Deep Convolutional Neural Networks (CNN) for Medical Image Analysis

N. Deepa, SP.Chokkalingam

Abstract: ***Deep learning plays an important role in prediction and analytical process. Deep learning applications are recognizing patters, recognizing speech, NLP (Natural Language Processing), etc. It is a subset of machine learning and its techniques raise research interests as it solves many problems which could not be approached before. This paper provides detailed analysis of deep learning and its techniques used in various applications and especially to provide an extensive reference for the researchers in deep learning and its algorithms, implementation techniques and applications used in recent technologies. This paper will also help to improve investigation of deep learning and highlights new research areas and advancements of technology.***

I. INTRODUCTION

Artificial Intelligence (AI) is an important field of computer science which thriving enormous research hotspots and applications. AI is an attempt of human intelligence and generates intelligent machines that process information. Its main agenda is to cultivate brain–like machines [1]. AI has been part of many fields like robotics, NLP (Natural Language Processing), Expert-System, Image Processing, etc. Machine Learning (ML) is act as a core for AI and comprises different kinds of disciplines like convex analysis, approximation, probability and complexity theory. Machine learning technology provides computers the capability to computations without any pre-programmed. In order to improve performance of a computer, Machine Learning utilizes induction as well as synthesis concepts [2]. Machine Learning technology implemented in different kinds of fields especially diagnosing diseases and bioinformatics. Machine and Deep learning technology plays a vital role in computer field and it act as an expert for predictions and making decisions. Deep learning technology is a kind of machine learning technology [3]. These technologies used to extract the data and process for as per requirements. The fundamental idea of Deep learning is to acquire data representations by improving abstraction levels. Different kinds of architectures for deep learning have proposed including Convolutional Neural Network (CNN), Deep Auto-Encoder, Deep Neural Network (DNN), etc. [4]. Image processing is the growing concept in medical field. Image processing delivers significant information on decision making. Different kinds of steps are followed on medical field before obtaining output [5]. Medical image is given as input to the deep learning and it is partitioned into segments in order to concentrate on important area. Next, those segments are used to extract significant information with the help of information retrieval techniques[6]. Then the required features are obtained without noise by using noise removal techniques. The obtained data classified by using classifier and predictions are done by using classification. These steps are followed for every experiment performed in machine and deep learning [7].

Generally the machine learning algorithms are classified as the following [8].

- ✓ Supervised learning
- ✓ Semi-supervised learning
- ✓ Un-Supervised learning
- ✓ Reinforcement learning and
- ✓ Active learning

Where as in deep learning, the techniques are advanced concepts of machine learning which classifies data and predictions are done accurately by using Neural-Networks [9]. Large amount of information used to build a large neural network.

In the field of medical, diagnosing diseases is a challenging task. The health care department gives a huge data for the evaluation of medical diagnostic, patient details, treatment methods, prescriptions and supplementary data etc. [10]. These data associated with unsuitable or irrelevant data which is viewed as the main challenge to remove. So the mining is essential to process the report efficiently and effectively. Different kinds of algorithms are available in machine learning for specific classifier usage [11]. This classifier distributes the data according to its characteristics or nature.

Machine learning techniques are used to find data sets [12]. The recognizing pattern is the key concept of machine learning which retrieves information from medical images for identification of diseases and treatments [13]. The following diagram represents the steps used in machine learning and deep learning algorithms.

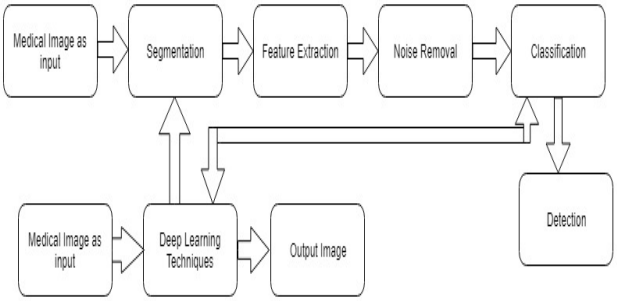

Figure 1. Deep Learning Workflow

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II. DEEP LEARNING APPROACH IN MEDICAL AREA

Characterized data obtained by learning features for the issues given [14]. This kind of knowledge followed in various deep learning techniques. In these deep learning model techniques, different layers or stages used to convert given images into target images which give details about particular diseases [15]. The model used for analyzing image is called as CNN (Convolutional Neural-Networks). The CNN model has various stages or layers which convert given input to targeted output by using convolutional filters [16].

A. Classifications

1. Classifying Images

The main motive of deep learning is to explore issues related to clinical in order to provide treatments earlier [17]. The classification is done by giving several images to produce a single diagnostic image which states disease exists or not. According to this concept, test taken for diagnosing is considered as a model. In [22], the features extracted by modifying images and obtained 57.6 percentage of accuracy with the help of multiclass evaluation technique for knee osteoarthritis [18][19]. The cytopathology technique produces 70.5 % for CNN information retrieval.

2. Classifying Objects

The classifications of object are essential for concentrating chunks in medical images. In CNN techniques, more than two classes are used to highlight chunks [20]. The retrieved information about chunks is essential for the betterment of accuracy. The patching images in CNN techniques have the various measures of objects [21].

B. Organ Detection and Region Detection:

Classification followed by finding of objects and its localization is the subsequent level of CNN techniques. Segmentation is an important stage in which extraction takes place [22][23][24]. Significant details of an objects and removing noise while retrieving important information are done in segmentation pace. The deep learning based 3 Dimensional data parsing techniques are used to handle issues raised while removing noises. MRI chunks of 2 dimensional and 3 dimensional are used to find the regions of objects. These objects emphasis diseases like heart descending aorta, aortic arch.

C. Segmentation

Image substructure processes are done in this segmentation stage. This process analyzes quantitatively for image features [25][26]. Brain examine or cardiac examine is the best example for this scenario. Identification of particular pixels for objects is done in CAD functions. These pixels are making up the objects noticeably. The up-sampling layers combined with down-sampling layers in U-net merges convolution samples and de-convolution samples [27].

D. Registration

Transformation from different data sets into a one coordinate process is called registration. This is an essential step which provides assessment or incorporating data from various perspectives, depth, sensors and time etc. [28]. This iterative process offers to choose particular category of bounds or parameters to specify standard. Similarity calculations for two images using deep learning techniques are done in this process [29]. Patient details are obtained in this and also can perceive growth of diseases, remedy validations and assessments patient details through anatomical plans.

Newly, different modalities have emerged together to diagnose diseases as well as treatment for accurate results. This registration process requires combining various modality data. More number of registration methods based on learning techniques proposed to get finest correlated features. However, this process requires known correspondences a lot especially in training progression. To overcome this drawback, unsupervised learning technique is proposed to retrieve features of image for MRI modality registration [30].

III. RESULTS & DISCUSSIONS

Deep learning is one of the multifaceted technologies. Researchers require more time to attain the deep learning techniques. More number of tools designed for deep learning in recent decades and suitable for investigators or researchers. Some widely used tools used in deep learning as follows [31][32].

- Caffe Tool:

It is an industry level based tool and most familiar in the computer vision area. It is designed as open framework developed by Yangqing Jia. Fast running, fine tuning, training models without any codes, specializing in processing images and supporting Python API (Application Program Interface) are the identified pros. Scalability issues, needs code for new layers, a lot of extension and dependence and network structure based on layers are the weakness of this tool [33].

- Torch Tool:

This tool is based on scientific computing and can support more number of machine learning based algorithms. This is tool is developed with C and supports all technologies. Flexibility, optimistic, easy to write codes for new layers, supports computational schemes based on Lua and pre trained prototypes are the main advantages of this tool. Steep learning, network structure based on layer, no scalability and python API supporting issue are the main drawbacks of this tool [34].

- Theano Tool:

The MIT (Montreal Inst. of Tech.) developed this tool in the year 2008. This tool is implemented using Python language. It has packages like Pylearn2, Keras etc. which supports deep learning. It is an architecture based on symbolic tensor model. The main advantages are flexibility, recursive network support, portability and it has many packages based on high level deep learning. The major

weaknesses are compilation issues, code modification difficulties and low number of pre-trained prototypes [35].

- TensorFlow Tool:

It is an open source developed by Google and compatible with legacy deep learning neural networks. It uses data flow grids for numerical computation. Every single node in this data flow signifies a mathematical operation. Similarly every edge signifies data arrays. This tool is platform independent. The advantages are high quality, supports different GPUs, faster, rapid development, distributed training and good portability. The main drawbacks of this tool are it requires larger memory space; pre-trained prototypes are low and dynamic convolutional input operations are not supported [35].

Table 1 presents the results obtained from experiments using tools.

S.No	Name Of Image Data Set	Number of Images	Classification SOTA	Detection SOTA	Segmentation SOTA	Action SOTA	Key point Detection SOTA	Recognition SOTA
1	IMAGENET	150 images per each of 3k synsets	3.57% top-5 error (ResNet 2015)	73.1 mAP for 85 object categories.	NA	NA	NA	NA
2	PASCAL VOC	7k labeled images	NA	75.9 mAP at IoU = 0.5	89.0 mAP	NA	NA	NA
3	MS COCO	200k labeled images containing 1.5M instances of 80 classes	0.52 mAP at IoU = s0.5:0.05:0.95	NA	0.48 mAP	NA	0.76 mAP	NA
4	SPORTS-1M	1M sports videos of average length-5.5mins 609abeled for 487 sports classes	NA	NA	NA	73.3%	NA	YES
5	YOUTUBE-8M	8M YouTube videos that are between 2-10mins have at least 1000 views and labeled for 4800 entities. The average video length is about 4 minutes.	NA	NA	NA	0.839 GAP(Global Average Precision)	NA	YES
6	CIFAR-10	100 classes with super classes that contain 500 training images and 100 test images.	YES	NA	NA	NA	NA	NA
7	CIFAR-100	101 classes with 40-800 images per class with dimension 300×200 pixels	YES	NA	NA	NA	NA	NA

Table 1 Data set values obtained using tools

IV. CONCLUSION

The main motive of this survey is to give valuable insights to apply deep learning techniques in MRI modal based area. Deep learning techniques have been implemented in MRI based image analysis and processing. The deep learning helps to classify disease pattern enumeration and categorize from the processing of image. It permits to enhance analytical goals also generates prediction prototypes for the betterment of treatment. The researchers from medical image consider these tasks as challenges for continuing to flourish. This deep learning grows rapidly in health care based applications and it will conquer significant accomplishments in the medical field.

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