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A Survey on Analysis of Medical Images using Deep Learning Approach

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Abstract -- Artificial intelligence and machine learning over the last decade have had a major impact on the healthcare industry as these innovative analytics strategies become more accurate and applicable to a variety of tasks.In computer vision and speech recognition applications, deep neural networks exceed human or other machine learning skills. These capabilities have lately been used to healthcare issues such as computer-assisted detection/diagnosis, disease prediction, image segmentation, and image synthesis, among others.This paper proposesaComparative evaluation of Image Detection and classification techniques using Deep Learning approach to diagnose human bodydisease particularly Lung abnormalities.

Keywords -- CNN, Deeplearning, Medical Image, Classification , Segmentation

I. INTRODUCTION

The Artificial Intelligence (AI) is the major field to display human intelligence in a machine.The artificial intelligence is the major domain and machine learning and deep learning are subsets of this domain.Deep Learning is a subset of Machine Learning that involves neural networks with three or more layers.

Computer vision is a branch of artificial intelligence (AI) that allows computers and systems to extract useful information from digital photos, videos, and other visual inputs, as well as conductactions or make recommendations based on that data.A lot of data is required for computervision. It repeats data analysis until it detects distinctions and, eventually, recognizes images.Deep learning, a sort of machine learning, and a convolutional neural network (CNN) are two key technologies utilized.
Image Detection and Classification are the two techniques normally applied in Medical Image Analysis.Medical Image analysis tasks includes : feature extraction and representation, feature selection for classification, and feature and image classification.

The detection of images or objects is a computer-based technologythat processesand detects the image. Convolutional neural networks (CNNs) are deep neural networks which have the functionality to categorize and section images.An Encoder and Decoder models are made use in CNN Architecture for Segmentation.An Encoder and Decoder models are made use in CNN Architecture for Segmentation.Image classification involves a computer that can can analyse an image and perceive the ‘class’ the picture falls under.

Various actions are performed before capturing the output into a medical image.First,the medical image is injected as input to the deep learning algorithm . The image is then divided into various segments and the area of interest is magnified.Information retrieval technology then extracts features from these segments.Then the required characteristics are selected and noise is removed.The data extracted is then classified using a classifier after which predictions are done using the data classified.

II. MODERN IMAGING TECHNIQUES

Medical Images are typically used by Radiologists to diagnose and treat disease.It involves different imaging modalities and techniques to image the physical body for diagnostic, treatment and follow up purposes and plays a crucial role to enhance public health.Some of the modern Imaging Techniques include:

1. X-rays

X-rays are a type of radiation called electromagnetic waves. X-ray imaging creates pictures of the inside of a body. The images show the parts of the body in different shades of black and white.

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2. Magnetic Resonance Imaging (MRI)

Magnetic resonance imaging is a medical imaging technique that uses a magnetic field and computer-generated radio waves to create detailed images of the organs and tissues in your body.The MRI machine can produce 3D images that can be viewed from different angles.

3. Computed Tomography (CT)

Computed tomography is an imaging procedure that uses special x-ray equipment to create detailed pictures, or scans, of areas inside the body. It is sometimes called computerized tomography or computerized axial tomography (CAT).

4. Ultrasound Imaging

Ultrasound imaging uses sound waves to produce pictures of the inside of the body. It helps diagnose the causes of pain, swelling and infection in the body's internal organs and to examine an unborn child (fetus) in pregnant women.

5. Nuclear Medicine Imaging

Nuclear medicine imaging is a method of producing images by detecting radiation from different parts of the body after a radioactive tracer is given to the patient. The images are digitally generated on a computer and transferred to a nuclear medicine physician, who interprets the images to make a diagnosis.

III. CNN-BASED DEEP NEURAL SYSTEM

Convolutional Neural Network, also known as CNN is a sub field of deep learning which is mostly used for analysis of visual imagery.CNN is a class of deep feed-forward artificial neural networks (ANN).CNN detects distinct features from images all by itself without human intervention.They are normally used to segment and classify images and are particularly most suited for Medical Imaging Domain

1. CNN Architecture for Classification

CNN Architecture for Classification involves the following layers:Convolutional layer,Pooling layer and a Fully Connected layer as shown in Fig. 1. Convolution and Pooling layers are used for Feature Extraction.Feature detection can be done using Convolution layer while Feature Selection is performed using Pooling layer.

Fully Connected layer receives the output from Convolution and Pooling layer for Classification

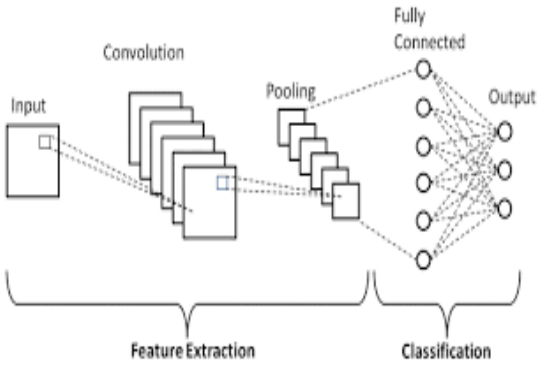

Fig. 1. CNN Classification Architecture

2. CNN Architecture for Segmentation

Segmentation involves dividing a input into segments for image analysis.Segments are made up of sets of one or more pixels.The Architecture involves the use of Encoders and Decoders as shown in Fig. 2.The Encoder is a Convolutional neural network that encodes the input image to a Latent space representation and then the Decoder is a Transposed neural network that decodes the representation.

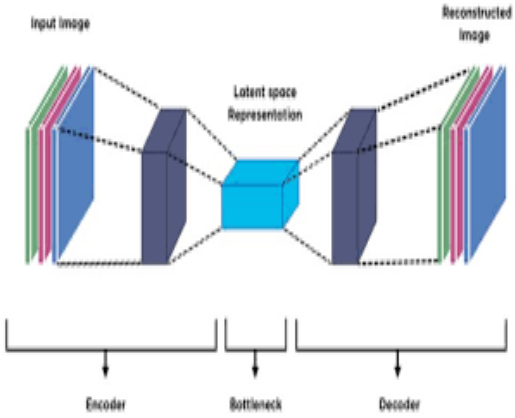

Fig. 2. CNN Segmentation Architecture

IV. COMPARATIVE EVALUATION

Medical imaging is one of the most popular disciplines in which deep learning is being studied extensively.Most of the pre-trained models seem to fail on medical images.In terms of Efficiency,deep learning in medical imaging should produce powerful and human-like results.However the Medical Imaging analysis domain often faces difficulty in terms of workforce expertise,production and Data.

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Dataset related to Medical Imaging domain are normally rarely seen when compared with other domains.Normally Machine Learning or Deep learning models when fed with good vast amounts of data,usually performs better.So due to rarity of medical images, a model cannot perform unless fed with vast amount of medical data.Radiologists who are familiar with deep learning Techniques are also rare.Annotating and Analyzing a medical image requires a lot of time,practise and effort .

TABLE I. shows a Comparative Evaluation of Medical Image Analysis techniques.Supervised Deep Learning techniques are the most used for Analyzing medical Images.Especially Convolutional Neural Networks(CNN) have been frequently used and have achieved good results.The Performance was found to be sub-optimal in challenging medical problems and very less when low training examples are fed.Systems or Hardware with high Computational power and speed are usually required to run Deep network models.

TABLE : Comparative Evaluation of Medical Image Analysis techniques

Samir S. Yadav and Shivajirao M. Jadhav [6]	Deep Convolutional neural Network based medical image classification for disease diagnosis	2019	X-ray	1.Performance comparision of three differant classification methods 2.Analysis of Data Augmentation	SVM with ORB,transfer learning of VGG16 and InceptionV3 ,training capsule network	CNN is an excellant feature extractor and is utilized to classify medical images and 2.Augmentation improves Performance	1. Too complicated transforms of the picture introduce some noise in the feature 2. 2.A very complex network is hard to train as a result accuracy is still low.	Augmentation Parameters - Rotation,short Range,zoom Range,Horizontal Flip	SVM with ORB - 0.776 and VGG16 - 0.923
Ioannis Livierisa et al [7]	Detecting Lung Abnormalities from X-rays using an improved SSL Algorithm	2019	X-ray, CT	1.performance of proposed EnSL Algorithm against the self-labeled algorithms 2.Statistical Comparision between all compared semi-supervised algorithms	Algorithms - EnSL, Self-training, Co-training, Tri-training,Co-Bagging, CST-Voting,Co-Forest	EnSL was the most efficient and robust method.It exhibited highest accuracy and performance	Iteration results were not stable	Sensitivity,Specificity,F-measure and Accuracy	>70%
MATEJ GAZDA et al [8]	Self-Supervised Deep Convolutional Neural Network for Chest X-ray Classification	2021	X-ray	1.Propose a neural network that solves pretext tasks 2.Utilize the pretrained CNN as a feature extractor	1.Train a deep CNN in a self supervised fashion 2.CXR Classification	The obtained results of unsupervised model are competitive with supervised counterparts and accurate CXR Classification	1.Some Datasets are compiled from X-ray images from differant Institutions,which could result in bias	AUC,Sensitivity,Specificity	AUC = 97.7%
Hisaichi Shibata et al [9]	Versatile anomaly detection method for medical images with semi-supervised flow-based generative models	2021	X-ray and CT	1.Predict the logarithm posterior probability that a medical image is normal 2.Train model with normal and non-normal images	Adopt two FDG model in conjunction with Bayes' Theorem	Computer-aided Detection system can reduce workload on Radiologists and the method has no constraints on density estimator	The performance is inferior to that of the most recent supervised discriminative models and impossible to indicate the lesions with the method	ROC Curve	AUC ≈ 0.98 for CXRs , AUC ≈ 0.99 for BCTs
David Olayemi Alebiosu,Fermi Pasha Muhammad [10]	Medical Image Classification: A Comparison of Deep Pre-trained Neural Networks	2019	X-ray	1.Train VGG-16 and AlexNet on ImageNet 2.Generate a model for the Classification task	1.Convolutional Neural Network 2.Support Vector Machine	CNNs potential was fuuly utilized by training on large scale datasets	Obtaining a high classification accuracy for individual class is difficult and some images were misclassified	Classification accuracy percentage	VGGNet-16 + SVM = 79.60 % , AlexNet + SVM = 84.27%

Ke Yan et al [11]	DeepLesion: automated mining of large-scale lesion annotations and universal lesion detection with deep learning	2018	CT	1. Develop a DeepLesion Dataset 2. Develop Automatic Lesion Detection Algorithm based on RCNN	1. Use CT Images with RECIST diameters as Annotation tool 2. MXNet deep learning framework with VGG-16 as backbone	The Dataset contains all kind of Radiology findings and the detector can help find all types of lesions.	Lack of complete labels,missing annotations and noise in lesion annotations	FROC,Sensitivity	Sensitivity = 81.1% at 5FPs per Image
YAN KUANG et al [12]	Unsupervised Multi-Discriminator Generative Adversarial Network for Lung Nodule Malignancy Classification	2020	CT	1. Dataset Construction 2. Model Training 3. Malignancy Classification	1. Construct sample dataset using LIDC-IDRI dataset 2. Encoder and MDGAN model 3. Test dataset using the model	Unsupervised learning was succesfully applied to classify lung nodules with better classification results	clinical image dataset of pulmonary nodules has the problem of a few data and missing labels	(A)Accuracy (S)Sensitivity (Sp)Specificity	A-95.32% S-94.15% Sp-90.78%
ParnianAfshar et al [13]	3D-MCN: A 3D Multi-scale Capsule Network for Lung Nodule Malignancy Prediction	2020	CT	Input 3D patches of the nodules at three different scales and predict nodules's malignancy	3D-Multiscale Capsulenetwork-CapsNet	Overcomes shortcomings of CNN And handles small datasets	Whole nodules were not well represented in single 2D slices and failed to generate satisfactory predictions since only central slice was considered.	(A) Accuracy, AUC,(S) sensitivity ,(Sp)Specificity	A-93.12% AUC= 0.9641 S-94.94% Sp-90%

V. CONCLUSION AND FUTURE WORK

Recent advancements in the field of Machine Leaning and Deep Learning has had a major impact on Medical Image Analysis because of it's self learning capabilities ,cost effectiveness and reduced workload on Radiologists.The Paper evaluated here attempts to give a comparative Evaluation on Medical Image Analysis Techniques like Classification and Segmentation.Majority of the diseases examined here are related to Lung abnormalities like pneumonia and Lung Cancer.

The Advantages, drawbacks and parameters considered for each method are reviewed.In future,more Medical images are to be annotated and processed in order to get rid of the issue of rarity of Medical images.So with large amount of data,the model performs efficiently with better results.

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