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BRAIN STROKE DETECTION USING CONVOLUTIONAL NEURAL NETWORKS

Akshaya M D[1], Farhan N[1,] Sreelakshmi S P[1] ,Anandhu Uday[1] ,Mithun Vijayan[2]
[1]Student , Department of Electronics & Communication Engineering
[2]Asst. Prof , Department of Electronics & Communication Engineering
Dr. APJ Abdul kalam technological university, kerala, india

Abstract : Public health burden of stroke is staggering throughout the world. Stroke is a medical condition in which poor blood flow to the brain causes cell death. Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) are the two frequently used modalities for brain imaging. Fast and accurate treatment is a necessity. Conventionally, medical images are analyzed manually for stroke detection. The development of automated systems can improve medical outcomes. Convolutional Neural Networks (CNN) have been shown to have excellent performance in automating multiple image classification and detection tasks. The proposed CNN architecture has 13 layers. In this paper we used 2000 images to train and test the CNN model. The model had obtained classification accuracy of above 90%. Thus the model has the capability to assist doctors in making preliminary diagnosis.

***IndexTerms* - Brain stroke detection; image preprocessing; 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. The World Health Organization (WHO) defines stroke as "rapidly developing clinical signs of focal disturbance of cerebral function, lasting for more than 24 hours or leading to death, with no apparent cause other than of vascular origin." The three major cerebrovascular diseases that stroke encompasses are: ischemic stroke, primary intracerebral hemorrhage and spontaneous subarachnoid hemorrhage. Among these ischemic stroke occurs more often, accounts for approximately 70-80%. It is also called as cerebral infraction. Hemorrhagic strokes are of two types: Intraparenchymal hemorrhage (IPH) and Subarachnoid hemorrhage (SPH). IPH is a medical condition characterized by bleeding within the brain, whereas SPH is characterized by vessel rupture in the cerebrospinal fluid (CSF) - filled subarachnoid space surrounding the brain. CT and MRI are the two frequently used imaging modalities preferred by doctors for stroke detection. These imaging techniques can provide relevant critical diagnostic information in the evaluation and treatment of patients. Clinical presentations and radiologic findings vary with types of stroke. Doctors use visual detection, pattern recognition, cognitive reasoning and memory for the interpretation of diagnostic conclusions from the image But there are some factors that limits this manual methodology of stroke detection. Limited number of experts in this field, unknown delineation of objects, heterogeneity of images are few of the aforementioned problems. These all make the overall diagnostic procedure tedious. Time taken by doctors to arrive at a clinical conclusion is crucial in this case. Because if stroke in the early stage is detected and proper treatment is provided, then there are chances of patient recovery to normal life. Else, it may cause irreversible health problems to the patient. To prevent those serious consequences, fast and accurate treatment is a necessity.

Considering the above stated problems, this paper presents an automatic stroke detection system using Convolutional Neural Network (CNN). CNN have been shown to have excellent performance in automating multiple image classification and detection tasks.

Stroke when not treated appropriately on time, it may lead to permanent disability or even cause death. So that quicker and accurate treatment is crucial in such conditions. There are some factors that delay diagnosis procedure due to difficulties in examining the images manually.

Heterogeneity of images, unknown delineation of objects, image quality are few of the above stated problems. Considering these issues, researchers keep on investigating in this field for finding an optimum solution. Most of the researches are based on the development of automatic system capable of assisting doctors by providing accurate results quickly. . Some of the relevant literature surveys are as follows:

In 2020, H. Ko, H. Chung, H.Lee and J. Lee published a paper on identifying and classifying intercranial hemorrhage (ICH) based on CNN and long short term memory [1]. They used CT images of five subtypes of ICH. They used Xception model as a

backbone for identification and classification. It consists of 36 convolutional layers. Through a global average pooling layer, it is connected to an LSTM layer. This technique improved the exactness of ICH identification and classification.
In 2019, B.R. Gaidhani, R.R. Rajamenakshi and S. Sonavanepublished a paper on classifying brain stroke MRI images into normal and abnormal images and delineate abnormal regions [2].The paper presents an approach that uses two types of convolutional neural network. They used LeNet for classification and SegNet for semantic segmentation. The abnormal image classified by LeNet is passed to SegNet for segmentation which is auto encoder decoder model. SegNet will delineate abnormal regions.The accuracy obtained on classification is 96% and segmentation is 85%.

In 2019, A. Kumar, A. Debnath, T. Tejaswini, S.Gupta, B. Chakraborty and D. Nandi published a paper on segmentation of brain stroke lesions [3]. The paper presented an approach that uses U-Net and multipath network. This model gives more flexibility. The outcomes show that the proposed model beat a portion of the other existing CNN based structures but themodel requires a few enhancements for the recognition of very small lesions.The disadvantage of using U-Net is that to have nice outcomes the size of U-Net should be practically identical with the size of features. It sets aside significant time to train because of numerous layers.

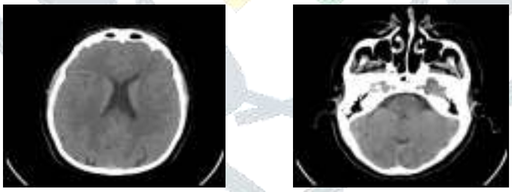
In 2018, D.R. Pereira, P.P.R. Filho, G.H. de Rosa, J.P. Papa and V.H.C. de Albuquerque published a paper on detection of stroke from CT images [4]. They used Convolutional Neural Networks improved by Particle Swarm advancement (PSO). Ischemic and hemorrhagic strokes are considered. The dataset contains three distinct kinds of images for each case. ImageNet is considered for testing purposes and CIFAR-10 for testing intensions. . The method got accuracy near 99%.

In 2017, C. Chin et al published a paper on automated stroke detection using CNN [5]. The paper presented a framework that will start preprocessing to eliminate the region which is not the conceivable of the stroke region. They used CT images. For training and testing the images are then given to convolutional neural network. CNN module which comprises two convolutional layers, one max pooling layer and a fully connected layer are utilized. Each convolutional layer incorporates a ReLU. The results showed that the model got accuracy higher than 90%.

The development of automatic system can improve medical outcomes. Fast and quicker results can be produced, thereby assisting medical persons. These related works can serve as a basis for more accurate and efficient system in future.

II. MATERIALS

Compared to MRI, CT scans are widely available, less expensive and quicker. The primary radiological examination that is often performed in the case of stroke suspicion is Non enhanced CT. It can also provide information required to make decisions during emergency. Due to the aforementioned reasons we decided to use CT images for training the CNN model.
The dataset used in this paper is collected from Kaggle. Consisting of 82 CT scans of dimension 650x650 in jpg format, including 36 scans for patients diagnosed with intracranial hemorrhage with the following types: Intraventricular, Intraparenchymal, Subarachnoid, Epidural and Subdural. Each CT scan for each patient includes about 30 slices with 5 mm slice-thickness. Figure 1 shows the images of both normal and stroke case.



(a) (b)

Fig 1: (a) Normal case and (b) Stroke case

III. METHODOLOGY

3.1 PREPROCESSING

In the pre-processing stage, certain transformations are applied to the raw data. The input images are gray scale images with pixel values in the range 0 and 255; 0 in black and 255 in white. These pixel values are too high for the model to process. Feature scaling is applied to have all the values of features within the range 0 and 1. Shear range randomly apply shearing transformations. Zoom range zooms inside the image randomly. All these transformations reduce the problem of overfitting.

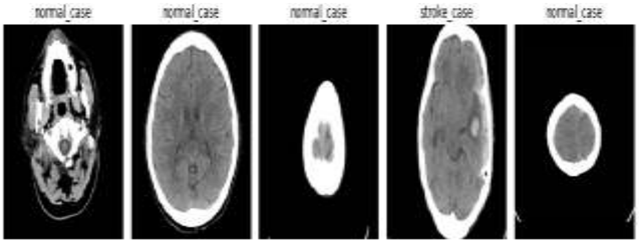


Fig 2: Data after preprocessing

3.2 CNN ARCHITECTURE

Convolutional Neural Network is a class of deep, feed forward artificial neural network, which explicitly assume that the input are images. CNN takes images as input and extract features from the image. The structure of the layers of neural network is defined by CNN architecture. CNN architecture comprises of input layer, hidden layers and output layer.. Based on a repeated pattern of sequences there are different types of CNN architecture. The specific architecture is selected based on the task to be performed. Overall performance can be improved by selecting the suitable architecture. One can either use previously developed CNN models or construct own architecture based on task requirement.

Convolutional layer is the core building block of CNN architecture. The parameters of convolutional layer consist of a set of learnable kernels. Each kernel extends through the full depth of the input volume. Pooling layer down samples the spatial dimension. Max pooling, min pooling and average pooling are the three types of pooling layers. Max Pooling- operation selects the maximum element from the region of the feature map covered by the filter. Min pooling select the minimum element. Average pooling selected the computed average element. The last few layers of neural network are formed by the dense layers.

.In this paper, the proposed CNN architecture has 13 layers. Built up by 5 convolutional layers, 4 max pooling layers, a flatten layer and 3 dense layer. The CNN architecture for binary classification is illustrated in fig. 3

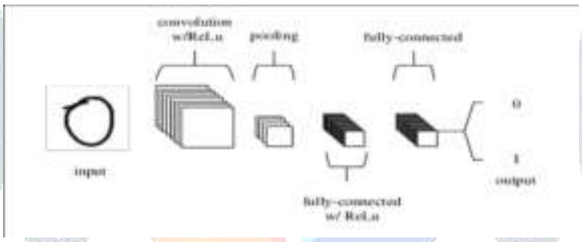


Fig 3: CNN architecture for binary classification.

The input image size to the CNN is 300x300. The first convolutional layers has 32 filters with size 3x3 followed by a max pooling layer with a pool size 2x2. It is then followed by 2 convolutional layers, max pooling layer and another convolutional layer with 64 filters of size 3x3. The seventh layer is a max pooling layer. Then a convolutional layer with 64 filters is added. Again, a maxpooling layer forms nineth layer. After that, a flattening layer is followed by three dense layers with neurons 128,64 and 1 respectively.

IV. RESULTS AND DISCUSSION

The model is implemented in Keras framework in Python using Tenserflow. In the training stage, stochastic gradient descent is adapted to minimize loss among actual and predicted values of training set. Binary crossentropy is used for evaluation of losses during training. The whole dataset is separated in three folders for training, testing and final validation. The accuracy of the model is shown in fig 4.

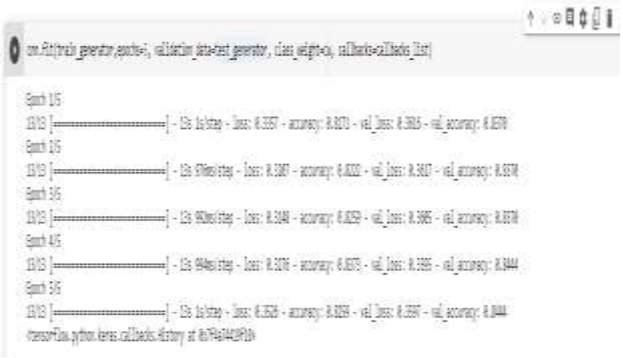


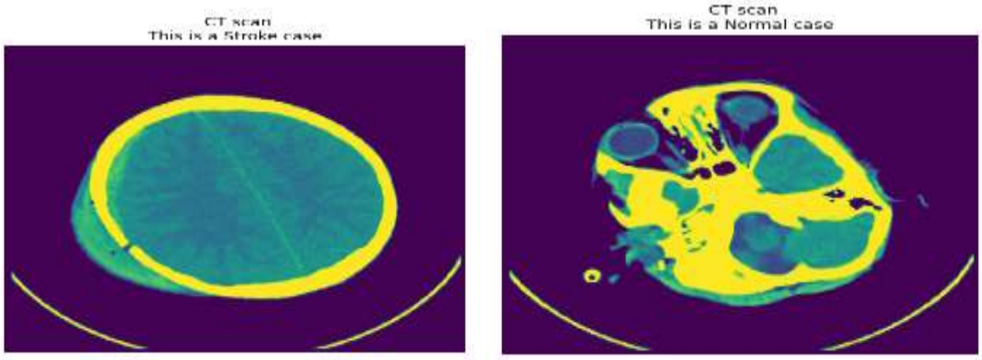
Fig 4: Training the CNN model.

Accuracy is one metric for evaluating classification models. Accuracy has the following definition:

Accuracy= number of correct predictions/ Total number of predictions.

Initially, we got an accuracy around 75% because of the unbalanced data. We used callbacks methods early stopping and reduce learning rate on plateau to improve the accuracy. Finally, we got accuracy of above 90%.

The model accurately predicted actual stroke as stroke case and actual normal as normal case. Both the cases are shown in figure 4. The model obtained an overall classification accuracy of above 90%.



(a) (b)

Fig 4 (a): Predicted actual stroke case (b): normal case.

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V. CONCLUSION

In this paper, CT scans with ICH positive and negative images are used to train the CNN model. CNN have been shown to have excellent performance in automating multiple image classification and detection tasks. The images are in jpg format and of dimension 650x650. The model is implemented in Keras framework. The CNN module consists of 13 layers. Accuracy is used as the evaluation matrix. The model had obtained a classification accuracy of above 90%. Thus the method can assist doctors by providing fast and accurate image interpretation and thereby improving patient.

REFERENCE

[1] H. Ko, H. Chung, H.Lee and J. Lee, "Feasible Study on Intercranial Hemorrhage Detection and Classification using a CNN-LSTM Network" *Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC)* 2020; pp. 1290-1293

[2] B.R. Gaidhani, R.R. Rajamenakshi and S. Sonavane "Brain Stroke Detection Using Convolutional Neural Network and Deep Learning Models" *International Conference On Intelligent Communication and Computational Techniques (ICCT),* 2019; pp. 242-249.

[3] A. Kumar, A. Debnath, T. Tejaswini, S.Gupta, B. Chakraborty& D. Nandi "Automatic Detection of Ischemic Stroke Lesion from Multimodal MR Image" International Conference on Image Information Processing (ICIIP) 2019; pp. 68-73

[4] D.R. Pereira, P.P.R. Filho, G.H. de Rosa, J.P. Papa & V.H.C. de Albuquerque "Stroke Lesion Detection Using Convolutional Neural Networks" International Joint Conference on Neural Networks(IJCNN) 2018; pp. 1-6

[5]C. Chin et al., "An automated early ischemic stroke detection system using CNN deep learning algorithm" International Conference on Awareness Science and Technology (ICAST) 2017; pp. 368-372.