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A Review on Stroke Detection Using Convolutional Neural Networks

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ABSTRACT: Stroke is a serious medical condition in which poor blood flow to the brain causes cell death. Ischemic and Hemorrhagic are the two main types. Stroke when not treated properly on time, it may even lead to death or permanent disability. Usually doctors use medical imaging techniques like CT, MRI for the detection of stroke. This paper presents an overview of Convolutional Neural Network (CNN) based automatic system for stroke detection.

KEYWORDS: Brain Stroke, Convolutional Neural Network

I. INTRODUCTION

In most countries, stroke is one of the leading causes of death. Stroke is a medical emergency in which poor blood flow to the brain causes cell death. There are two main types of stroke: ischemic, due to lack of blood flow, and hemorrhagic, due to bleeding. Neuroimaging provides extensive information on the brain and vascular health. Multimodal CT and MRI delineate the hemodynamic of ischemic stroke that may be used to guide treatment decisions and prognosticate regarding expected outcomes. But in many cases the involved area of the brain does not appear abnormal for the first several hours after the onset of the stroke. Stroke when not treated properly on time, it may even lead to death or permanent disability. Researchers are investigating to find an optimum solution for this. Most of the inventions are based on the development of automatic system capable of detecting stroke from images. Convolutional Neural Networks (CNN) are proven to be efficient in pattern recognition and feature extraction from images. There are several CNN based automatic system developed for the purpose of assisting doctors in stroke detection. In this paper, we will explore some of the major works that can serve as a basis for the development of more advanced systems in future

II. LITERATURE SURVEY

Kamnitsas K, Chen L, Ledig C, Rueckert D, and Glocker B (2013) presented a multi-scale 3d convolutional neural networks for lesion segmentation in brain MRI [7]. A dual pathway, 11-layers deep, three-dimensional Convolutional Neural Network is proposed for brain lesion segmentation.The benefits of using small convolutional kernels in 3D CNNs was analyzed, which allow to develop a deeper and thus more discriminative network, without increasing the computational cost and number of trainable parameters. To overcome the computational burden of processing 3D medical scans, an efficient and effective dense training scheme is devised. Furthermore, an efficient solution for processing large image context by the use of parallel convolutional pathways for multi-scale processing is proposed, alleviating one of the main computational limitations of revious 3D CNNs.

Yanran Wang, Katsaggelos A K, Xue Wang, and Todd B Parrish (2016) presented a method for stroke lesion segmentation [6]. A novel method called Deep Lesion Symmetry ConvNet is proposed to automatically segment chronic stroke lesions using MRI. An 8- layer 3D convolutional neural network is constructed to handle the MRI voxels. MR imaging of the human brain demonstrates a symmetrical property on axial and coronal planes. When the stroke lesion occurs, the symmetrical property breaks down. Based on this intuition, two patches are extracted to describe one voxel, one is the original patch surrounding that voxel and the other corresponds to the symmetric patch in the opposite hemisphere. The two patches are fed into the network at the same time. The high average dice coefficient achieved demonstrates the effectiveness of the method. While the initial results are very encouraging, the topic deserves further investigations, especially in the special cases where stroke lesions spread not only in one hemisphere but in the whole brain.

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C. Chin et al.(2017) presented a method for automatic ischemic stroke detection system using CNN deep learning algorithm [5]. After entering the CT image of the brain, the system will begin image preprocessing to remove the impossible area which is not the possible of the stroke area. Finally, they input the patch images into the convolutional neural network for training and testing. CNN module which consists two convolutional layers, one max pooling layer and a single fully connected layer are used. Each convolutional layer includes a ReLU. Data augmentation is used as a solution to limited data. The accuracy of the proposed method is higher than 90%. It means that the proposed method can effectively assist the doctor to diagnose.

D.R. Pereira, P.P.R. Filho, G.H. de Rosa, J.P. Papa & V.H.C. de Albuquerque (2018) presented a method for stroke lesion detection using convolutional neural networks [4]. The problem of stroke detection in CT images is dealt using Convolutional Neural Networks optimized by Particle Swarm optimization (PSO).Two different kinds of strokes are considered, ischemic and hemorrhagic.The dataset comprises three different types of images for each case, i.e., the original CT image, one with the segmented cranium and an additional one with the radiological density's map. They also considered ImageNet for testing purposes and CIFAR-10 for testing intentions. The proposed method obtained classification accuracy close to 99%.

B.R. Gaidhani, R.R Rajamenakshi and S. Sonavan (2019) presented a method for Brain stroke detection using Convolutional Neural Network and Deep Learning Models [1]. Brain stroke is diagnosed from MRI using CNN and deep learning models. The proposed methodology is to classify brain stroke MRI images into normal and abnormal images and delineate abnormal regions using semantic segmentation. In particular, two types of convolutional neural network that are LeNet and SegNet are used. LeNet is used to classify normal and abnormal patient. Then this abnormal patient data is passed to SegNet which is auto encoder decoder model for segmentation which delineate abnormal regions. Accuracy got on classification model is 96% and segmentation model is 85%.The experimental results show that these deep neural networks are absolutely relevant to brain stroke diagnosis.

A. Kumar, A. Debnath, T. Tejaswini, S.Gupta, B. Chakraborty& D. Nandi (2019) presented a method for automatic detection of ischemic stroke lesion from multimodal MR image [3]. The proposed architecture is a fusion of bio-medical image segmentation architecture U-Net and multi path network that gives the model more flexibility towards deciding the amount of encoding/decoding needs to be done.This multi path architecture enables us to capture different levels of encoded state that helps in more robust decision making for the task of lesion segmentation. Experimental results show that the proposed model outperformed some of the other existing CNN based architectures. But the model requires some improvements for the detection of very small lesions.

H. Ko, H. Chung, H.Lee and J. Lee (2020) presented a feasible study on intercranial hemorrhage detection and classification using a CNN-LSTM Network [2]. The feasibility of automatic identification of intercranialhemorrhage (ICH) based on CNN and long short term memory (LSTM) is presented. Head CT images of five subtypes (Intraparenchymal, Intraventricular, Subarachnoid, Subdural and Epidural) of ICH are used. Xception model as a backbone consisting of 36 convolutionallayersare used for identificationand classification. It is then connected to an LSTM layer through aglobalaverage pooling layer. Finally, connected to fully connected layer and sigmoid. The proposed method enhanced the accuracy of ICH identification and classification.

DanfengGuo, Haihua Wei, Pengfei Zhao and Xin Wang (2020) presented a method that can simultaneously classify and Segment intracranial hemorrhage using a fully convolutional neural network [8]. Accurate detection, subtype classification and volume quantification of intracranial hemorrhage(ICH) are critical aspects in ICH diagnosis. A multi-task fully convolutional network, ICHNet, for simultaneous detection, classification and segmentation of ICH is proposed. The proposed framework utilizes the inter-slice contextual information and has the flexibility in handling various label settings and task combinations. It contains a shared encoder to extract features for both classification and segmentation tasks while utilizes a convolutional long short-term memory (ConvLSTM) module to capture the sequential information embedded in consecutive slices.Experimental results show that the architecture outperforms baseline models for both classification and segmentation tasks by a noticeable margin.

III. CONCLUSION

Stroke when not treated on time, it can cause serious health issues which may even lead to death or permanent disability. Fast and accurate treatment is thus a necessity. Doctors face several problems while finding out the occurrence of stroke using imaging methods. Sometimes it may not be visible for the naked eyes due to image quality,

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unknown delineation of objects etc. So the development of an automatic system can diagnose stroke using CT, MRI or any of the imaging modality. Convolutional Neural Network has found to be efficient in detecting features from the input images. Many of the systems developed using CNN has obtained higher accuracy, thereby assisting doctors in preliminary diagnosis. So the upcoming advancements in such type of automatic system can improve medical outcomes in the near future.

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