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An Exploration on the Implementation of Deep Learning in Medical Image Processing

Padma Priya J

Abstract— Image processing is a strategy to play out certain tasks on an image, so as to get an upgraded image or to extricate some valuable data from it. It is a kind of signal processing wherein input is an image and output might be image or attributes/highlights related with that image. Image processing fundamentally incorporates three stages: bringing in the image by means of image procurement devices; dissecting and controlling the image; outcome in which result can be an adjusted image or report that depends on image examination. Image improvement and categorization are the significant territories in image processing. Image upgrade systems are numerical strategies that are planned for acknowledging improvement in the nature of a given image. Image grouping comprises of database that contains predefined designs that contrasts and distinguished article to arrange in to legitimate classification. Early Artificial Intelligence (AI) frameworks utilized example coordinating and master frameworks. The thought behind Machine Learning (ML) is that machine can learn without human mediation. The machine needs to figure out how to effectively deal with an assignment given the information. Deep Learning (DL) is the achievement in the field of AI. DL is a subset of ML in AI that has systems equipped for learning unaided structure information that is unstructured or unlabeled. DL models, with their staggered structures are useful in separating convoluted data from input images. DL is used in medical image processing for different areas like image reconstruction, lesion detection, detecting and classifying lesions in mammogram, reducing of unnecessary thyroid biopsies, therapeutic image segmentation, medical image handling, radiology, medical image classification, medical image investigation, Medical Resonance Imaging (MRI). In this article, the uses of Deep Learning in various zones of medical image processing are examined.

Index Terms— Artificial Intelligence (AI), Artificial Neural Networks (ANNs), Deep Convolutional Neural Networks (DCNNs), Deep Learning (DL) algorithm, DeepLesion, Machine Learning (ML), Medical Resonance Imaging (MRI).

1 INTRODUCTION

Machine Learning (ML) is an area of study that permits computers to gain from information or experience and make an expectation dependent on the experience. It empowers the computers or the machines to settle on information driven choices as opposed to being explicitly programmed for completing a specific assignment. These programs or algorithms are planned such that they learn and improve after some time when are presented to new information.

ML can be divided into three classifications. They are supervised learning, unsupervised leaning and reinforcement learning. In supervised learning, we have marked information containing input X and a label Y. Our assignment is to discover the mapping between the variable (X) named the independent variable and the variable (Y) named the dependent variable. In unsupervised learning you just have input information (X) and no corresponding output variables. The aim of unsupervised learning is to show the basic form or delivery in the details so as to learn more about the information. Reinforcement learning, concerning Artificial Intelligence (AI), is a sort of exceptional programming that trains calculations using a game plan of remuneration and discipline.

- *Padma Priya J is an Assistant Professor at GITAM School of Technology, GITAM (Deemed-to-be-University), Bengaluru, India. She has Bachelors Degree in Electronics and Communication Engineering, Masters Degree in Communication Systems from Anna University, and Master of Business Administration in Human Resource Management. Her area of research interest lies in Wireless Communication, Image Processing, Fiber-optic communication, and Antennas. Email: padmapriyacollege@gmail.com*

A Reinforcement learning algorithm learns by interfacing with its condition. The operator gets awards by performing precisely and punishments for performing incorrectly. The specialist takes in without intercession from a human by extending its prize and constraining its punishment.

Deep Learning (DL) is a subset of Machine Learning that manages calculations roused by the structure and capacity of the human cerebrum known as Artificial Neural Networks (ANNs). As neural framework will mimic the human cerebrum so Deep Learning is in like manner a kind of copy of human psyche. The work flow of Deep Learning is as per the following.

To start with, recognize the real problem so as to get the exact solution and it should be understood. The feasibility of Deep Learning also should be checked (whether or not it should fit Deep Learning or not). Second, we need to recognize the significant details that should compare to the actual problem and ought to be arranged appropriately. Third, select the Deep Learning Algorithm appropriately. Fourth, algorithm should be used while training the dataset. Fifth, last testing should be done on the dataset.

Uses of DL are vast and lot of technologies presently utilizes DL to improve the task. Some areas where DL used are Self-driving cars, Voice search and virtual assistants, Machine translation, picture caption generation, Colorization of Black and White Images, Medical imaging, Real-time object recognition in the image (Google lens).

This paper describes the applications of DL in medical image processing. Image acquisition and interpretation are very much important for the precise findings of disease. Picture securing gadgets have enhanced drastically over the ongoing years. For example at present radiological images are obtained (X-Ray, CT (Computer Tomography) along with MRI checks and so forth) with higher resolution. Even though the image acquisition devices have enhanced drastically, image interpretation methods still required improvement. Here is the application of ML or DL. Nowadays, it is possible to get big amount of data regarding a particular disease due to improved technology in acquiring medical images. But the data obtained is of the broad variety from patient to patient. Because of this, conventional learning strategies are not dependable. ML has advanced in the course of the most recent couple of years by its capacity to move through mind boggling and large information.

DL systems have gotten the genuine standard for a wide assortment of computer vision issues. They are not constrained to picture processing, be that as it may, are beating various procedures in zones like normal language handling [1], [2], [3], speech recognition and synthesis [4], [5] and in the examination of unstructured, tabular-type information utilizing substance embeddings [6], [7].

Medical care uses of DL run from one-dimensional bio-signal examination [8] and the expectation of medical occasions, for example seizures [9] and heart failures [10], to computer-aided detection [11] and finding [12], supporting clinical dynamic and endurance investigation [13], to sedate revelation [14] and as a guide in treatment determination [15], to expanded operational productivity [16], stratified consideration conveyance [17], and examination of electronic wellbeing records [18], [19].

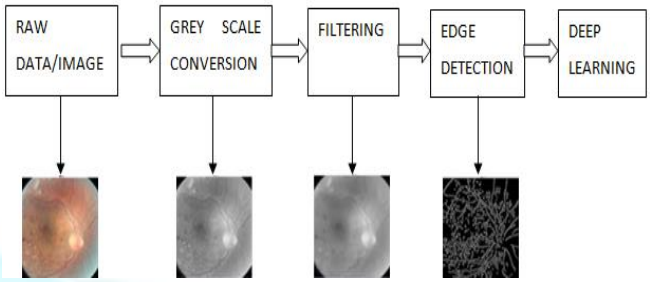
The rest of the paper is arranged as follows. The section 2 explains latest work done in medical image processing based on DL. A discussion based on different works mentioned in section 2 based on the results obtained are carried out in section 3 and section 4 is the conclusion.

2 DEEP LEARNING IN IMAGE PROCESSING

In this segment, the applications of DL within different areas of Medical Image Processing are to be discussed. Many researchers have already worked in these areas. Fig. 1 depicts the simple block diagram of the image processing with DL.

In Fig. 1, raw data or the images which was collected or extracted has noise like blur and more contrast. Therefore it is hard to separate the wanted highlights from the pictures that results in miss-classification of information in the course of training, validation and testing. To extract appropriate characteristics, image processing is required for features identification or features extraction. Here, raw data is first changed over into grey scale that is by changing RGB (Red Green Blue) (3-bands) picture to grey-scale (1-band) picture. The grey-scale picture is passed through any of the suitable filters based on the requirement to discard noise and all the pixels are standardized to the information around the pixel power esteems.

From the separated picture, highlights, for example, white lesions and a small number of fine veins can be extracted. To highlight the features edge detection is tried on this contrast information. For Deep Learning algorithm, this edge



recognized picture is taken as input for proper classification.

Fig. 1. Block diagram of the image processing

DL is classified into two categories: Supervised and Unsupervised. Labeled data and unlabeled data are dealt with supervised and unsupervised learning respectively. Interrelationships between data elements will be learnt by the machines. Convolutional Neural Network (CNN) along with Residual Neural Network (RNN) mostly popular DL supervised learning models. The generally famous DL unsupervised learning models are Deep Belief Neural Network (DBNN) along with Auto-encoders. For medical image characterization and segmentation CNN is used. For characterization RNN is used. DBNN is also implemented for segmentation. Auto-encoder is utilized for characterization and segmentation. This is represented schematically in Fig. 2.

In [20], it was mentioned that DL furnishes exciting answers with great precision for medicinal imaging and it is a key technique for future applications in medical field and discussed how DL architecture and its most effective is utilized in medical image segmentation and categorization and also the confrontation DL based techniques for medical imaging and open research problem. They have concluded that DL has increased a focal position towards the computerization of our day by day life and conveyed extensive improvement when estimated to conventional ML algorithms and in the next 15 years, DL based implementations will assume control over human and the majority of the day by day exercises will be carried out by autonomous machine. They have also highlighted the huge obstruction is inaccessibility of explained dataset i.e. whether enough training data will be got without affecting the exhibition of DL algorithms and therefore reduces the growth of DL in health sector.

Suvajit Dutta et al. [21] have mentioned that, for immense measure of dataset and implementations requesting complex functions demanding increased precision with lesser time complexities DL systems are vanquishing over the predominant conventional methodologies of Neural Network. DL procedures are used for medical images such as Diabetic

Retinopathy (DR) and Computed Tomography (CT) data. Fundamental image processing and k-means clustering for detection of image severity tiers and Artificial Neural Network (ANN) was applied on the information to get the fundamental categorization outcome was proposed. This article also finds how different ML algorithms can be actualized for a supervised way to deal with to get exact outcomes with less difficulty feasible. It is concluded that for approval of the training labels with grouping upgrade the training accuracy. Single band and multiband images were used in which both DNN (Deep Neural Network) and CNN will be able to distinguish pixel intensities all the more precisely. It was also suggested that with the CPU (Central Processing Unit) training DNN performs superior to different systems.

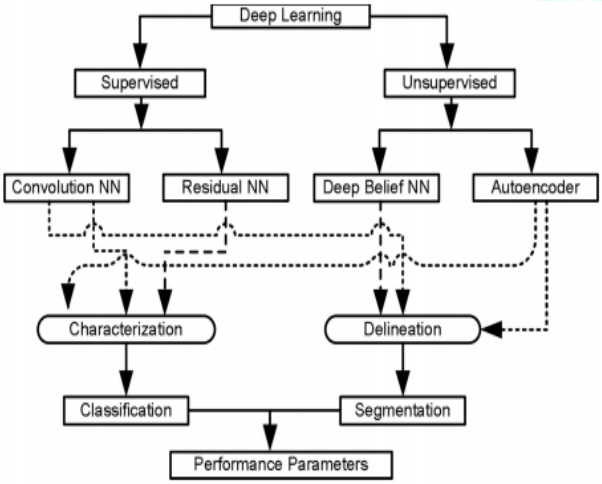


Fig. 2. Classification of DL models and their implementations in image characterization and segmentation

Application of ML algorithm in medical image investigation was reviewed pointing on CNN [22]. Key research fields and utilizations of medical picture categorization, localization, recognition, segmentation, and registration were covered in this article. They have concluded that in medical picture examination, the absence of information is two-overlap and increasingly intense: there is general absence of openly accessible information, and scarce of excessive standard labeled information and also the ML algorithms have outperformed human execution in picture acknowledgment errands and perform superior to people in medical picture examination.

Computer Aided Design (CAD) framework dependent on one of the best object identification structures, Faster R-CNN (Region-Convolution Neural Network) was proposed by Dezso Ribli et al. [23]. Without any human intervention the framework identifies and groups malignant or benign lesions on a mammogram. The technique sets the cutting edge order execution on public INbreast database, AUC (Area Under the Curve) = 0.95. The methodology depicted here has accomplished second position in the Digital Mammography DREAM challenge with AUC = 0.85. The framework arrives at high affectability with not very many erroneous positive imprints per picture on the INbreast dataset when used as a detector. They have concluded that the technique depicted right now perhaps the best methodologies for cancer grouping in mammograms. This system was ready to distinguish 90% of the threatening sores in the INbreast dataset with just 0.3 incorrect positive imprints per picture. With no explanation or client connection the framework utilizes the mammograms as the main information. Consequently, the high-priced, conventional CAD results, that have contentious proficiency, could be exchanged with the latest evolved; DL based open source object location techniques sooner rather than later. With additional training information provided, these models can possibly turn out to be essentially progressively exact. Free Response ROC (FROC) Curve examination outcomes recommend that the suggested model can be applied as a discernment enhancer instrument that helps radiologists to identify more cancers.

Perone et al. [24] proposed a present, easy and end-to-end completely automated human spinal cord gray matter segmentation technique utilizing DL was devised which works on in vivo and ex vivo MRI (Magnetic Resonance Imaging) acquiring. The technique was evaluated against six independently created strategies on a GM (Gray Matter) segmentation task. It was concluded that this approach is the first to accomplish better outcomes in 8 out of the 10 measurements utilized in the SCGM (Spinal Cord Gray Matter) segmentation challenge. The whole expectation pipeline is streamlined utilizing back proliferation and gradient descent and this technique gives better outcomes to numerous measurements and significant parameter decrease. This methodology utilizing enlarged channels gives more than 6X parameter decrease contrasted with U-Nets, and furthermore outflanks different strategies in numerous measurements which is parameter-effective and that it can catch a progressively minimal portrayal of the information regularities when contrasted and increasingly complex models, for example, U-Nets. This suggested approach is tried on information gained utilizing Phase-Sensitive Inversion Recovery (PSIR) arrangement, however didn't work given that the model was not prepared on PSIR information into the current datasets before preparing the model or even via preparing a particular model for PSIR information.

An elevated level outline of how to construct a Deep Neural Network (DNN) for medical picture categorization was discussed in [25]. This paper concluded that, with just 65 training cases the intensity of transfer learning and DNNs, an accurate classifier was built that differentiated chest versus stomach radiographs with a modest quantity of code. ML was more accessible in medical imaging due to the accessibility of systems and elevated level libraries. It provided an establishment for those keen on beginning with ML informatics extends in medical imaging.

In this paper titled "DeepLesion: automated mining of large-scale lesion annotations and universal lesion detection with deep learning" by Ke Yan et al. [26] described how to mine and reap the bottomless review medical information to

construct an enormous scope lesion picture dataset and this procedure is versatile and requires negligible manual comment exertion. To create DeepLesion, a dataset with 32,735 injuries in 32,120 Computer Tomography (CT) cuts from 10,594 investigations of 4,427 exceptional patients was bookmarked in the institute. Several of lesion types in this dataset, as lung nodules, liver tumors, extended lymph nodes. It can possibly be utilized in different medical picture applications. A universal lesion detector was trained using DeepLesion that can discover a wide range of lesions with one bound together structure. 81.1% sensitivity was achieved using this proposed lesion detector with fine false positives per image. It was concluded that DeepLesion is made out of an assortment of lesions and has numerous potential applications and a general lesion finder was developed which can discover a wide range of lesions with one bound together structure. Its effectiveness was proved by qualitative and quantitative results.

Alexander S. Lundervold and Arvid Lundervold published "An overview of deep learning in medical imaging focusing on MRI" [27]. In this paper, a short outline of latest advances and some related difficulties in ML applied to medical picture preparing and picture examination was provided and particularly focused on DL in Magnetic Resonance Imaging [MRI]. This work give a beginning stage to individuals keen on testing and adding to the area of DL in medical imaging by calling attention to great instructive assets, cutting edge open-source code, and fascinating wellsprings of information and issues identified with medical imaging. They have concluded that as ML scientists and specialists acquire understanding, it becomes simpler to group issues as indicated by what arrangement approach is the most sensible: (i) best moved toward utilizing DL systems start to finish, (ii) best handled by a mix of DL with different strategies, or (iii) no DL segment by any stretch of the imagination.

In [28], discussed general purposes behind the fame of DL first, remembering a few significant leaps forward for software engineering. The fundamentals of perception along with Neural Networks were reviewed alongside some crucial hypothesis. Medical image processing is one of these areas particularly in picture identification and acknowledgment, picture segmentation, picture enrollment, and Computer-Aided Diagnosis (CADx). Likewise latest patterns in physical reenactment, demonstrating, and recreation have prompted shocking outcomes. A portion of these methodologies disregard earlier information and have the danger of creating impossible outcomes which is the current limitations of DL. Promising methodologies that may have the option to determine these issues later on was also briefly discussed. It was concluded that the area of DL and associated theory was introduced and the general outline on the area and possible destined implementations was provided. Particularly perceptual tasks were learned so far but with the arrangement of devices exhibited here it was believed that many more problems can be tackled and DL will most likely stay a functioning examination area for the coming years.

Application of DL in Image reconstruction was discussed in [29]. Key questions like, what are the difficulties in acquiring training information? Would we be able to find structures not present in the training information? What is the threat of deducing unverified picture details? were addressed in this paper. They have concluded that studied calculations will be the key for future computational advances in microscopy.

In [30], "Reduction of unnecessary thyroid biopsies using deep learning" was proposed by Zeynetti Akkus et al. In this paper, guided order framework utilizing DL that predicts danger of nodules from B-mode US was displayed. Transverse and longitudinal pictures of 150 benign and 150 harmful thyroid nodules with biopsy demonstrated outcomes were gathered. The dataset was separated into training (n = 460), validation (n = 40), and test (n = 100) datasets. Nodules from B-mode US pictures were physically portioned and the nodule cover is given as a subsequent information channel to the Convolutional Neural Network (CNN) for expanding the consideration of nodules regions in pictures. The exhibition of various CNN designs, for example, Inception and Resnet50 CNN structures with various information pictures was assessed. At the point when the limit was set for most noteworthy exactness the Inception V3 model demonstrated the best execution on the test dataset: 86% (sensitivity), 90% (specificity), and 90% (accuracy). The ROC curve recommended the quantity of biopsies might be decreased by 52% without missing patients with threatening thyroid nodules, when the limit was set for most extreme affectability (0 missed malignant growths). They have inferred that this exhibition can be additionally improved by including more patients into the training and extra data from different US modalities such as Doppler and Shear Wave

In this [31], a basic examination of well known strategies that have utilized DL systems for medical picture segmentation was presented. The most widely recognized difficulties were summarized and potential arrangements were suggested. The most well known system structures applied for medical picture segmentation was also summarized and their favorable circumstances over the precursors were highlighted. An outline of the fundamental preparing strategies for medical picture segmentation was given. It was concluded that this paper might assist researchers to pick appropriate system structure for their concern and should additionally know about the potential difficulties and the arrangements. Elastography images.

From the above discussion we can understand that DL can be utilized for medical picture processing in various stages. It very well may be utilized for picture identification and acknowledgment, picture segmentation, computer aided diagnosis, along with image reconstruction. The following section describes DL based method for diagnosing some specific diseases.

3 DEEP LEARNING FOR DIAGNOSING THE DISEASES

Accuracy is one of the major requirements while diagnosing the diseases. The methods based on DL provide

futuristic precision. DL provides new entryways in restorative picture investigation that have not been previously. Deep learning in medical care includes a wide scope of medical issues extending from cancer investigation and ailment observation to customized treatment proposals. Diabetic Retinopathy (DR) is a infection affecting eyes owing to Diabetic. As this illness won't show any side effects in its beginning times, it is very troublesome and tedious procedure to detect DR manually. In order to detect DR an expert should analyze the hued picture of retina which leads to defer the treatment. Automatic identification of DR using DL is a better solution. Gulshan et al. [32] tried Deep Convolutional Neural Network (DCNN) for identifying DR. They used Eye Picture Archive Communication System (EyePACS-1) dataset along with Messidor-2 dataset for categorization and discovery of moderate and more regrettable referable. A dropout layer technique for training the DCNN is used by Kathirvel [33] for identifying DR. Datasets such as Kaggle fundus, DRIVE and STARE in the classification of fundus used for training. Pratt et al. [34] used NVIDIA CUDA DCNN library in Kaggle dataset comprising of over 80,000 digital fundus pictures. They likewise approved the system on 5,000 pictures. Works mentioned above is summarized in Table I.

Table I: Summary of Deep Learning in Diabetic Retinopathy

Authors	Model	Dataset	Accuracy (Acc) or Sensitivity (Sens) or Specificity (Spec)
Gulshan et al.	DCNN	EyePACS-1	Sens: 98.6% Spec: 94.5%
		Messidor-2	Sens: 97.2% Spec: 94.0%
Kathirvel	CNN with Dropout Layer	Kaggle-fundus	Acc: 97%
Pratt et al.	Cu-DCNN Library	Kaggle-fundus	Acc: 76%

Many other works also have been done using DL for diagnosing or detecting diseases such as GastroIntestinal (GI) Diseases [35], [36], [37], [38], [39], [40], Tumor detection [41], [42], Alzheimer's and Parkinsons Diseases identification etc.

4 Conclusion

In this work, a review of the latest developments in Deep Learning used in medical image processing was conducted. For image detection, recognition and segmentation many works have been done based on Deep Learning algorithms and it outperform conventional methods. Deep Learning is not mostly used in the area of image registration. For some diseases, it is more difficult and tedious to detect as it is not showing any symptoms in its early stages. In such cases an expert should examine the data very carefully which leads to delay the treatment. One solution for this is Deep Learning dependent techniques which are used in detecting or diagnosing many diseases. Computer Aided Diagnosis (CADx) is another field where Deep Learning is used effectively. I also observed that the CNN architecture used along with Deep Learning is computationally very efficient. In order to get accurate results, Deep Learning required large amount of data. This is the limitation currently facing in the area of Deep Learning. Solution is to use the regular supervised training with updated data, which may help to fill the gap.

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