Brain Tumor Detection Using CNN

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Abstract*: *A lump that grows rapidly without any control is known as tumor. The tumor is very dangerous and in many cases it leads to death also. When the tumor is at early stage, it is very difficult for doctors also to figure it out and by using only MRI images is also not very help full because these mri images contains vey disturbances and noises also. So, here image processing techniques plays a vital role in diagnosing and visualizing these MRI images easily. In this paper, we have proposed a method that helps to detect brain tumors from the MRI images. In the beginning, we have done processing of the image given and convert it into grey scale images and after that we have used filters like Gaussian or median filters to removes noises and disturbances from the images. In the last, we have constructed the CNN layers and perform the binary classification using CNN (Convolution Neural Network) that helps us to determine whether the images has tumor or not.

Index Terms*: *Tumor Detection, Convolutional Neural Network, Gaussian Filters.

1. INTRODUCTION

Our human body has many types of cells. Each cell does its own function. In our body, cells continue to divide themselves in particular order to form new cells and to remove the old ones. This phenomenon of body removing the old cells and making new cells keeps our body healthy and allows us to work properly. But sometimes, some cells lost their capability and grow without any order and these cells forms a mass of tissue we call it as a tumor which is very dangerous.

These tumors can be benign or malignant. Malignant tumors lead to cancer while benign tumors are not cancerous. Brain tumor occurred when the cells were dividing and growing abnormally. It is appearing to be a solid mass when it diagnosed with diagnostic medical imaging techniques. There are two types of brain tumor which is primary brain tumor and metastatic brain tumor.

Primary brain tumor is the condition in which the tumor formed in brain and spreads continuously. Meta-static brain tumor is the condition in which tumor is formed anywhere in the body and spreads through the brain.

The symptom having of brain tumor depends on the size, location and type of the tumor. It occurs when the tumor compressing the surrounding cells and gives out pressure. Besides, it is also occurring when the tumor blocks the fluid that flows throughout the brain. The common symptoms are having headache, nausea and vomiting, and having problem in balancing and walking.

With the improvement of modern medical standards, imaging technologies in medical are playing a vital role in medical research and diagnosis. Research on medical diagnostic image data is very important as tumor diseases are going more and more complex and more challenging lately. Brain tumor has become a key research topic in the medical field. The diagnosis of brain tumors is usually based on imaging data analysis of brain tumor images. Accurate analysis of brain tumor images is a key step in determining a patient's condition.

According to the Indonesian Ministry of Health, Indonesia ranked 8th in Southeast Asia and 23rd in Asia in terms of cancer patient in 2018 [1]. Tumors specially, Brain tumors are the second leading cause of death in cancer. As compared to men women are mostly affected by the brain tumors in all cases. This is fact that over the past decade brain tumors incidences have increased in several other countries [2]. Medical imaging is a key factor in diagnosing brain tumors and can help prevent the most dangerous diseases. MRI is a imaging technique used by researchers to detect brain tumors in this modern era [3]. MRI is one of the most widely used imaging techniques for brain tumors because it does not use ionizing
radiation [4].

Therefore, how to accurately detect brain tumor images is very important and this is the reason which motivate us to work on them. In this paper, we were asked to experiment with a real-world dataset of brain tumor, and to explore how deep learning algorithms can be used to detect the image consist tumor in the

dataset. We were expected to gain experience using deep learning algorithms and various libraries are used for data visualization, transformation etc. So, our main objective of this project is to classify the tumor or non-tumor images using deep learning algorithms. To gain the main objective of this project we had done many smaller objectives like augmentation, cropping, visualization, transforming and many more.

2. Literature Review

In this research paper, we have used CNN to detect the brain tumor in MRI images and we have also accumulated some information from other research papers as well.

2.1 Brain Tumor

Brain Tumor is caused by the abnormal growth of uncontrolled multiplication of cells. But sometimes, some cells lost their capability and grow without any order and these cells forms a mass of tissue we call it as a tumor which is very dangerous. There are two types of brain tumor which is primary brain tumor and metastatic brain tumor[4].Brain tumor can also be classified as low grade tumor or high grade tumor. High grade tumors are more dangerous than low grade tumors. Diagnosing brain tumor is really difficult because it is the most complex structure of the body. It takes the lives of nearly 250,000 people each year.

2.1.1 Brain tumor types

1. Benign Tumors:
They do not spread other parts of the bodies and are not cancerous. But, they can cause problem when they press on nerves that restricts the blood flow. These tumors have a very low chance of recurrence[5].

2.Pre-malignant Tumors: These tumors are more dangerous than the Benign ones' because they can be cancerous if the cell growth and cell changes can't be monitored carefully throughout the treatment.

3. Malignant Tumors: These tumors are cancerous and easily damage the nearby tissues. In this, the cancer cells may break and spread tumor in other parts of the body also[6].

2.2. Convolutional Neural Network

It is a neural network that process data with grid structure. Convolution is an operation in the convolution layer based on algebraic line function that duplicates the filter matrix in an image for processing [8]. The convolution layer is the most important layer to apply. Another type of layer commonly used is a composite layer, which is a layer used to take the maximum or average number of pixel segments of an image.

The complex features can be learn by creating a feature map by the CNN. A few feature maps can be count by the convolution layer kernel that is wrapped in an input sample. Maps are transferred to maximum collection layer, which saves the informative data and discard the remaining data. These maps are transferred to the top collection layer, which stores the relevant features and discards some. The CNN suspension is shown in Figure 1 [9].

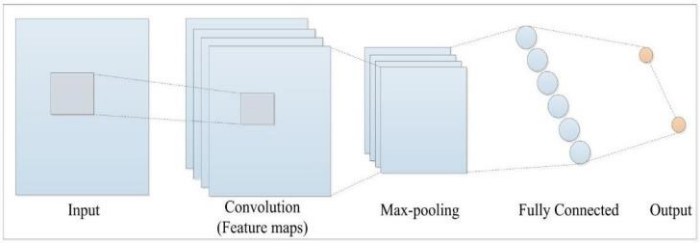

Fig 1. CNN architecture [11]

2.2.1. Convolution Layer

It is the interior layer in the Convolution Network that helps to extract different features from the provided input. It performs transformations at linear level of the given data and does not change the spatial information of the data. To process the input data training on CNN convolution kernels are determined from the layer's weight.

2.2.2. Subsampling Layer

It helps to decrease the size of data and increase feature positions. It divides the output of the convolution layer into smaller grids and decreases the max value for each grid to make small image matrix.. The small size image helps the next layer to process it easily.

2.2.3. Fully Connected Layer

It changes data size to be categorized. Each neuron has to change into one-sided data before it can incorporated into another interconnected layer in the convolution layer [9].In this process, data loses its spatial information and network is applied at the end of this layer.

3. Proposed Methodology

In this paper, we have detect the whether an MRI image contain brain tumor or not. For this we have used the image dataset. This will be done in many phases. After importing dataset, we have converted image into grey scale image and blur it slightly. We have applied some filters to remove noises and to find out contours in the images so that we can crop them afterwards. The images are split into training, testing, and validation dataset. We plot the bar graph for better visualization of dataset distribution. After this we have done the zero padding to maintain the dimensions of image to after filtering.

Then we construct the layers of CNN and perform binary classification that is in 0 and 1. The images with brain tumor come in 1 that is tumor detected and images with no tumors comes in 0 that is tumor not detected.

3.1 About CNN

CNN stands for convolutional neural network. We have used this algorithm in our research paper that helps in the identification of two dimensional images and allow us to get information from it. It consists of input, zero padding, convolution, max pooling and fully connected layer. It needs less preprocessing as compared to others image processing algorithms we have used.

3.2 Input Layer

Input layer should contain image dataset. Image is represented by three cross three matrix. You need to reshape into single column.

3.3 Convolution Layer

A convolutional layer contains a set of filters whose parameters need to be learned. The height, width of the image volume is greater than the image filter. Dot product between input and filter is calculated at the spatial position.[7] The output volume of this layer is obtained by layering the all presently active maps of all the filters along with their depth dimensions. Each neuron in the activation map is connected to a small region of the input volume since the height of each filter and width of each filter is smaller than the input provided.

3.4 Polling Layer

This layer is usually in cooperated between two successive convolutional layer. Pooling layers are used to reduce the dimensions of the feature maps. Thus, it reduces the number of parameters to learn and the amount of computation performed in the network. It summarizes the feature present in the region of the feature map which is generated by convolutional layer. Due to this further operations are performed on summarized features instead of precisely positioned features generated by the convolution layer. By this model become robust to variation in the position of the features in the input images. Max pooling is one type of pooling layer.

3.5 Fully Connected Layer

This layer is the essential component of Convolutional Neural Networks (CNNs), which have been proven very successful in recognizing and classifying images for computer vision. The Convolutional neural network process begins with convolution and pooling, breaking down the image into features, and analyzing them independently[10]. The result of this process feeds into a fully connected neural network structure that drives the final classification decision.

3.6 Experiment

In this project we have detect the whether an MRI image contain brain tumor or not. For this we have used the image dataset. This will be done in many phases. After importing dataset, we have converted image into grey scale image and blur it slightly.

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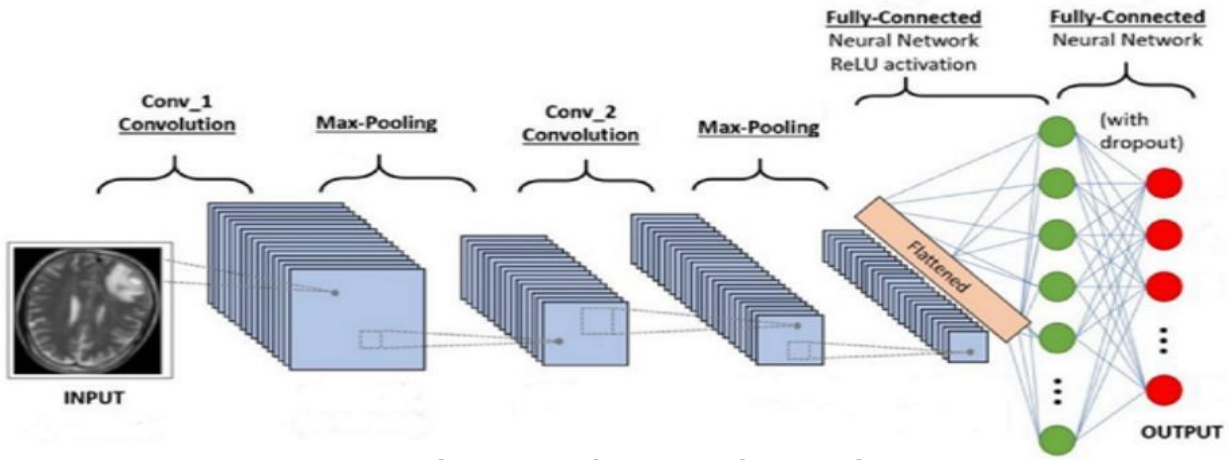

Fig 2.1. Complete CNN architecture with various layers

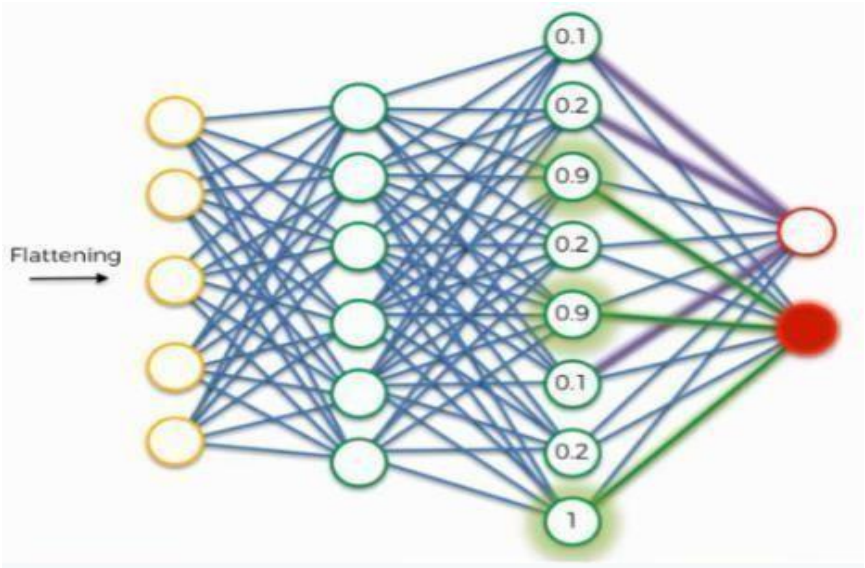

Fig 2.2. Fully Connected Layers in the network

3.7. About Dataset

In this study, we have use Brain Tumor Dataset that consists of brain MRI images from kaggle. This dataset has 2000 images that has been divided into two separate equal groups first 1000 images have brain tumors and other 1000 images do not have brain tumor.

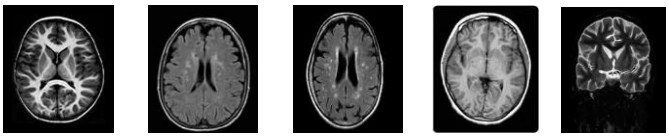

Fig 3. No Tumor Images

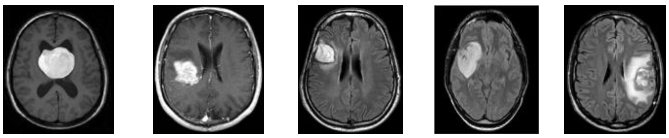

Fig 4. Tumor Images

3.8 Image Analysis

3.8.1 Contour:

It is very useful to calculate the effective area in the image. After that, we have grabbed the largest contour using imutils.grab_contours() and max() function respectively as shown in given figure.

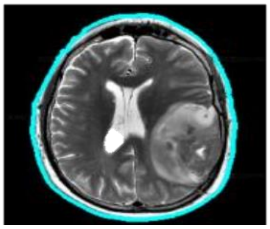

Fig 5. The largest Contour

3.8.2 Cropping:

It is the processing in which we will remove the extra part of image by calculating extreme points in the image. That's why, we have calculated four extreme points (left extreme, right extreme, top extreme and, bottom extreme point) to crop the images. After cropping the image will look like as image shown in given figure.

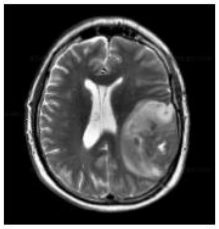

Fig 6.1 Original image

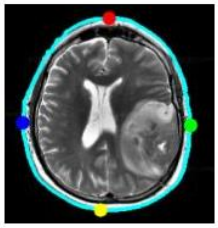

Fig 6.2 Extreme points

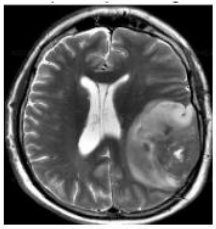

Fig 6.3 Cropped image

3.8.3 Resizing of image:

Sometimes, it is necessary to increase the size of the image to perform the detection operation easily. So, we use cv2.resize() function provided by OpenCV to resize the image.

3.8.4 Visualization of images:

Since, we need a visual summary of information which makes it easier to identify patterns and trends. For that purpose, we have used imshow() function of Matplotlib library which is used to display the images.

Fig 7. Image Visualisation

We have also used iplot() function to get interactive plots and used to display the no of classes in the training and testing dataset.

Fig 8. No. of classes

4. Result Analysis

In this research paper, we got the accuracy through binary classification. This is the most used technique for classification.

4.1 Accuracy of the model—

Accuracy is evaluating the performance of the model by finding that how much the predicted results by the model are correct in compare to real data. For that purpose, we have used plot_metrics() and confusion metric to get accuracy.

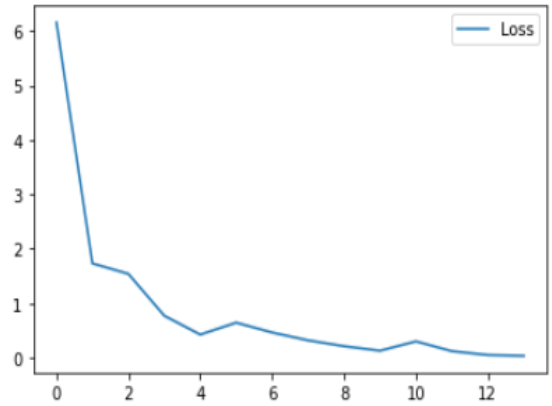

Fig 9. Loss

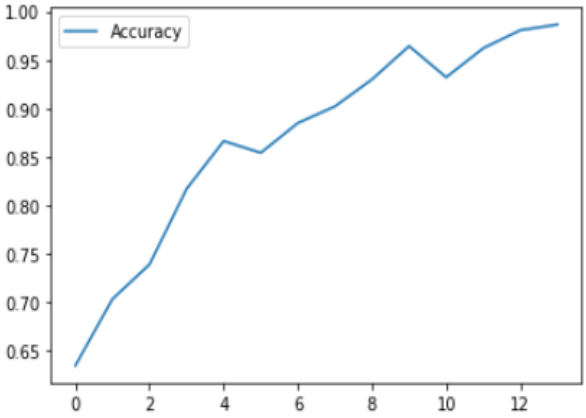

Fig 10. Accuracy

- Confusion matrix showing the validation accuracy in the fig.
- Blue color of matrix shows the validation accuracy ratio
- White color represents the validation loss ratio

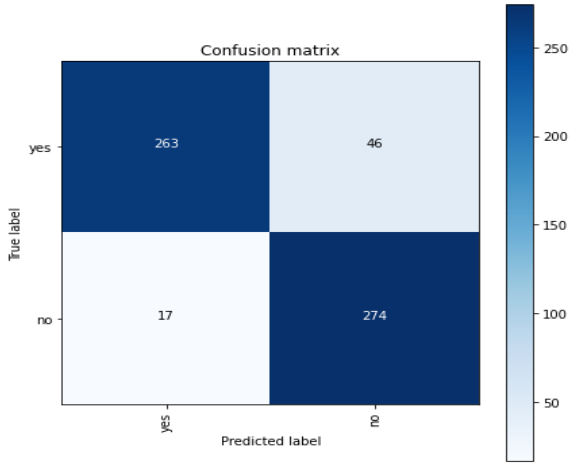

Fig 11. Confusion Matrix

As a result, we got an accuracy of 96% through binary classification and our model predicts the images as shown below:

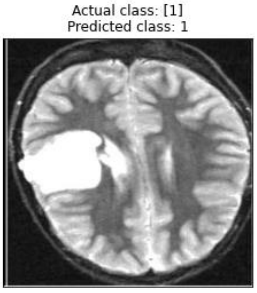

Fig 12.1

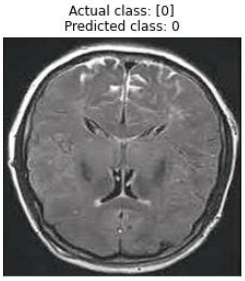

Fig 12.2

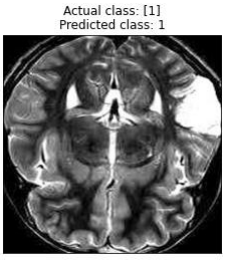

Fig 12.3

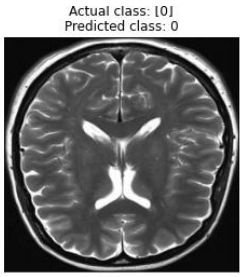

Fig 12.4

5. Conclusion

Brain tumor is the dangerous disease. The main objective behind this project is to review an idea of detection of brain tumor from the MRI image which is taken as an input and can classify whether the given is having a tumor or not by using Convolutional Neural Network. Experimental results classify whether MRI image contain brain tumor or not, with an accuracy of 96% through binary classification.

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