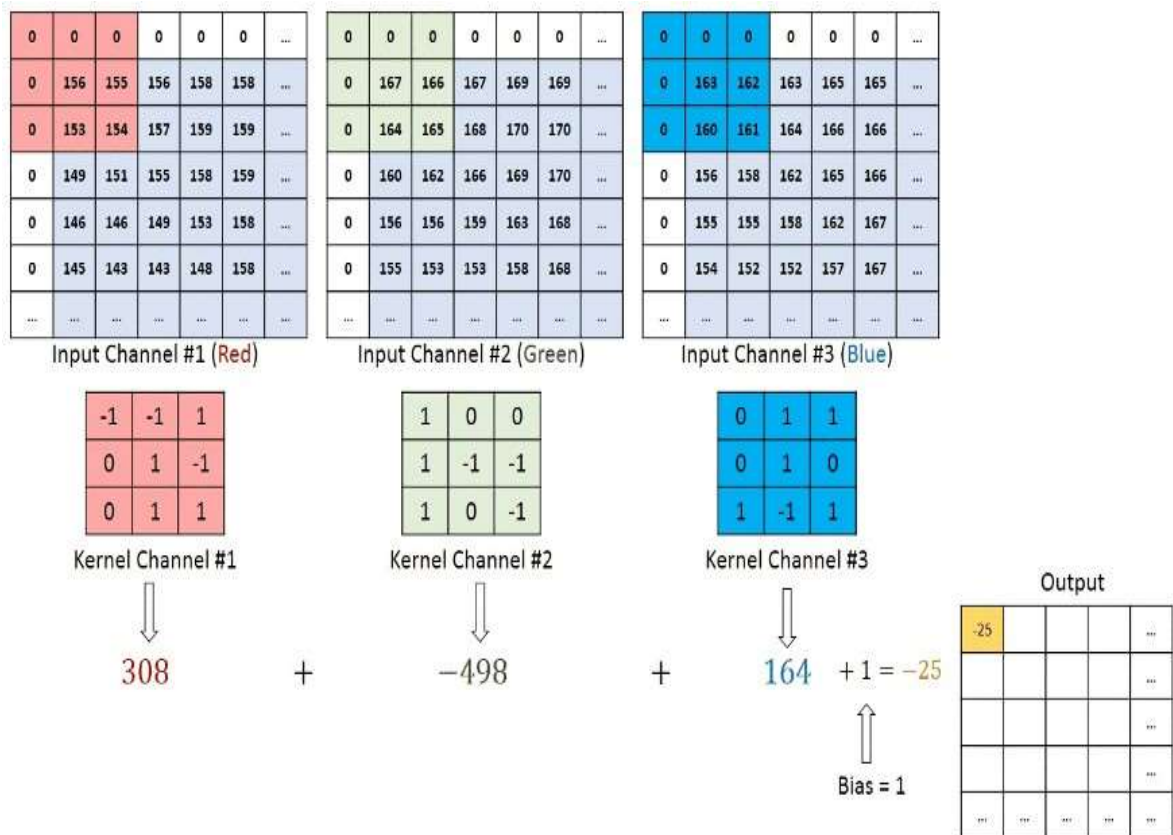


Fig. 4.10: RGB color, channel CNN working

Convolutional neural networks are composed of multiple layers of artificial neurons. Artificial neurons, a rough imitation of their biological counterparts, are mathematical functions that calculate the weighted sum of multiple inputs and outputs an activation value. When you input an image in a ConvNet, each layer generates several activation functions that are passed on to the next layer. The first layer usually extracts basic features such as horizontal or diagonal edges. This output is passed on to the next layer which detects more complex features such as corners or combinational edges. As we move deeper into the network it can identify even more complex features such as objects, faces, etc.

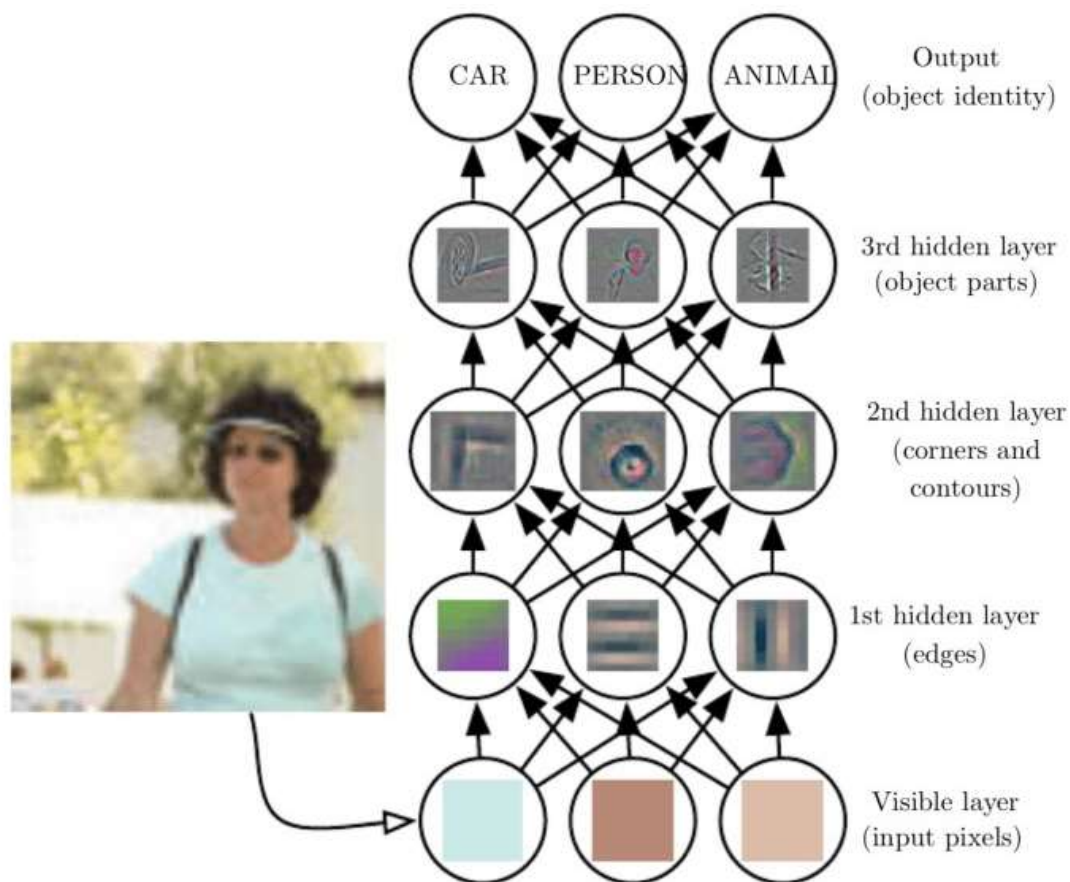


Fig. 4.11: Working of CNN

Based on the activation map of the final convolution layer, the classification layer outputs a set of confidence scores (values between 0 and 1) that specify how likely the image is to belong to a “class.” For instance, if you have a ConvNet that detects cats, dogs, and horses, the output of the final layer is the possibility that the input image contains any of those animals.

4.5.3. Pooling Layer

Similar to the Convolutional Layer, the Pooling layer is responsible for reducing the spatial size of the Convolved Feature. This is to decrease the computational power required to process the data by reducing the dimensions. There are two types of pooling average pooling and max pooling. I've only had experience with Max Pooling so far I haven't faced any difficulties.

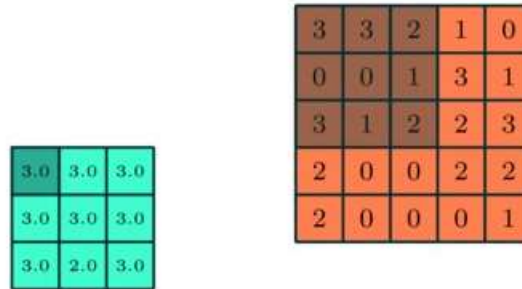


Fig. 4.12: Pooling Layers

So what we do in Max Pooling is we find the maximum value of a pixel from a portion of the image covered by the kernel. Max Pooling also performs as a Noise Suppressant. It discards the noisy activations altogether and also performs de-noising along with dimensionality reduction. On the other hand, Average Pooling returns the average of all the values from the portion of the image covered by the Kernel. Average Pooling simply performs dimensionality reduction as a noise suppressing mechanism. Hence, we can say that Max Pooling performs a lot better than Average Pooling.

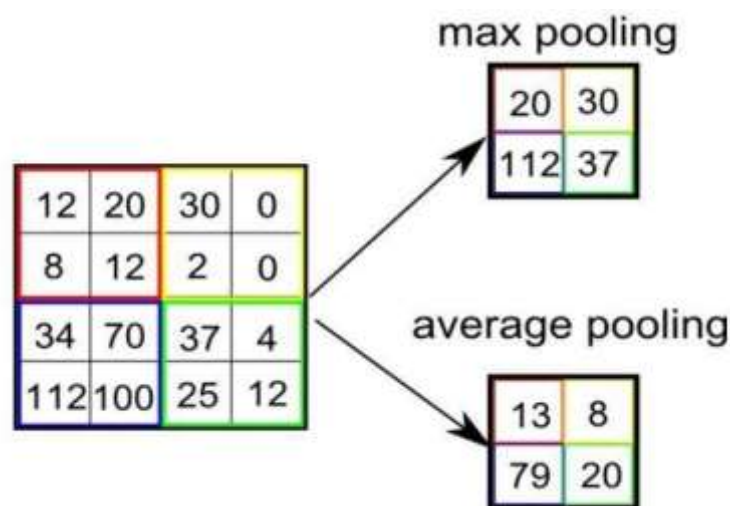


Fig. 4.13: Types of Pooling

4.6 PYTHON

4.6.1 Numpy

Numpy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

Uses of Numpy

Numpy can be used to perform a wide variety of mathematical operations on arrays. It adds powerful data structures to Python that guarantee efficient calculations with arrays and matrices and it supplies an enormous library of high-level mathematical functions that operate on these arrays and matrices.

4.6.2 Keras

Keras is a powerful and easy-to-use free open-source Python library for developing and evaluating deep learning models. It wraps the efficient numerical computation libraries Theano and Tensor Flow and allows you to define and train neural network models in just a few lines of code. It was developed with a focus on enabling fast experimentation. Being able to go from idea to result as fast as possible is key to doing good research. Keras is an API designed for human beings, not machines. Keras follows best practices for reducing cognitive load: it offers consistent & simple APIs, it minimizes the number of user actions required for common use cases, and it provides clear and actionable feedback upon user error.

4.6.3 Tensor Flow

Tensor Flow is a free and open-source software library for machine learning and artificial intelligence. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks.

4.6.4 Tensor Flow Ecosystem

Tensor Flow provides a collection of workflows to develop and train models using Python or JavaScript, and to easily deploy in the cloud, on-perm, in the browser,

or on-device no matter what language you use. If the data API enables you to build complex input pipelines from simple, reusable pieces. It is a symbolic math library that uses dataflow and differentiable programming to perform various tasks focused on training and inference of deep neural networks.

Advantages of Tensor Flow

- Open-source platform. It is an open-source platform that makes it available to all the users around and ready for the development of any system on it.
- Data visualization.
- Keras friendly.
- Scalable.
- Compatible.
- Parallelism.
- Architectural support.
- Graphical support.
- Difference between Keras and Tensor Flow, Keras is a neural network library while Tensor Flow is the open-source library for a number of various tasks in machine learning. Tensor Flow provides both high-level and low-level APIs while Keras provides only high-level APIs.

4.6.5 SKlearn

Scikit-learn (formerly scikits.learn and also known as sklearn) is a free software machine learning library for the Python programming language. It features various classification, regression and clustering algorithms including support-vector machines, random forests, gradient boosting, k-means and DBSCAN, and is designed to interoperate with the Python numerical and scientific libraries Numpy and SciPy. Scikit-learn is a Num focus fiscally sponsored project.

Uses of Sklearn

Scikit-learn is probably the most useful library for machine learning in Python. The sklearn library contains a lot of efficient tools for machine learning and statistical modeling including classification, regression, and clustering and dimensionality reduction.

Sklearn in Python:

Scikit-learn is a free machine learning library for Python. It features various algorithms like support vector machine, random forests, and k-neighbors, and it also supports Python numerical and scientific libraries like Numpy and SciPy.

4.7 RESNET-50

ResNet-50 is a convolutional neural network that is 50 layers deep. You can load a Pre trained version of the network trained on more than a million images from the ImageNet database. The pre trained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals.

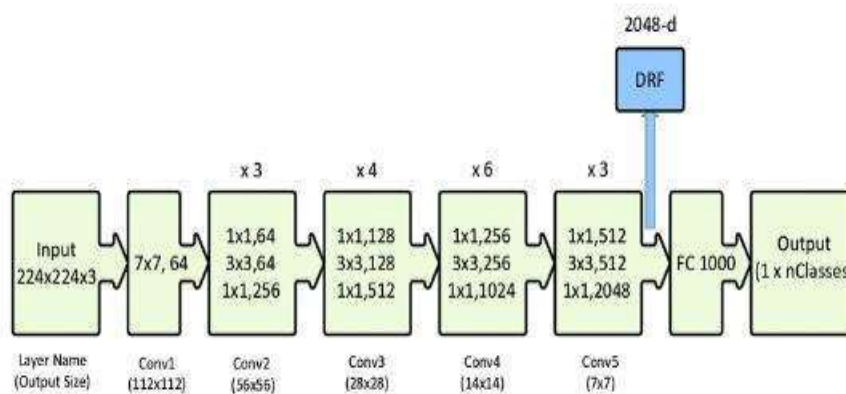


Fig. 4.14: Block diagram Resnet-50

4.7.1 Xception in Python

Xception is an extension of the inception Architecture which replaces the standard Inception modules with depth wise Separable Convolutions. The architecture of Xception (Entry Flow>Middle Flow>Exit Flow)

4.7.2. CNN Xception

Xception is a deep convolutional neural network architecture that involves Depth wise Separable Convolutions. ... This observation leads them to propose a novel deep convolutional neural network architecture inspired by Inception, where Inception modules have been replaced with depth wise separable convolutions.

4.7.3 SGD Optimizer

Stochastic gradient descent is an iterative method for optimizing an objective function with suitable smoothness properties. It can be regarded as a stochastic approximation of gradient descent optimization, since it replaces the actual gradient by an estimate there.

Uses

Stochastic gradient descent (often abbreviated SGD) is an iterative method for optimizing an objective function with suitable smoothness properties (e.g. differentiable or sub differentiable).

4.7.4 Dropout

Dropout is a technique used to prevent a model from overfitting. Dropout works by randomly setting the outgoing edges of hidden units (neurons that make up hidden layers) to 0 at each update of the training phase.

4.7.5 Flatten

The `flatten ()` function is used to get a copy of an given array collapsed into one dimension. syntax: `ndarray.flatten (order='C')`

4.7.6 Dense

Dense is the only actual network layer in that model. A Dense layer feeds all outputs from the previous layer to all its neurons, each neuron providing one output to the next layer. It is the most basic layer in neural networks.

4.7.7 Dense Layer

Dense Layer is simple layer of neurons in which each neuron receives input from all the neurons of previous layer, thus called as dense. Dense Layer is used to classify image based on output from convolutional layers.

4.8 MAX POOLING 2D

Max pooling operation for 2D spatial data. Down samples the input along its spatial 2 dimensions (height and width) by taking the maximum value over an input window (of size defined by pool size) for each channel of the input.

4.8.1 Working of Max Pool

Max Pooling is a pooling operation that calculates the maximum value for patches of a feature map, and uses it to create a down sampled (pooled) feature map. It is usually used after a convolutional layer.

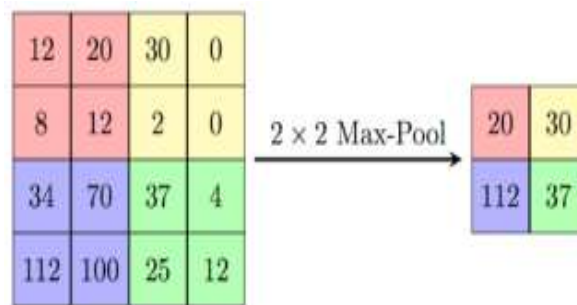


Fig. 4.15: Working of Max Pooling

4.8.2 Conv2D

Conv2D class. 2D convolution layer (e.g., spatial convolution over images). This layer creates a convolution kernel that is convolved with the layer input to produce a tensor of outputs. If use bias is true, a bias vector is created and added to the outputs.

4.8.3 Matplotlib

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension Numpy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK.

Uses

Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python. Matplotlib makes easy things easy and hard things possible. Create publication quality plots. Make interactive figures that can zoom, pan, and update.

4.8.4 Keras Image Data Generator

Keras Image Data Generator is a gem! It lets you augment your images in real-time while your model is still training! You can apply any random transformations on each training image as it is passed to the model. This will not only make your model robust but will also save up on the overhead memory.

4.8.5 Pillow

Python Imaging Library is a free and open-source additional library for the Python programming language that adds support for opening, manipulating, and saving many different image file formats. It is available for Windows, Mac OS X and Linux.

Uses

Pillow is a Python Imaging Library (PIL), which adds support for opening, manipulating, and saving images. The current version identifies and reads a large number of formats. Write support is intentionally restricted to the most commonly used interchange and presentation formats.

4.9. STREAMLIT

Streamlit is an open-source Python library that makes it easy to create and share beautiful, custom web apps for machine learning and data science. In just a few minutes you can build and deploy powerful data apps. It is the fastest one and easiest way. It is the one of the network which works under the server of google net to give specific output. By using Streamlit run app.py we can upload the images in the image net and we get the output has whether the stone is present or absent.

CHAPTER 5

RESULTS AND DISCUSSION

The collection of datasets of kidney is around 1,799 images and they are divided into stone and normal data set. The images in the database are exposed to the pre-processing stage where the resizing task is carried out to maintain the uniform dimension among the images. To initialize training method and training rate we used Xception and set optimizer as SGD, We trained 200 to 500 epochs and we achieved 98% accuracy. Fig 5.1 and 5.3 shows the training for 200 to 500 epochs. This can detect an image with two classes that is presence of kidney stone and absence of kidney stone. We have used Streamlit to execute the results as it is an open source python library for machine learning and data science. After predicting, if the data contains kidney stone that image is processed with filters to remove background noise and the stone area is highlighted with this we can analyze the stone area and size. Based on that further treatment can be proceeded. Main advantage is that the identification of the level. It is the main in the clinical treatment.

5.1 Output for Training Images

```
# Training
Training_model = model.fit(training_set,
                            steps_per_epoch= 10,
                            epochs= 200,
                            validation_data= validation_set,
                            validation_steps = 10)

Epoch 1/200\n10/10 [=====] - ETA: 0s - loss: 0.0102 - accuracy: 1.0000
WARNING:tensorflow:Your input ran out of data; interrupting training. Make sure that your data
-----
10/10 [=====] - 46s 5s/step - loss: 9.4705e-05 - accuracy: 1.0000
Epoch 196/200
10/10 [=====] - 47s 5s/step - loss: 1.5512e-04 - accuracy: 1.0000
Epoch 197/200
10/10 [=====] - 46s 5s/step - loss: 1.1135e-04 - accuracy: 1.0000
Epoch 198/200
10/10 [=====] - 45s 4s/step - loss: 4.5200e-04 - accuracy: 1.0000
Epoch 199/200
10/10 [=====] - 48s 5s/step - loss: 3.2217e-05 - accuracy: 1.0000
Epoch 200/200
10/10 [=====] - 45s 5s/step - loss: 1.8052e-04 - accuracy: 1.0000
```

Fig. 5.1: Training process for 200 epochs

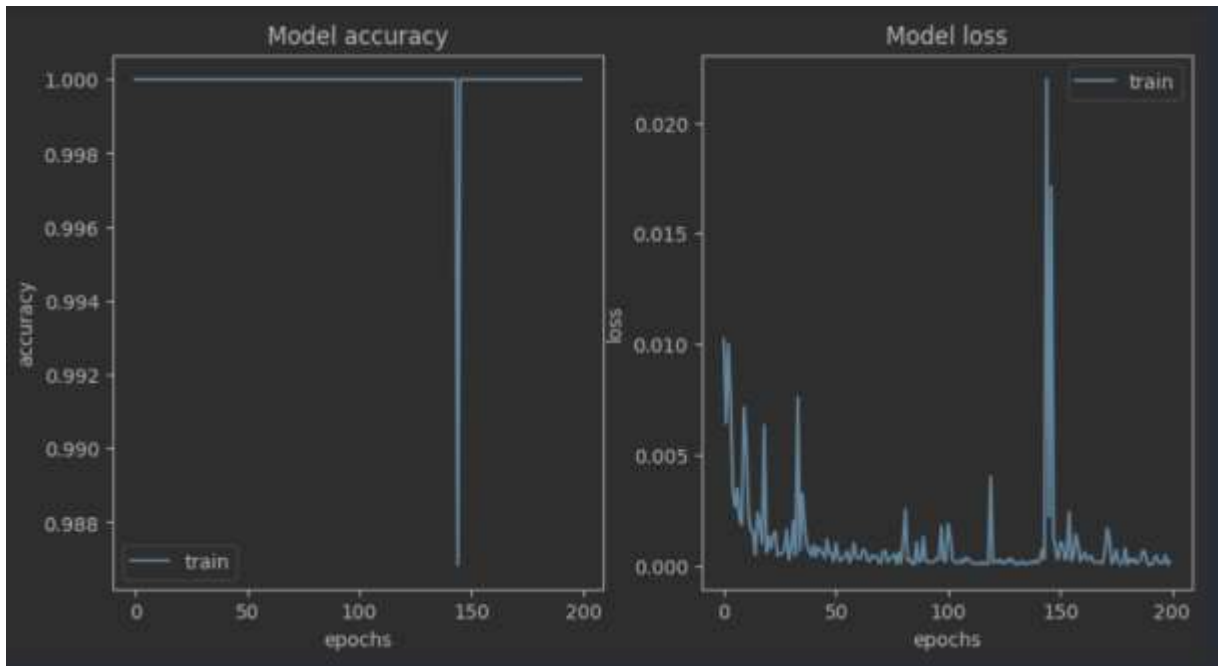


Fig. 5.2: Model Accuracy and Model Loss Graph for 200 Epochs

```

# TRAINING
Training_model = model.fit(training_set,
                           steps_per_epoch= 20,
                           epochs= 500,
                           validation_data= validation_set,
                           validation_steps = 20)

Epoch 1/500\n20/20 [=====] - ETA: 0s - loss: 0.9088 - accuracy: 0.4781\nWARNING:tensorflow:Your
20/20 [=====] - 84s 4s/step - loss: 0.4975 - accuracy: 0.7697\nEpoch 39/500\n20/20 [=====]
20/20 [=====] - 85s 4s/step - loss: 0.1907 - accuracy: 0.8833\nEpoch 140/500\n20/20 [=====]
20/20 [=====] - 85s 4s/step - loss: 0.1370 - accuracy: 0.9719\nEpoch 241/500\n20/20 [=====]
20/20 [=====] - 85s 4s/step - loss: 0.1003 - accuracy: 0.9781\nEpoch 322/500\n30/20 [=====]
20/20 [=====] - 112s 6s/step - loss: 0.0799 - accuracy: 0.9750\nEpoch 403/500\n20/20 [=====]
-----
20/20 [=====] - 85s 4s/step - loss: 0.0448 - accuracy: 0.9986
Epoch 496/500
20/20 [=====] - 85s 4s/step - loss: 0.0448 - accuracy: 0.9986
Epoch 497/500
20/20 [=====] - 85s 4s/step - loss: 0.0617 - accuracy: 0.9986
Epoch 498/500
20/20 [=====] - 85s 4s/step - loss: 0.0560 - accuracy: 0.9844
Epoch 499/500
20/20 [=====] - 85s 4s/step - loss: 0.0424 - accuracy: 1.0000
Epoch 500/500
20/20 [=====] - 85s 4s/step - loss: 0.0488 - accuracy: 1.0000

```

Fig. 5.3: Training process for 500 epochs

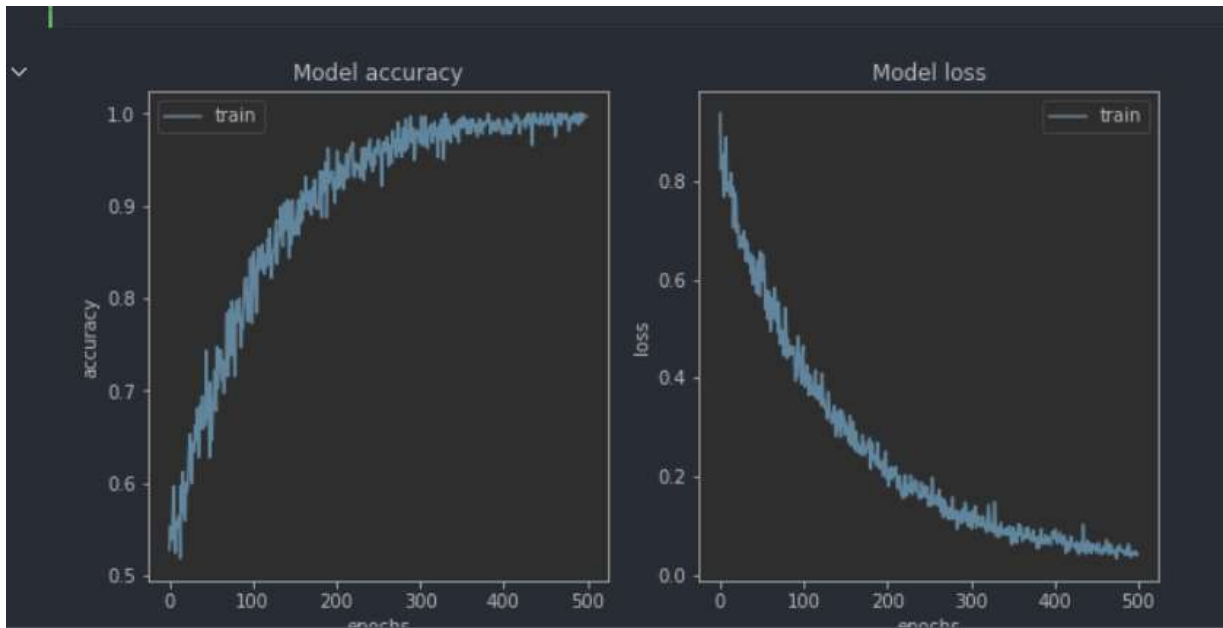


Fig: 5.4: Model Accuracy and Model Loss Graph for 500 Epochs

Epochs	Accuracy	Loss
50	0.7188	0.5529
100	0.8250	0.3961
200	0.9594	0.1773
300	0.9563	0.1301
400	0.9906	0.0534
500	1.0000	0.0480

Table.5.1: Model Accuracy and Model Loss

The datasets in the previously mentioned images were trained using Convolutional Neural Networks (CNN) with various epoch sizes, such as 200 and 500, and their model accuracy and model loss are also displayed in Fig 5.2 and 5.4. Depending on the data, the output for 200 epochs ranges from high to poor for loss and from low to very high for the accuracy. For 500 epochs, the accuracy is gradually increasing and the loss is gradually decreasing.

5.2 DEVELOPMENT OF WEBSITE USING STREAMLIT SOFTWARE

Following the training phase, a platform for the identification of kidney stones is built utilising the streamlit software. This website allows users to upload trained images, which are then processed to determine if kidney stones are present. The projected kind will draw attention to the typical if kidney stones are absent.

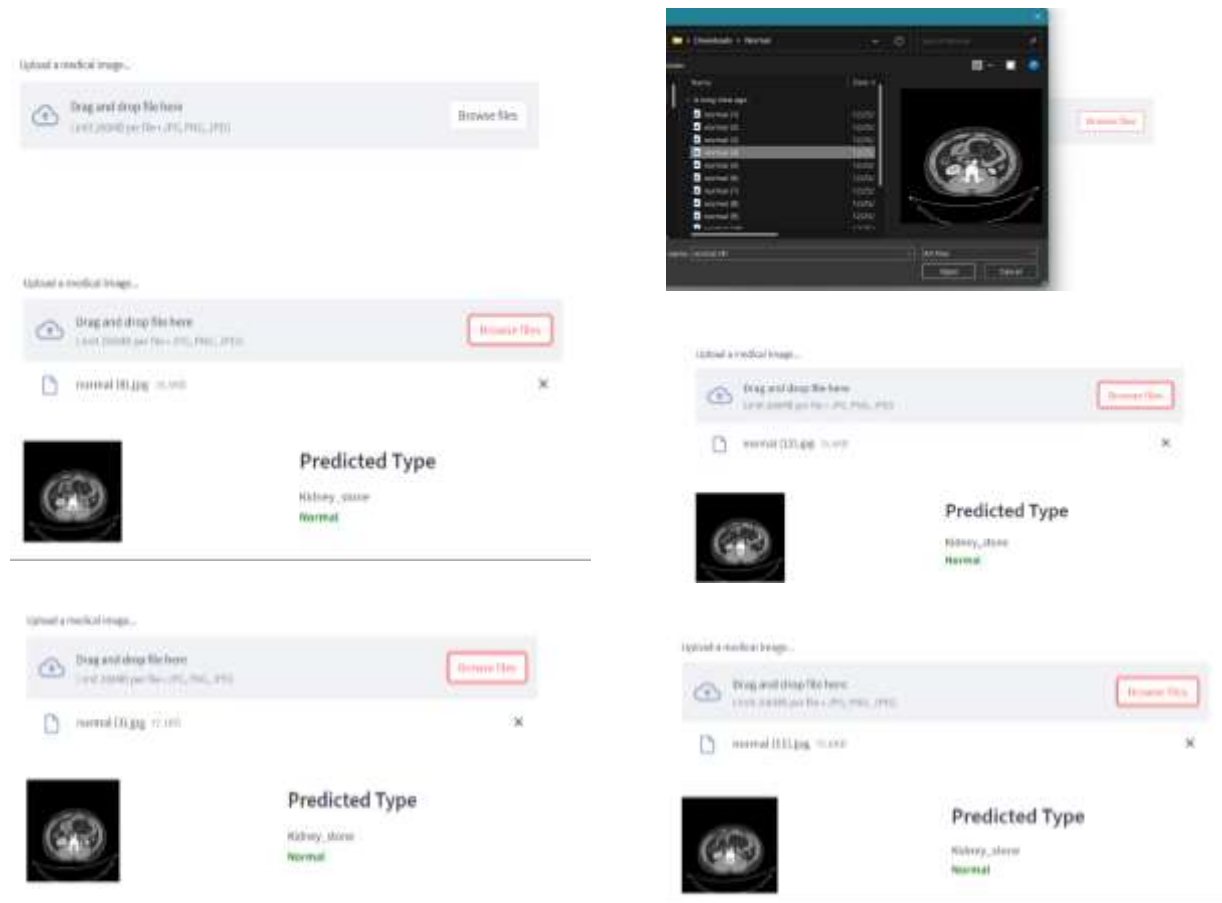


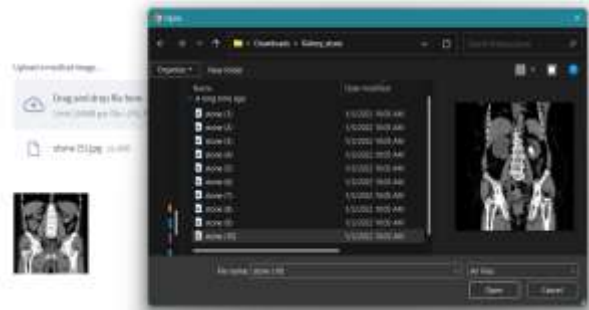
Fig. 5.5: Output Images for Absence of Kidney Stone (Normal)

The images that needs to be predicted either kidney stone is present or absent is uploaded in the webpage that is using the Streamlit software. Once the website is open it ask to upload the image. After uploading the image the website starts running then predicted type displays the presence and absence of kidney stone. The Fig.5.5. Describes the uploaded image has normal kidney.

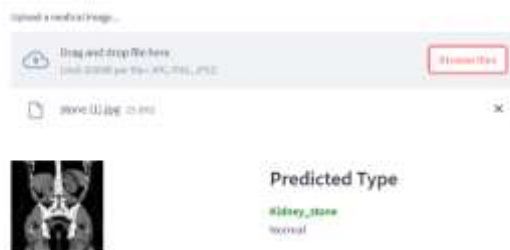
Kidney Stone Detection from Medical Images



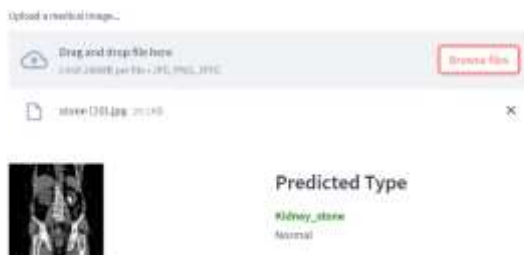
Kidney Stone Detection from Medical Images



Kidney Stone Detection from Medical Images



Kidney Stone Detection from Medical Images



Kidney Stone Detection from Medical Images



Fig. 5.6: Output Images for Presence of Kidney Stone

The projected type will draw attention to the kidney stone if it is there. The Fig.5.6. Describes the uploaded image has kidney stone. Once kidney stone is predicted it is run with another code where the kidney stone image is analyzed and the kidney stone presence region is highlighted.

5.3 HIGHLIGHT THE REGION OF RENAL CALCULI

The Image segmentation is done using watershed software.

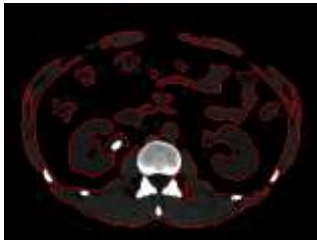
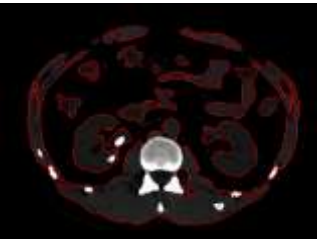
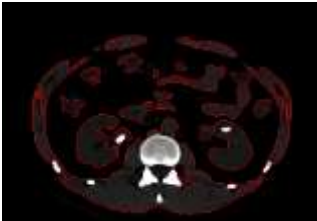
INPUT IMAGE	NOISE REMOVAL	BACKGROUND REMOVAL	OUTPUT IMAGE
			
			
			
			
			

Table.5.2: Highlighting the Kidney Stone Region.

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

The deep learning technique used in this model's development relates to the detection of kidney stones utilizing CT scans. We successfully trained the model using Keras and Tensor Flow. The images were successfully resized. CNN performs image recognition. Kidney stone presence and absence are classified in the dataset of the input images. The necessary findings are achieved with Streamlit, and the kidney stone-presence region is highlighted. The model created can be utilized to discover numerous abnormalities because it takes less time and produces instantaneous results.

6.2 CONCLUSION

Due to its propensity to produce accurate results, image processing opens the door for kidney stone identification since computer-aided diagnosis tools are feasible techniques. Machine learning algorithms are referred to as artificial intelligence, a new trend. So, in the field of AI, using deep learning techniques, it is possible to detect kidney stones automatically using CT images. Finding anomalies like stones, cysts, etc. is made easier because to the introduction of automated kidney stone detection methods.

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