**Engineering and Technology Journal for Research and Innovation (ETJRI)**
**ISSN 2581-8678, Volume IV, Issue I, Jan 2022**

# A Review on Medical Image Analysis using Deep Learning

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***Abstract*— This extensive survey is based on analysis and processing of medical images like MRI, CT Scan, PETs, Ultrasound, X-rays which play a vital role in healthcare sector. Artificial Intelligence is being applied extensively for the analysis of images. Machine Learning and Deep learning, the subsets of AI are used thouroghly for the analysis purpose. Many ready made software frameworks like NiftyNet, MIScnn are being employed. Various parts of the body like brain, lungs, retina, and breast are studied. Various processes or techniques of image processing like classification, segmentation, localization, detection and registration have been dealt with in case of medical images. Convolutional Neural Networks and Deep Neural Networks have been used for the analysis of medical images. This is all about big data so big image datasets like ImageNet have been used. Matlab, Python and R language can be used for the analysis.**

***Keywords*—Deep Learning, Medical Image Analysis**

## I. INTRODUCTION

Various fields of life are using Artificial Intelligence (AI). Medical and healthcare sector is not untouched by ANN, ML and then ultimately deep learning. CNNs are used for various medical image analysis purposes. Field of X-ray radiology [1], Ultrasound, CT scan, Medical Resonance Imaging (MRI) scans, positron emission tomography (PET) are being improved using DNNs and CNNs [2]. Gone are the days, when medical images had limited datasets. Now a day, big data is being analyzed and evaluated using deep learning techniques. Many software algorithms and softwares like NiftyNet [3] and MIScnn [4] are being developed continuously, particularly used for medical image analysis. Imaging techniques like classification, segmentation, localization, detection and registration are being studied [5]. Medical application areas like neuro, retinal, pathology, cardiac, breast etc are being studied [6].

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## II. CONVOLUTIONAL NEURAL NETWORK

CNNs have many layers like input layer, Rectified Linear Unit (RELU) layer, pooling layer and output layer decide whether image is disease infected or not [5]. Image acquiring, image artifact removal, normalizing images and image quality improvement is done using different deep learning methods [7]. Supervised and unsupervised learning techniques have been used for these purposes [5].

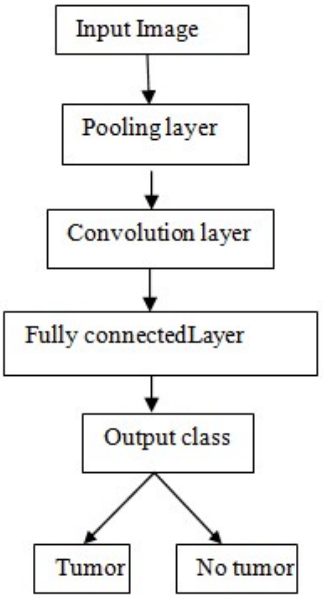


Fig.1 CNN layered architecture

## II. MEDICAL IMAGE ANALYSIS IN PRESENT DAY

X. Chen et al. (2021) – In this paper, image registration algorithms have been studied. This paper discusses all deep learning based medical

registration since 2013. Various image registration methods in recent times are studied [8].

Muller & Kramer (2021) - In this paper, open-source Python framework MIScnn is discussed for image segmentation. It is used for deep learning model training, prediction and evaluation. MI Scan is run on Kidney Tumor segmentation. It is an open source library available at Git repository [4].

Jungo et al. (2021) – Pymia is an open source Python based package for data handling and evaluation in medical image processing using deep learning. Data handling is flexible (2D, 3D, full or patch wise) with independence of deep learning framework. Integrating smoothly in the present deep learning frameworks like TensorFlow and PyTorch. Functionalities like result calculation and reporting (CSV files, console) and training progress monitoring. Large number of domain-specific metrics for image segmentation, reconstruction and regression, AlexNet, U-net, GPUs and increase in data availability enhanced impact of deep learning [9].

Xie et al. (2021) – Computer aided detection/diagnosis has progressed a lot. It is used for lung cancer, breast cancer, glaucoma and skin cancer. Datasets like ImageNet, COCO, ChestXray14 and DeepLesion suffer from small dataset. Knowledge and experience i.e., domain-knowledge of doctors are added in these datasets to improve them. Additional knowledge is incorporated from natural datasets or other medical datasets. Training and diagnostic pattern of medical doctors is added to datasets. Lesions are detected using improved datasets [10].

Ma et al. (2021) – Adverserial attacks/examples can compromise with medical deep learning systems. Adverserial attacks can be detected easily [11].

Wiestler & Menze (2020) – In this paper, advancement in deep learning have developed neural network algorithms surpassing human performance in image classification and segmentation. Computer scientists and neuro-oncologists are going hand-in-hand for understanding deep learning techniques. Building blocks of artificial neural network like convolutional neural network are studied. Imaging features like genotype are also explained. Hurdles in wide use of algorithms are explained [12]

Renard et al. (2020) – In this paper, medical image segmentation tool is used. It is used for clinical diagnosis and computer assisted surgeries. Accuracy is improved by deep learning algorithms in comparison to classical segmentation. Deep learning methods are complex in nature. They have high variability so calls for reproducibility of results. In this literature review, variability and reproducibility for medical images using deep learning technique have been studied. Mainly, three fields are studied (1) framework of deep learning (2) variability sources (3) segmentation results evaluation [13].

Smailagic et al. (2020) – O-MedAL, an online deep learning method for medical image analysis is dealt with. MedAL AL framework is extended. Technologies machine learning and classification are used in healthcare application areas. Active Learning (AL) is studied in detail on the basis of novelty, accuracy, data efficiency and computation efficiency [14].

Zhu et al. (2019) – In this paper, overview of deep learning for neuroimaging methods are used. Radiological clinical applications for classification, risk assessment, segmentation, etc., AI techniques are also employed for image acquiring, image artifact removal, normalizing images and image quality improvements, reducing radiation dose and reducing time interval of imaging [7].

Maier et al. (2019) – Reasons for popularity of deep learning are studied. Fundamentals like basic neuron and other artificial neural networks are studied. Network training and deep learning are also discussed. Important architectures in deep learning like Auto-encoders, Generative Adversarial networks (GANs), Google's Inception network, Ronneburger's U- net, ResNets, Variational networks, RNNs are dealt with. Advanced deep learning concepts like Data Augmentation, Precision learning, Adversarial examples, Deep reinforcement learning are also touched upon [15].

Latif et al. (2019) – In this paper, image

classification, object detection, pattern recognition, etc. are surveyed. Deep learning supervised and unsupervised learning techniques have been used for prediction using standard dataset. Accuracy is increased by extracting meaningful patterns for some particular diseases. This is a survey kind of paper regarding ML anddeep learning methods for medical images [16].

## III. MEDICAL IMAGE ANALYSIS FEW YEARS BACK

Yoon et al. (2019) – In this paper, automated analytical systems as a database system are used for improving medical images using computers. Construction of large data is done. Deep learning AI architectures are used for high precision diagnosis of medical images. Labeling and standardization of medical images is done. Quick and accurate final diagnosis results are observed. Data augmentation is done through rotation, by left and right flips to increasethe data.

Lundervold & Lundervold (2019) - Medical image processing using Deep learning is done especially considering MRI. ANN, ML then deep learning improved medical data analysis and diagnostics. Focus, in this paper, is on MRI like MRI acquisition, retrieval, segmentation to disease prediction. Big data, software frameworks, computing ability, use of neural networks is deeper than previous times. Building blocks of CNN like convolutional layers, Pooling, Dropout regularization and Batch normalization are discussed. CNN architectures like AlexNet, VGG, GoogleNet, ResNet, Highway nets, Densenet, ResNext, SEnets, NASNets, YOLO, GANs, Siamese nets, V-net are compared. Process from image acquisition to image registration is explained [18].

Budd et al. (2019) – In this paper, role of humans in fully automatic deep learning is found to be beneficial. In future research, human-in-the-loop computing needs to be explored. Key areas discussed are 1) Active Learning, 2) Interpretation and refinement, 3) Practical considerations and 4) Related areas are explored [19].

Fourcade & Khonsari (2019) – In this paper, the problem investigated is whether algorithms of deep learning may increase visual diagnosis in medicine. Systematic study of research papers in various medical arenas like Dermatology, Thoracic, Senology, O-M-F surgery, Gastro-enterology are studied [20].

Gibson et al. (2018) – NiftyNet which is an open source platform for medical imaging is dealt with. It accelerates and simplify deep learning solutions. NiftyNet helps in imaging applications like segmentation, regression, image generation and representation [3].

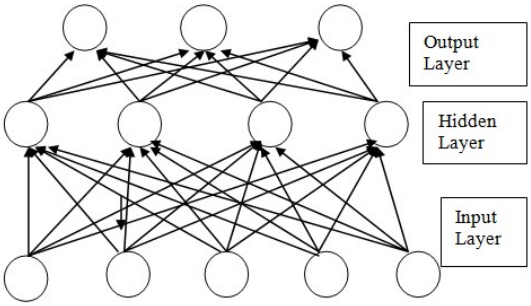


Fig 2. Artificial Neural Network

Razzak et al. (2018) – In this paper healthcare sector which is using deep learning with good accuracy is discussed. Quest for deep learning and machine learning is discussed. ANN and deep learning architecture is studied. Comparison of various architectures is done like DNN, CNN, RNN, Deep Conventional Extreme Learning Machine (DC-ELM), Deep Boltzmann Machine (DBM), Deep Belief Netwok (DBN), Deep Auto-encoder (dA). Applications like diabetic Retinopathy, Histological elements detection, Gastrointestinal (GI) disease detection, Alzheimer's and Parkinsons disease detection is done [21].

Dinggang Shen et al. (2017) – In this paper, deep models like feed forward neural network unsupervised feature representation learning, stacked auto-encoders, deep belief networks, deep Boltzmann machine, CNNs are studied. Organ or body part detection, cell detection is done. Deep learning detection and diagnosis are studied with the help of computer system [30]. Ker at al. (2017) – History of Medical image processing is studied in this review paper. CNNs, convolution layers, Rectified Linear Unit (RELU) layer, fully connected layer are studied in case of supervised learning models. Auto-encoders, Restricted

Boltzmann Machines and DBNs, generative adversarial networks are studied in case of unsupervised learning models. Usage of medical image analysis like classification, localization, detection, segmentation, registration are dealt with [5].

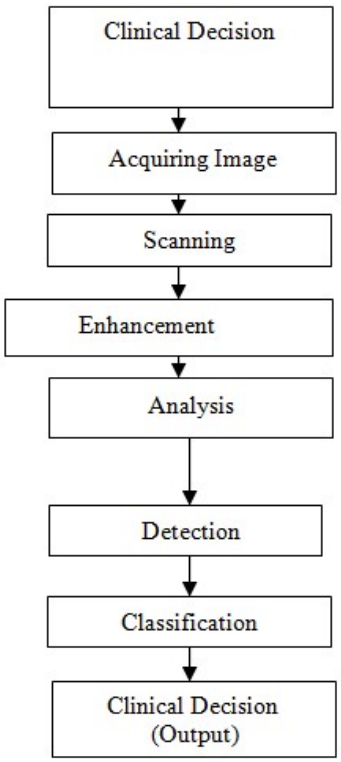


Fig.3. Flowchart

Bhat (2017) – This survey deals with deep learning for object detection, image classification, segmentation and registration. Application areas are neuro, retinal, pathology, cardiac and breast [6].

M. Chen et al. (2017) – Computed tomography is used to help disease diagnosis. Computer assisted diagnosis (CAD) using AI has shown importance in healthcare. Labeled dataset for CT analysis creates a lot of problem. In this paper, convolutional encoder deep learning framework is used for lung nodules. It requires a small amount of labeled data for learning of features. Convolutional encoder method can be used for similarity measurement of lung nodule images [22].

Pawlowski et al. (2017) – In this paper, DLTK (Deep Learning Toolkit) for medical image analysis is discussed. DLTK is based on TensorFlow. FCN and U-Net are tested. It is especially created for biomedical image analysis. U-Net is proved better than FCN except in case of right adrenal gland [23].

Litjens et al. (2017) – Very extensive survey on CNN technique. Use od deep learning for image classification, detection, segmentation etc. is surveyed. Supervised and unsupervised learning algorithms are discussed. Deep CNN architectures are studied. Deep learning uses for lesion classification, organ localization, lesion detection, segmentation and registration are surveyed. Image retrieval, image generation and enhancement also discussed [24].

De Bruijne (2016) – In this paper, image diagnosis, and disease prognosis and risk assessment using machine learning are studied. Three main factors discussed are (1) variation in imaging protocol, (2) learning from weak labels and (3) interpreting and evaluating results [25].

Cho et al. (2015) – In this paper, Convolutional Neural Networks (CNN) are used for natural image classification systems. It has given very good results. Use of CNN systems to medical image classification is very promising. But without accuracy goal cannot be achieved. Optimum size of training data set is determined for high accuracy with low variance [26].

Bar et al. (2015) – In this paper, deep learning techniques are examined for pathology detection in chest radiograph data. CNNs are used because they can learn mid and high level image representations. CNN is explored for different pathologies in chest X-ray images. Non- medical learning deep learning technique is used. ImageNet is used to train CNN [1].

Xu et al. (2014) – In this paper, automatic extraction of feature representation is done using deep learning (DNN). Multiple instance learning (MIL) framework is used for classification training with deep learning features. Automatic feature learning is better than manual feature. Unsupervised technique can reach nearly equal performance to fully supervised technique [27].

Brosch & Tam (2013) – In this paper, many times learning of medical images for modeling anatomical parameters including applications like segmentation & registration. Many times learning method uses layered networks ( deep belief networks DBNs).

DBNs are being employed in computer vision because of object recognition. Efficient training technique for DBNs for training 3D medical images practically [28].

Alison Noble et al. (2011) – For more informative clinical information of medical images like X-ray, computed tomography, magnetic resonance imaging (MRI), positron.

## IV. CONCLUSION

R language and even Matlab can be used for the analysis of various medical images. Deep learning toolbox can be very useful for further investigation and improvement of medical images. Though different techniques of Artificial Intelligence, machine learning and deep learning have been extensively used in this review for the analysis purpose.

**Acknowledgment:**

We owe special thanks to Prof (Dr) Raghavendra Sharma HOD ECE department and staff of Amity University for making this review possible and making possible to study various aspects of the topic.

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