Detecting Brain Tumor Using A Convolutional Neural Network

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Research titled **"Detecting Brain Tumor Using A Convolutional Neural Network"**, submitted by Md. Rokonuzzaman, ID No: 161-15-7102, Mst. Abida Sultana, ID No: 161-15-6943 & Farjana Akhter, ID No: 161-15-7425 to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on Thursday, December 5, 2019.

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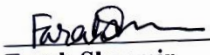

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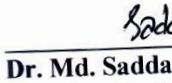

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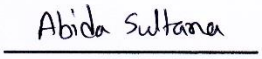

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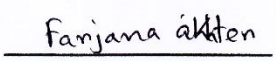

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Finally, we must acknowledge with due respect the constant support and patients of our parents.

ABSTRACT

Nowadays Machine Learning (ML) become most hot topic in the technology world. Newly invented machine with Artificial Intelligence (AI) taking every place of our life.

Neural Network may be a modern machine learning field that picked up a parcel of intrigued over the past few a long time. That's why people are trying to invent new technology for better lifestyle. In this paper we propose 13 layer Convolutional Neural Network (CNN) model that are detecting brain tumor from mri image. The model is combined with the automatic feature extractor, standard Multi-Layer Perceptron(MLP) and activation function. Our proposed model has accomplished decently high accuracy with low cross-entropy rate.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Our body made by millions of cells. When some cells are behave abnormal than early stage of tumor began . Brain is the most important part of our body. Brain tumor is a serious issue. If we can detect tumor in early stage than it will be possible to prevent that disease, otherwise it will go out of control and can be deadly [7,8]. In our country doctor are not available all time and they are costly to rural people. In our country there are 75%-80% are rural people. So a big number of people can't get the service of doctor in right time.

So we decided to help them. We want to develop a system that will take a Magnetic resonance imaging (MRI) scans image of brain as an input and detect the tumor or not and give the result as output [4,5]. We want to take the help of Artificial intelligence (AI). We want to use Convolution Neural Network (CNN) to classify image. We proposed a CNN based illustrate where we input pictures in five convolution layer, five max pooling layer, a flatten layer and two dense layer [9-11].

1.2 Objective

Nowadays we are using technology everywhere. In the field of health and medical, technology are used in every steps. There are different type to tumor [3, 6]. We just want to detect the existence of tumor. So we can describes these goals in a list like this:

- Our goal is to study how to detect tumor.
- To develop a platform that will be able to detect the existence of tumor

1.3 Motivation

We want to do something that will help people. In the third world country people are mostly suffer in the health and medical sector. So we decide to do something in this sector, which will help the rural people. We search and not found enough solution about brain tumor and we have reached on an idea and it's called "**Detecting Brain Tumor using A Convolutional Neural Network.**" Treatment of brain tumor is exceptionally expensive and time devouring. Our motivation is reduce some cost and time of the treatment of brain tumor.

1.4 Rational of the study

There is no doubt that there are thousands of works done on Image processing or object classification domain. But there are only a few works done on Detecting Brain Tumor. So our work is a new approach using different algorithms and simulation. To develop more efficient classifier application in the field we give out best effort to develop our own model.

Image processing is an advance approach it can be split into different categories: one of these is Image Compression another image enhancement and the last is the rebuilding, and estimation extraction. It helps to reduce the amount of memory which is required to store a digital picture. Picture can be defected. By digitization process and by faults image can be defected .Defected picture can be rectified utilizing Picture Upgrade techniques.

1.5 Research Questions

It was so challenging for us to complete this work. In order to have a realistic, efficient and accurate response to the problem, the researchers wishes to propose following questions to express this feelings and outcomes this problem.

- Can we collect row image data for deep learning research?
- Is it possible to pre-process the row data using deep learning approach?

- Is it possible to improve brain tumor treatment system using this approach?
- How people will be benefited by this approach?

1.6 Expected Outcome

In this section there is some points given that points was our min expected outcome. Expected outcome of this research based project is to build an algorithm or making a complete efficient procedure that will detect brain tumor with respect to the built model of trained dataset.

- Brain tumor can be detect.
- People can be benefited by this.
- They can improve the treatment system etc.

1.7 Layout of the Report

Chapter one have illustrated an introduction to the venture with objective, motivation, research questions, and expected outcome, this section describes the whole layout of this report.

Chapter two provides the discussion on what already done in this domain before. Then the later section of this second chapter shows the scope arisen from their limitation of this field. And very last, the root obstacles or challenges of this research are explained.

Chapter three describes the theoretical discussion on this research work. To discuss the theoretical part of the research, this chapter elaborates the statistical methods of this work. Besides, this chapter shows the procedural approaches of the CNN and Machine Learning classifier. And in the last section of this chapter, to validate the model as well as to show the accuracy label of the classifier, confusion matrix analysis is being presented.

Chapter four provides the experimental results, performance evaluation and result discussion. Some experimental pictures are presents in this chapter to make realize the project.

Chapter five discussed with summery of the study, future work and conclusion. t. This chapter is responsible to show the whole project report adhering to recommendation. The chapter is closed by showing the limitations of our works that can be the future scope of others who want to work in this field.

CHAPTER 2
Background Study

2.1 Introduction

In this section, we will discuss related works, research summary and challenges about this research. In related works section, we will discuss other research paper and their works, their methods, and accuracy which are related to our work. In research summary section we will give the summary of our related works. In challenges section, we will discuss how we increased the accuracy level.

2.2 Related Works

There are several studies published on Brain tumor classification. In 2016 A.R. Kavitha, L. Chitra and R. kanaga publish "Brain tumor segmentation using genetic algorithm with SVM classifier"[1]. This work sections the tumor utilizing Genetic Algorithm and recognizes and classifies the tumor utilizing SVM classifier.This makes a difference the specialist to examine the tumor at prior stages.The computer program bundle utilized is MATLAB form 13a platform. There are another work of T. Logeswari and M. Karnan in 2010 about "An improved implementation of brain tumor detection using segmentation based on hierarchical self-organizing map"[2].

2.3 Research Summary

Deep learning could be a method for executing Machine Learning. It is made of artificial neural networks. Neural systems work as comparative as our brain. CNN which implies Convolutional Neural Network is one of the most dynamic networks in deep learning. It is

an artificial neural network, which is additionally known as feed-forward ANN. In a "feed-forward" network data streams right through the systems.

Yann LeCun was the creator of CNN. Propelled from human processes he made it. Really CNN works like natural visual cortex. CNN is one of the foremost fruitful models in picture classification. CNN's classification exactness is way superior than any other conventional picture classification algorithms. In CNN we don't have to do highlight determination, but in other picture classification calculations, we have to be do it. There are distinctive sorts of layers that are utilized in CNN. Convolution layer contains a moving channel or part which passes through the picture. For the most part it passes through a 2D framework (representation of picture) and take a certain parcel and applies speck increase and stores it in another framework.

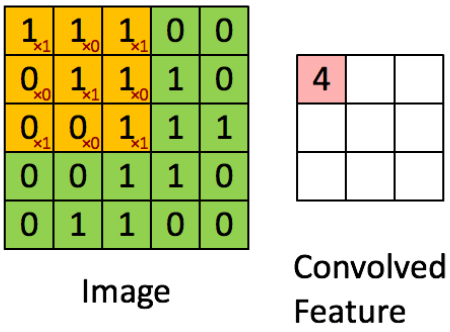

Fig 2.3.1: Convolution of a filter over 2D image

Measurement of the yield matrix can be calculated by an condition. Ready to see an condition bellow where,

n_{out} - Output dimension

n_{in} - Input dimension

f - Window size

s- Stride

$$n_{out} = floor\left(\frac{n_{in}-f}{s}\right) + 1$$

The above equation is used to find Output of the dimension.

Pooling layer for the most part sits another to convolution layer. It basically utilized to decrease memory and for quick computation. It diminishes the volume. Max pooling is one of the foremost utilized layers in CNN. It sets a part and finds the max number from the network.

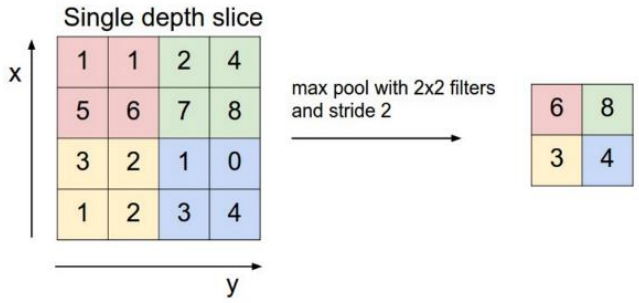

Fig 2.3.2: Max pooling

Completely associated layer gets 2D or 3D cluster as input from past layer and changes over the 2D or 3D cluster into 1D array. The yield layer of a convolutional neural network appears the likelihood of the classes. It is calculated by "Softmax" function. The condition of calculating the likelihood is given howl.

$$\sigma\left(x_j\right) = \frac{e^{x_j}}{\Sigma_i e^{x_i}}$$

2.4 Challenges

The main challenges of this work is collecting and processing the dataset, dealing with the data set was too hard. To clean and normalize we used several steps and methods. After all training with many layers with different size of epoch took long time in our machine, so getting the final output we waited so much with keeping patience

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

In this section we are going to elaborate the workflow of our novel approach to classify Brain tumor or not. There are some key point like data collection, processing, proposed model also described with relevant equation, graph, table and description. Own developed CNN based model applied and own dataset used in this work. The chapter is being closed by giving the clarification of our project's factual hypotheses and other than, giving the clear concept of the execution requirements.

3.2 Workflow

This research have few stages of workflow such as data collection, data processing data resize and augmentation, model selection etc.

Stage 1 - Data Collection: We collected data from web and created our own data-set by processing those raw data. Collecting data was so challenging, there is not a single dataset available in this domain.

Stage 2 - Data Processing: All data have been processed class by class after collection from various sources. There are lots of data having noise and errors. We manually process those data first then implement the selective dataset to the next step.

Stage 3 - Data Resize and Augmentation: After processing class by class data have been augmented and resized. For training purpose we had to go through data augmentation and resize. Augmented data give some overfitting that's why we done only a few and most important augmentation.

Stage 4 - Model Selection: To train and validate our data for better accuracy we choose out model. There are hundreds of convolutional neural networks. To get better accuracy with our machine configuration we implement few model and finally one model was selected for final training and testing process.

Stage 5 - Performance Evaluation: In this section, all the results have been discussed with graph. After training and testing those process gave us few accuracy graph with validation loss and accuracy. We also calculated the confusion matrix and a table for showing the precision, recall and f1 measure.

Stage 6 - Conclusion and Future Work: In this section there will be a conclusion and future work map.

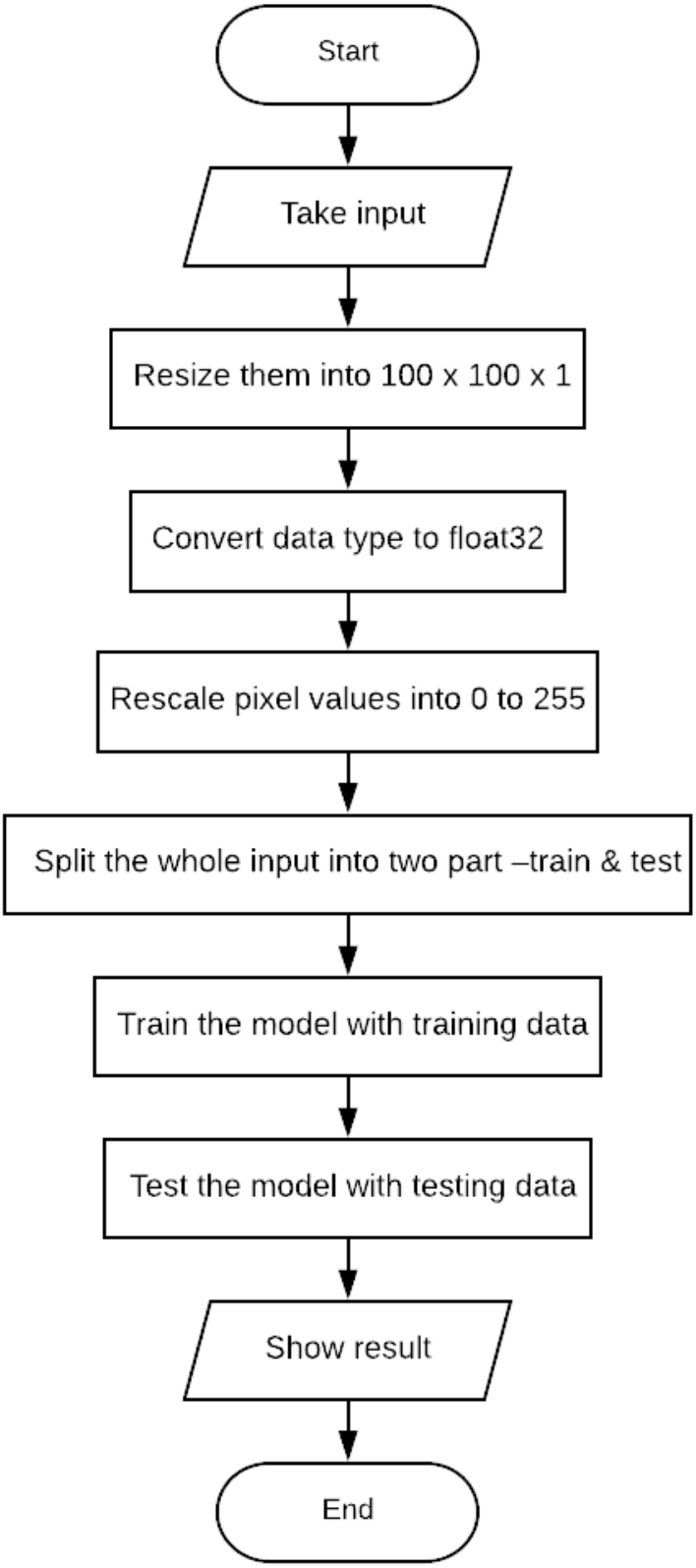

Fig 3.3: Workflow of our approach

3.3 Data Collection Procedure

We have made a dataset of 1770 pictures. The dataset have 2 classes. One class is fresh mri picture of brain and another class is mri picture of brain tumor. There are 685 image of fresh brain and 1085 image of brain tumor.

For testing dataset we collect image from Google. We took 44 image with no tumor and 32 image with brain tumor.

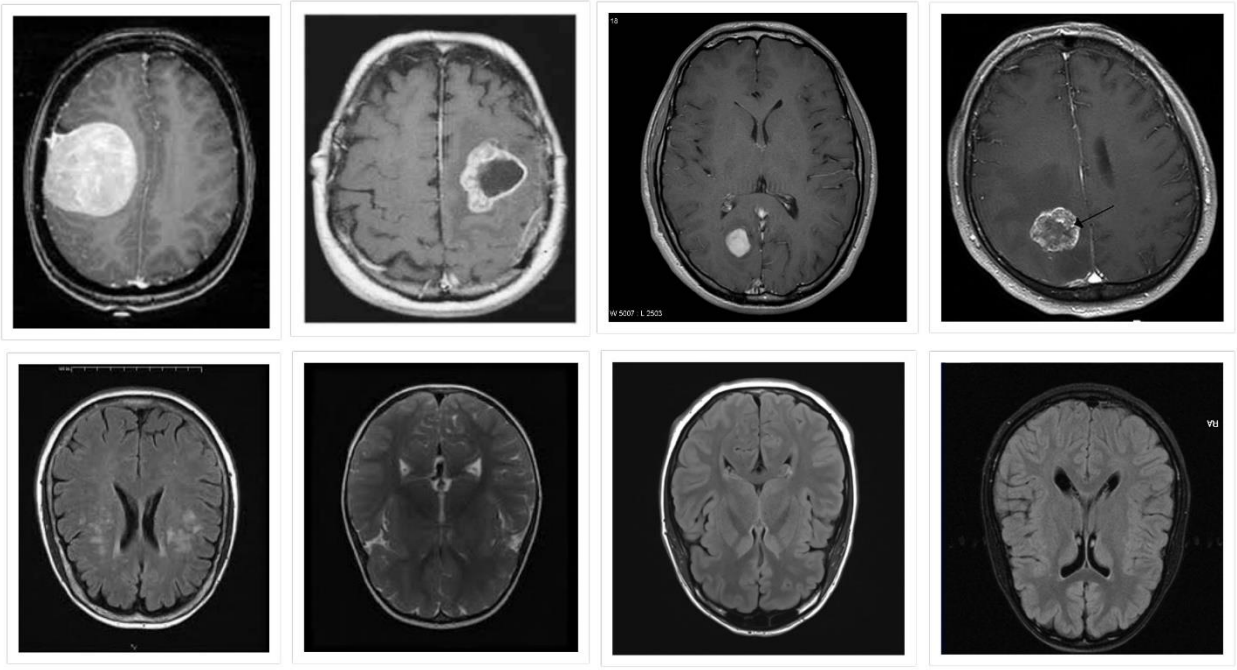

Fig 3.3: A small part of our dataset

3.4 Data Processing

Data processing system has two steps one is data augmentation another one is data preparation. When we bargain with the row data, the victory for the most part depends on the pre-processed information. The more productively data will be pre-processed; the result will be more accurate.

3.5 Data Augmentation

We falsely extended the dataset to maintain a strategic distance from overfitting. It includes esteem to base information by including data inferred from inner and outside sources inside an enterprise. It makes a difference to extend the amount of important information within the dataset. We increased the most information in 5 distinctive strategies, these strategies given below:

- Rotate left -90 degree
- Rotate left -180 degree
- Rotate left -270 degree
- Flip every image once

3.6 Proposed Methodology

We proposed our possess CNN model, which have 13 layers .There are five convolutional layers:

- The first layer have 16-3 x 3 filters and ‘relu’ as activation function.
- The second layer have 32-3 x 3 filters and ‘relu’ as activation function.
- The third layer have 64-3 x 3 filters and ‘relu’ as activation function.
- The forth layer have 64-3 x 3 filters and ‘relu’ as activation function.
- The fifth layer have 64-3 x 3 filters and ‘relu’ as activation function.

In expansion, there are five max-pooling layers each of estimate 2 x 2. We have a straighten layer, within the show. In conclusion there are two dense layer , where in one we utilized ‘relu ’ as activation function and within the other we utilized ‘sigmoid’ as activation work. We utilized sigmoid activation function to induce the probability of two class. Let’s have a brief discourse almost these layers underneath.

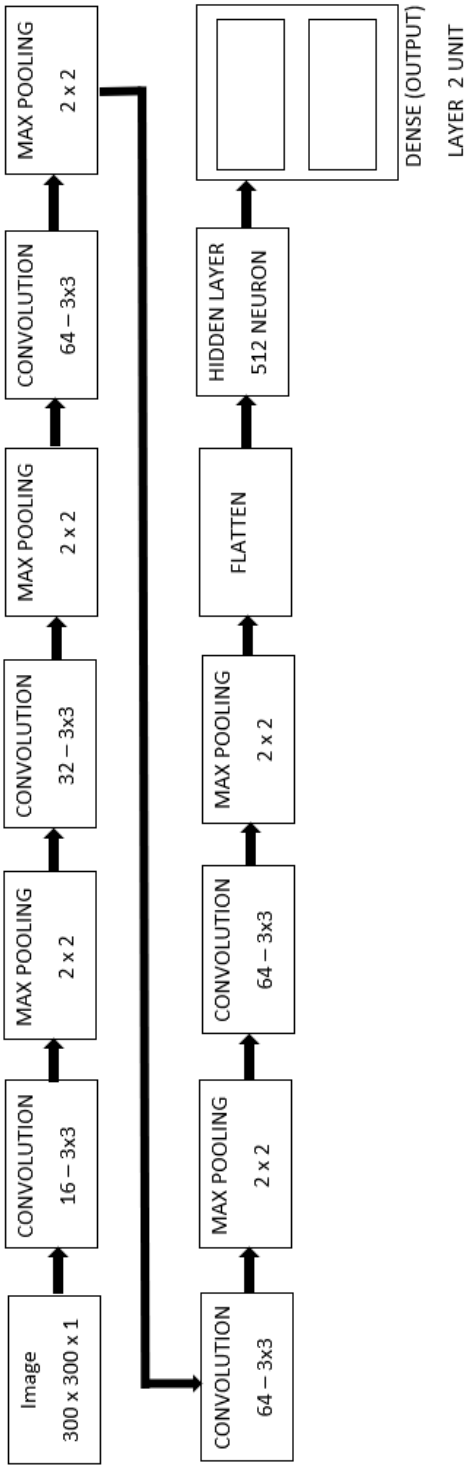

Fig 3.6: Architecture of our model

3.6.1 Convolutional Layer

CNNs have wide applications in picture and video recognition. When a computer sees an picture (takes an picture as input), it'll see an cluster of pixel values. Depending on the resolution and measure of the picture, it'll see a 32 x 32 x 3 cluster of numbers (The 3 alludes to RGB values). In a traditional convolutional neural organize architecture, there are other layers that are mixed between these conv layers. I'd emphatically energize those interested to examined up on them and get it their work and impacts, but in a common sense, they give nonlinearities and conservation of measurement that offer assistance to progress the strength of the arrange and control overfitting.

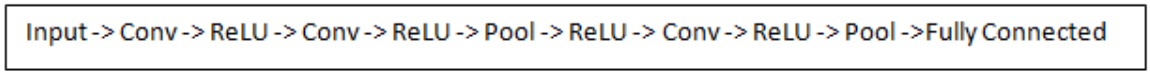

Fig 3.6.1: A classic CNN architecture

3.6.2 Feature extraction

Convolution is one of the main building squares of a CNN. The term convolution alludes to the mathematical combination of two capacities to create a third function. It consolidates two sets of information. Within the case of a CNN, the convolution is performed on the input information with the utilize of a channel or kernel to at that point create a feature map. We execute a convolution by sliding the channel over the input. At each area, a matrix increase is performed and sums the result onto the feature map.

3.6.3 Max pooling

Max Pooling may be a down examining procedure in Convolutional Neural Systems. The objective is to down-sample an input representation decreasing its dimensionality and permitting for assumptions to be made almost highlights contained within the sub-regions

binned. It is fundamentally utilized to decrease the estimate of the picture since the bigger number of pixels contribute to more parameters which can include huge chunks of data. Hence we require less parameters such that a CNN can still recognize the picture.Max pooling is discarded 75% of the activations and controlling overfitting.

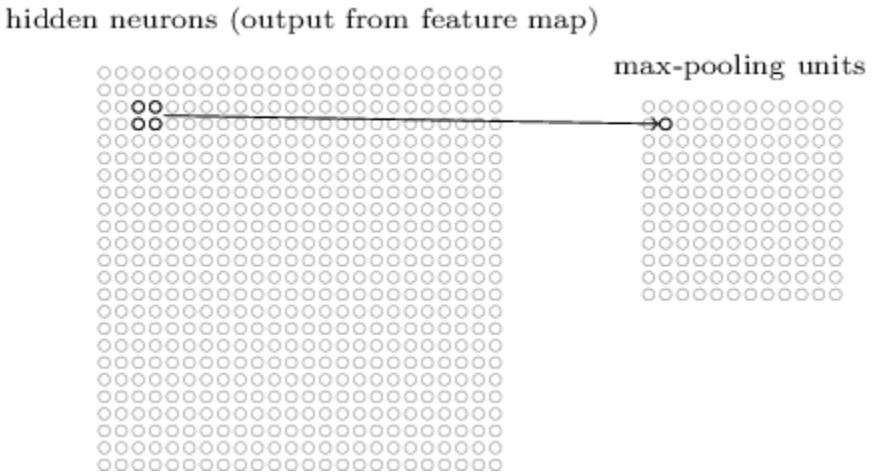

Fig 3.6.3: A pooling unit outputs the maximum activation.

3.6.4 Dense Layer

A dense layer is fair another title of completely associated layer. Comparative operations take put in thick layer where each neuron is associated with each other. It is additionally called thick since it speaks to a thick association of thick neurons. A dense layer has weights related with each neuron pair and with unique values. Different types of function like softmax activation function, SVM, and many others are used here for high-level reasoning in the neural network. But in our model, we stick used softmax for classification. After several convolution and pooling layers, we get some high-level features as input. These input images features are used as classifying to explore various classes. But when we combine convolution layer`s features and polling layer`s features it gives the better result of classifications.

3.6.5 Sigmoid

The Sigmoid Function curve looks like a S-shape.

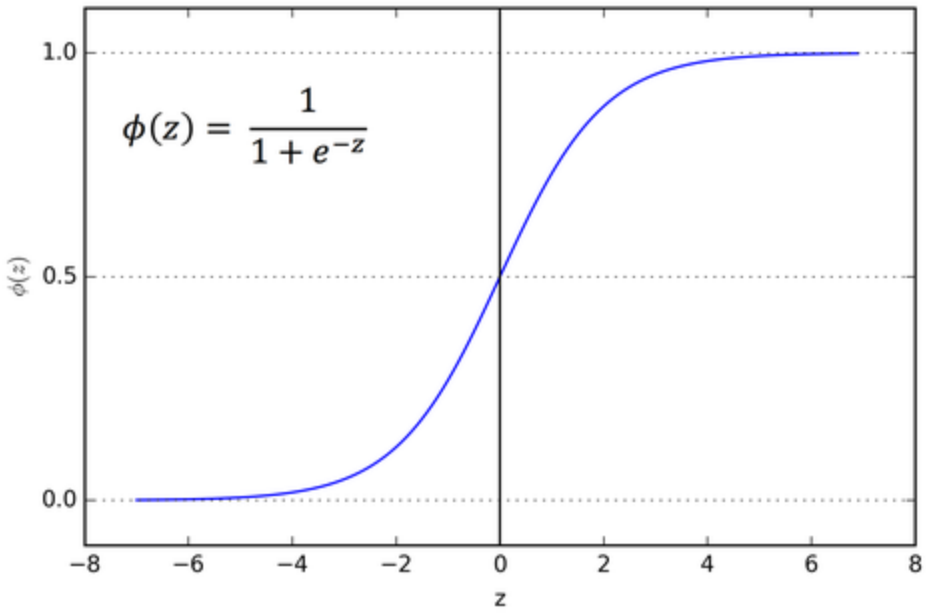

Fig 3.6.5: Sigmoid Function

The most reason why we utilize sigmoid work is since it exists between (0 to 1). Subsequently, it is particularly utilized for models where we ought to predict the probability as an output. Since probability of anything exists as it were between the range of and 1, sigmoid is the proper choice. The work is differentiable. Meaning , able to discover the slant of the sigmoid bend at any two points.

3.6.6 Flatten Layer

Flatten just takes that square and turns it into a 1 dimensional set.

3.7 Training the Model

We used RMSprop optimizer to compile our model. We utilized 100 % of training dataset to prepare and collect image from Google for validation. Training dataset has 1770 images. We have trained the network for 25 epochs.

3.8 Implementation Requirements

After the proper analysis on all necessary statistical or theoretical concepts and methods, a list of requirement has been generated that must be required for such a work of image Classification. The probable necessary things are:

Hardware/Software Requirements

- ✓ Operating System (Windows 7 or above)
- ✓ Hard Disk (minimum 500 GB)
- ✓ Ram (Minimum 4 GB)

Developing Tools

- ✓ Good internet connection
- ✓ Colab environment

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Introduction

In this section we described the construction process of brain tumor detection model. The overall prepare of the demonstrate separated into few steps like dataset collection, data preparation, data augmentation, data resize, proposed model portrayal and at last preparing strategy of the model.

4.2 Performance Evaluation

Training accuracy is as a rule the precision when the show is connected on the preparing data. When the model is connected on a randomly-selected pictures from diverse class, is known as approval accuracy. Fig appears a chart which contains preparing and validation accuracy of our model.

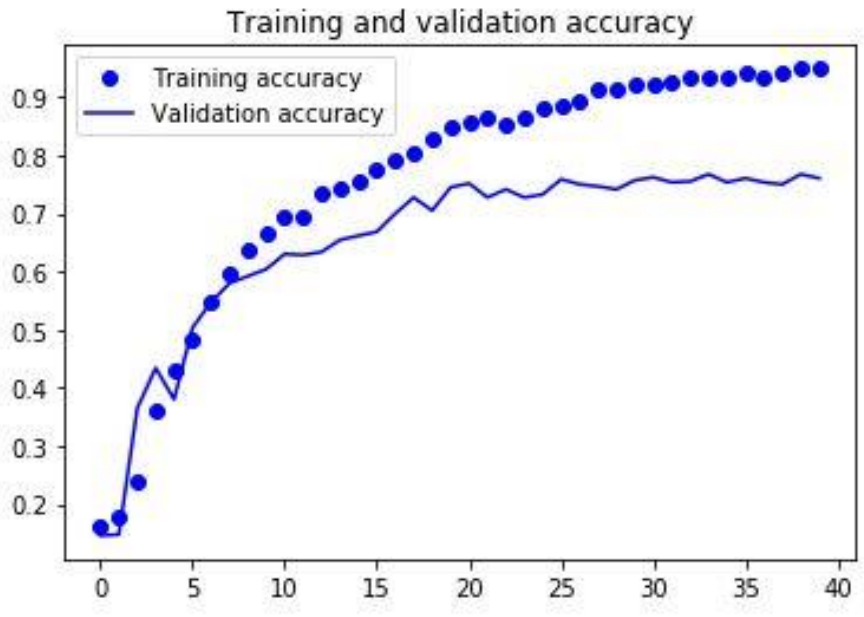

Fig 4.2.1: Training and validation accuracy

Training misfortune is the blunder on the training set of data. Validation misfortune is the mistake after running the approval set of information through the prepared organize. Fig appears a chart which contains preparing and approval misfortune of our demonstrate.

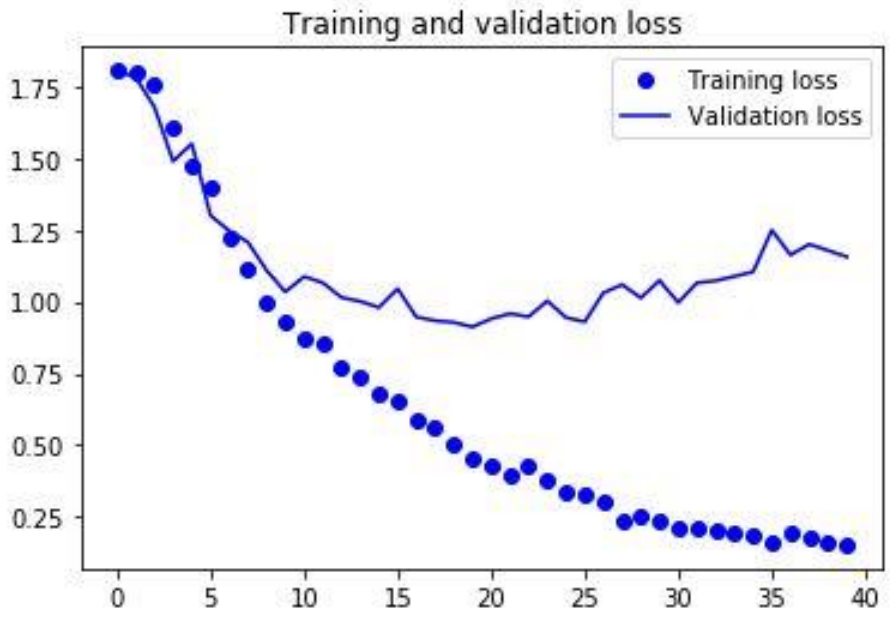

Fig 4.2.2: Training and validation loss

4.3 Result Discussion

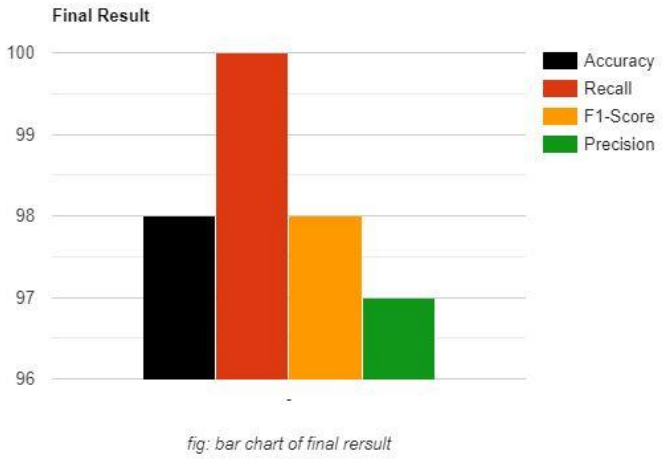

Fig 4.3: Bar chart of the final result

We calculated Precision, Recall and F1-score from test dataset containing 75 pictures. From the classification report we are able see Precession normal is 0.97, Recall normal is 1 and normal F1-score is 0.98. So it can be said that the execution of our classifier is nice. From table of Classification report able to see that the classifier accomplished a not too bad accuracy, which is 98.6%.

Precision: Within the field of data recovery, precision is the division of recovered documents that are significant to the query:

$$\text{precision} = \frac{|\{\text{relevant documents}\} \cap \{\text{retrieved documents}\}|}{|\{\text{retrieved documents}\}|}$$

Precision is utilized with recall, the percent of all important documents that's returned by the search. The two measures are sometimes used together within the F1 Score (or f-measure) to supply a single estimation for a system. Note that the meaning and utilization of "precision" within the field of information recovery varies from the definition of accuracy and precision inside other branches of science and technology.

Recall: Recall is the piece of significant instances that have been recovered over the whole sum of significant instances. High recall implies that an calculation returned most of the pertinent result.

$$Recall = \frac{tp}{tp + fn}$$

F-measure: f-score may be a measure of test's accuracy by considering both precision and recall. it is a harmonic average of precision and recall.

$$F - score = 2 * \frac{precision * recall}{precision + recall}$$

Accuracy: accuracy refers to the familiarity of the measured value to a known value.

$$accuracy = \frac{tp + tn}{tp + tn + fp + fn}$$

CHAPTER 5

CONCLUSION, RECOMMENDATION AND FUTURE WORKS

5.1 Introduction

It has no doubt that there are lots of research works on identifying brain tumor. In a variety of applications, it has become important. Now a days there are many kind of technology used in medical sector, so this approach will invent a new technology what is our main goal to find out something for medical and health.

5.2 Future Works

In our proposed method we can identifying brain tumor from mri image, we have utilized convolution neural networks to construct a demonstrate for our data. Our future objective is to form a stronger neural network to induce a stronger accuracy. For better accuracy we need more data to train our model, and also need better model to get better output. We want to find different type of brain tumor and different type of brain disease from brain mri image.

EFERENCES

[1] A.R. Kavitha, L. Chitra, R. kanaga "Brain tumor segmentation using genetic
algorithm with SVM classifier" Int J Adv Res Electr Electron Instrum Eng, 5 (3) (2016), pp. 1468-1471

[2] T. Logeswari, M. Karnan "An improved implementation of brain tumor detection using segmentation based on hierarchical self organizing map" Int J Comput Theory Eng, 2 (4) (2010), pp. 591-595

[3] Kruti G. Khambhata, Sandip R. Panchal "Multiclass classification of brain tumor in MR images" Int J Innov Res Comput Commun Eng, 4 (5) (2016), pp. 8982-8992

[4] G. Kaur, J. Rani "MRI brain tumor segmentation methods-a review" Int J Comput Eng Technol (IJCET), 6 (3) (2016), pp. 760-764

[5] V. Das, J. Rajan "Techniques for MRI brain tumor detection: a survey" Int J Res Comput Appl Inf Tech, 4 (3) (2016), pp. 53-56

[6] E.I. Zacharaki, S. Wang, S. Chawla, D. Soo Yoo, R. Wolf, E.R. Melhem, et al. "Classification of brain tumor type and grade using MRI texture and shape in a machine learning scheme" Magn Reson Med, 62 (2009), pp. 1609-1618

[7] G. Litjens, T. Kooi, B.E. Bejnordi, A.A. Setio, F. Ciompi, M. Ghafoorian, et al.
"A survey on deep learning in medical image analysis" Med Image Anal, 42 (2017), pp. 60-88

[8] Zikic, D., Ioannou, Y., Brown, M., Criminisi, A., 2014 "Segmentation of Brain Tumor Tissues with Convolutional Neural Networks" Proc. BRATS-

MICCAI.

[9] Zeiler, M.D., Fergus, R., 2014. “Visualizing and understanding convolutional networks.” In: Computer Vision–ECCV 2014. Springer, pp. 818–833

[10] Urban, G., Bendszus, M., Hamprecht, F., Kleesiek, J., 2014. “Multi-modal brain tumor segmentation using deep convolutional neural networks.” Proc. BRATS-MICCAI

[11] Prastawa, M., Bullit, E., Ho, S., Gerig, G., 2004. “A brain tumor segmentation framework based on outlier detection.” Med. Image Anal. 8, 275–283

APPENDIX

To complete the project we faced so many problem, first one was to determine the methodological approach for our project. It was not traditional work it was a research based project, more over there were not much work done before on this area. So we could not get that much help from anywhere. Another problem was that, collection of data, it was big challenge for us. There was no dataset available on this kind of sports, that's why we collect our own data and developed a best fit model. Working with this kind od data is so interesting.

Plagiarism Report: