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Review on Deep Learning Algorithm in Medical Image Analysis

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Abstract **-** The computer-assisted analysis for better understanding of images has been long-lasting issues in the medical imaging field. Deep learning algorithm is a convolution neural network which has rapidly developed into a methodology of selection for analyzing medical images. Deep learning helps in identifying, classifying, and quantifying the patterns in medical images. This paper reviews the deep learning concepts applicable to medical image analysis. It gives the insight about the use of deep learning for image classification, summarizes the challenges in deep learning and also points out the future direction in medical image analysis using deep learning.

Keywords: *Deep learning, Convolution neural network, Image Classification, Medical Image Analysis.*

I. INTRODUCTION

Deep learning allows computational models that are composed of combined supervision layers to learn representations of data considering complex levels of abstractions. It improves the state of art in visual recognition of objects, audio recognition and many supplementary domains such as genomics and drug discovery. It solves the problem associated with using artificial intelligence and it takes artificial intelligence to the next level[1]. Some of the deep learning algorithms used in researches are Convolutional Neural Networks (CNN), Deep Belief Network (DBN), Deep Neural Network (DNN), Recurrent Neural network (RNN), Deep Boltzmann Machine (DBM), Deep Autoencoder (DA), Deep Conventional Extreme Machine Learning (DC-ELM)[2].

For early detection of abnormalities, medical imaging techniques namely magnetic resonance imaging (MRI), computed tomography (CT), mammography, positron emission tomography (PET), ultrasound, and X-ray are used. The medical images are interpreted by the physicians and radiologist but it is a time consuming process and error may occur in detecting abnormalities from the image. Nowadays the medical images are analysed using image processing techniques but still there are prone to error and it is mostly semiautomatic. After the successful usage of deep learning techniques in other applications, it also provides a better solution for medical imaging with good accuracy [3]. It is used to diagnose the abnormalities and it is also used to measure the predictive target and offers prediction models to help the doctors efficiently[2]. Image classification is one of the first areas which got the major contribution from deep learning in medical image analysis. Though deep learning has given a major contribution to medical imaging there are various issues and challenges to be addressed. Being an emerging technique, a review on recent development is a timely needed one. The motivation of this survey is to give the review on deep learning based image classification algorithms in medical image analysis.

II. REVIEW ON DEEP LEARNING BASED IMAGE CLASSIFICATION

Hosseini-Asl, et al. [4] proposed a 3D CNN to detect the Alzheimer Disease (AD) from the brain MRI. Firstly the features namely the shape variations in the brain MRI are extracted using 3D – Convolutional Autoencoder (3D CAE). Then the 3D CNN is fine tuned for each specific AD classification. It outperforms several classifiers by robustness and accuracy. Sarraf and Tofighi [5] proposed CNN to classify AD from healthy brain in functional MRI and MRI images. The rate of detection for abnormalities in fMRI is 99.9% and for MRI the rate is 98.84% respectively. Then classification is performed on subject level and in this the decision making algorithm is applied. Finally accuracy got improved up to 97.77% and 100% for MRI and fMRI datasets. Kim, et al. [6] proposed a deep semantic mobile application to classify the disease at the cellular level (cytopathology). Initially the feature is extracted using deep neural network, and then to classify the cytopathological images deep convolution neural network is used. It shows the improvement of 70% classification accuracy on deep convolution neural network. Pan, et al. [7] worked on the comparative study of brain tumor grading performance between convolution neural network and back propogation neural network. The testing and training datas are MRI of 213 patients. The comparison is done based on the sensitivity and specificity. It shows the improvement of 18% on convolution neural network grading performance. Gao, et al. [8] proposed deep CNN to extract feature and classify the Human Epithelial-2 (Hep-2) to diagnose autoimmune disease. By applying data augmentation to the classification techniques, the proposed framework got better than the other existing models. Suk, et al. [9] proposed a Deep Boltzman Machine (DBM) to classify AD and MCI. The effectiveness of the proposed method is validated by performing experiments on the ADNI datasets. The maximal accuracy is 95.35% and it outperforms other competing methods.

Table 1: Some of the Deep Learning Based Image Classification Techniques

AUTHOR	TITLE	METHODS	REMARKS
Brosch, et al. [10]	Manifold learning of brain MRIs by deep learning.	DBN	AD classification is done using DBN with restricted Boltzman Machines (RBM) for

			manifold learning.
Suk, et al. [11]	Latent feature representation with stacked auto-encoder for AD/MCI diagnosis.	Stacked Autoencoder (SAE)	Using SAE the latent features are represented and AD and Mild Cognitive Impairment (MCI) is classified.
Ortiz, et al. [12]	Ensembles of deep learning architectures for the early diagnosis of the Alzheimer's disease.	DBN	DBN along with Support Vector Machine (SVM) is used to classify Ad and MCI
Kim, et al. [13]	Deep neural network with weight sparsity control and pre-training extracts hierarchical features and enhances classification performance: Evidence from whole-brain resting-state functional connectivity patterns of schizophrenia.	DNN SAE	The schizophrenia is classified using the DNN. The performance of DNN is improved using SAE.
Pinaya, et al. [14]	Using deep belief network modelling to characterize differences in brain morphometry in schizophrenia.	DBN	Supervised fine tuning is done on DBN to classify schizophrenia from the brain images.
Payan and Montana [15]	Predicting Alzheimer's disease: a neuroimaging study with 3D convolutional neural networks.	3D CNN SAE	The AD is classified from the brain using 3D CNN and SAE.
Suk and Shen [16]	Deep ensemble sparse regression network for Alzheimer's disease diagnosis.	CNN	CNN on sparse representation is found by regression model and using this this AD is classified.

III. CHALLENGES IN DEEP LEARNING

There are several challenges in applying deep learning to medical imaging. Some of the challenges are large number of training datasets are not available [13], the image acquisition of labels and annotations, labelling a large data consumes more time [17], If the images are annotated by the experts then also noise of the labels limits the development of algorithm [15]. In medical imaging mostly classification is presented as a dual task: foreground versus background, normal versus abnormal. However, this is often a gross overview as both classes can be highly varied. For example, the normal class frequently consists of completely normal tissue but also several types of slight abnormalities, which can be exceptional, and may rarely, include an extensive variety of imaging artifacts. Identification of slight abnormality is also a challenging task [17]. An uncomplicated solution would be to turn the deep learning system into a multiclass system by offering it with comprehensive annotations of all possible subclasses.

IV. RESEARCH FUTURE DIRECTION

In most medical image analysis multichannel images or 3D gray-scale are used, which needs pre-trained systems. The supervised deep learning systems can be changed to unsupervised system to overcome the annotation problem. The dataset unavailability can be resolved by the collaboration of inter-organization to improve the health quality.

CONCLUSION

Compared to the machine learning algorithm, deep learning plays a vital role in the automation of day to day life. Still use of deep learning in medical image analysis is quite slow compared to the other real world problems. In this survey, we highlighted the deep learning based image classification in medical image analysis. Then we have highlighted the challenges in using deep learning in medical image analysis. One of the large obstacles is unavailability of annotated dataset. Without affecting the deep learning performance, will we get enough training dataset is still a question. Recent development on other application shows that bigger the data, better the result. So far deep learning based image classification provides positive feedback. Lastly we conclude that there are limitless opportunities to improve the medical image analysis using deep learning.

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