# Brain Tumour Detection and Classification Using CNN

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***Abstract*— Unnatural and uncontrolled proliferation of brain cells is referred to as a brain tumor. As the skull of human is severe, any unanticipated development may compromise a person's functionality depending on the portion of the brain involved; additionally, it can impact the other body parts and affect the behavior of people. To detect the brain tumor, different imaging techniques are available. But MRI is one of the widely used technique. MRI is based on magnetic field and radio waves that generates quality images of body organs and tissues. After the detection of brain tumor, it is very important to know its type for the further treatment process. Deep Learning which is a subset of Machine Learning has shown impressive performance, specifically in classification and segmentation issues. The classification of several types of brain tumors using dataset of MR images is proposed using a Deep Learning model built on a Convolutional Neural Network. The suggested network topology performs admirably, with the overall accuracy 97.52%. The outcomes show that the model can be used for multiple classifications of brain tumors.**

***Keywords*— Brain tumor, CNN, MRI, Confusion Matrix, Accuracy, Data Augmentation**

## I. Introduction

The masses created by abnormal brain cell proliferation that occurs when the brain's regulatory mechanisms are disrupted are known as brain tumor.

An important area of research in the field of medical imaging is the early detection and classification of brain tumor, which assists in determining the most practical course of therapy to save patients' lives. Medical image analysis has greatly benefited from the advancement of new technologies that are based on AI and DL, particularly in the area of disease diagnosis.

There are numerous ways to categorize brain tumors, based on their size, shapes and location. Types of brain tumors can be primary tumors and secondary tumors. The majority of secondary tumors, are malignant tumors that initially develop in any other organ of the body before spreading to the brain.

Brain tumors can be found and categorized using many imaging modalities. But MRI is one of the most popular method.

In treating brain neoplasms, clinical decisions depends on MR Images at different stages in the complete treatment procedure. Tumor classification is difficult, as the overlapping of tissues can happen in imaging technique. A classification method which is computer-based is developed by combining conventional as well as perfusion MRI and used for different diagnosis.

## II. Overview of the Proposed System

The figure1 represents the block diagram for the model. Initially, choose a dataset for model. We have taken the dataset from Kaggle. The next step is divided into two sub steps: Image Extraction and Labels loading. After this preprocessing of the data is done. The main preprocessing technique that we are using is Dimensionality Reduction in which the image size will get reduced. After this we have done the data augmentation

The next step is data partitioning. In data partitioning, dataset is split into training and testing dataset. Training dataset is used for training the model and testing dataset is used for testing the trained model. Now the steps to build the model starts from setting the hyper parameters. These are nothing but the parameters laid down by the user to control the learning process in ML and their values are defined first and then learning process of the model begins. After that next step is to build the CNN Architecture. Then the network training is performed which helps to determine a set of weights in the network. This network training is done by taking the training dataset and our model is trained here. After training when the final model is ready testing dataset is used to test the model. Finally, the performance is computed using the confusion matrix.

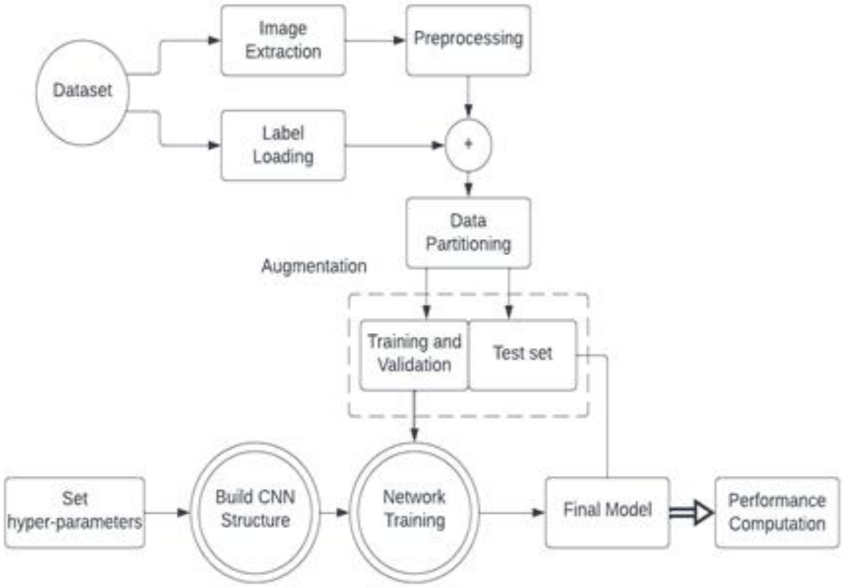


Fig. 1 Block Diagram of the Proposed Model

## III. METHODOLOGY

### A. Dataset

The dataset used, is taken from Kaggle. The dataset contains the MR images of 3 types of tumors: Glioma, Meningioma, and Pituitary tumor. It contains around 1000 images of each of the type of tumor. It also includes 1500 images with no tumor present.

### B. Data Preprocessing

Data preprocessing step is performed before feeding the images to the model. The images are resized to the dimensions 224,224 so as to decrease dimensionality and better performance of the model. Then the data is divided into training dataset and testing dataset in the ratio 80:20. Lastly, the images are augmented so the system can recognize them as new ones, and it avoids overfitting, increases the model robustness.

### C. Proposed CNN Architechture

Fig. 2 represents CNN architechture which consists of 16 layers. The input layer, which is the first layer, contains the pre-processed augmented images. When determining whether a particular MRI image of a patient has a tumor or not, they are then passed through the convolution layers and their activation functions, which are used in feature selection and down-sampling. This process is referred to as Classification-1.

One Input layer, two Convolutional layers, two ReLU layers, one Normalisation layer, two Maxpooling layers, two Fully connected layers, one Dropout layer, one Softmax layer, and one Classification layer builds the proposed CNN structure for Classification-1. Because the first CNN structure is used to classify an image into two classes, the output layer comprises two neurons. A 2D feature vector from the fully connected layer is used as the input for the SoftMax layer, which predicts the presence or absence of tumor.

The glioma, meningioma, and pituitary tumor are the three forms of brain tumors that the second CNN model classifies into. This is known as Classification-2.

One Input layer, six Convolutional layers, six ReLU layers, one Normalisation layer, six Maxpooling levels, two Fully connected layers, one Dropout layer, one Softmax layer, and one

Classification layer builts the proposed CNN structure for Classification-2. This structure has 25 layers in total. Because this second CNN model is intended to categorise a given image into 5 classes, the output layer comprises 5 neurons. A 5D feature vector from the final fully connected layer is fed into the SoftMax layer, which predicts the tumor type.

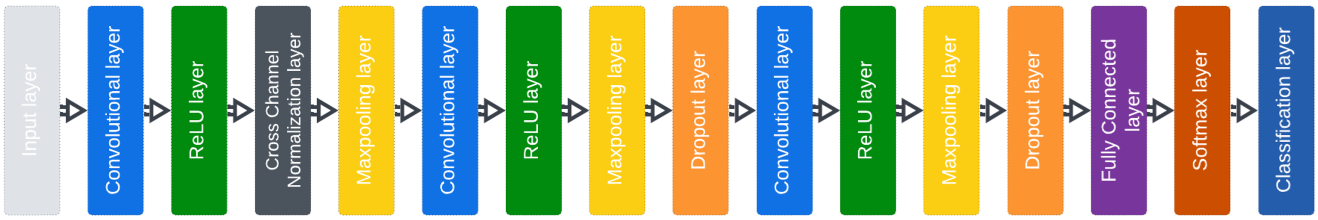


Fig. 2 Proposed CNN Architecture

*D. Regularization and Optimization*

Regularization is a technique that helps to prevent overfitting during training. First, by applying a geometric and colour distortion to the primary images, data augmentation is performed to prevent overfitting. To avoid network complexity, various network structures have then been tested. After that, the weights of the hidden layers were stochastically removed using dropout layers. As depicted in the equation below, L2 regularization is additionally performed to introduce weights decay and a penalty term is added to the cost function.

$$Cost\ function' = Cost\ function\ (Loss) + \lambda \sum_{i=1}^{k} w_i^2$$

here λ is the regularization parameter also known as hyperparameter, w represents the weights for i = 1,2,3…, k. The "early stop technique", is used to stop the training process before completion of all epochs to avoid the overfitting. To get to the global minimum, optimization is employed to change the network parameter and reduce loss function.

*E. Experiments and Results*

To evaluate the model performance there are many evaluation metrics. We have used accuracy to evaluate the performance of model. Accuracy depicts that how correctly the model predicts the class of a given instance. Mathematically accuracy is the value generated by dividing the number of correct predictions by the total number of predictions. The model accuracy graph and model loss graph are shown in Fig. 5 and Fig. 6 respectively.

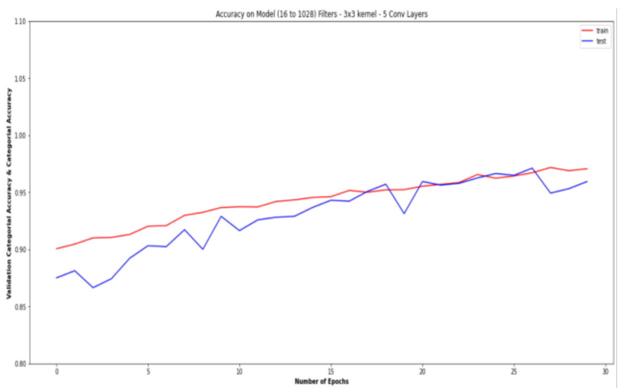


Fig. 5 Accuracy on Model

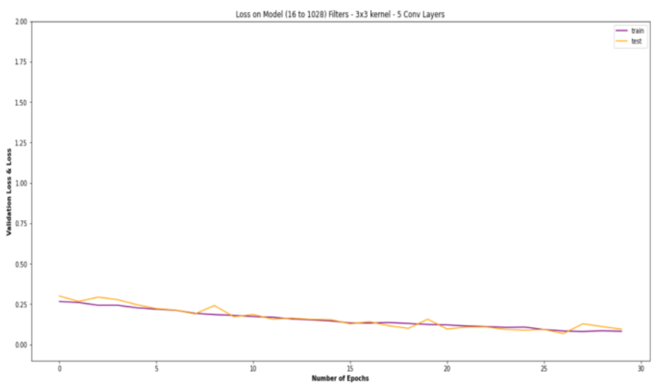


Fig. 6 Loss on Model

## Web Interface


Fig. 7(a) Home Page


Fig. 7(b) Web Interface after choosing Image

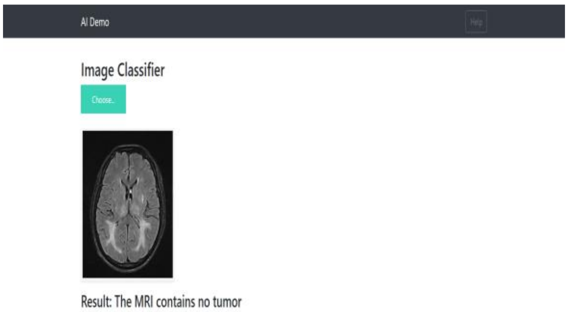


Fig. 7(c) Detection Result

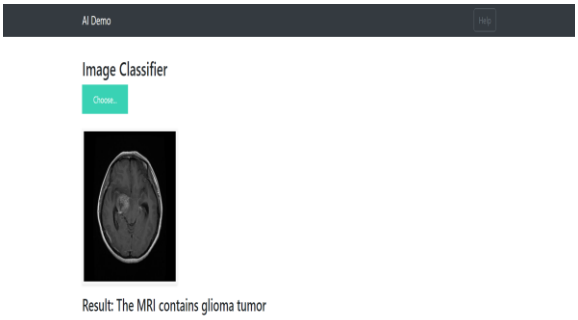


Fig. 7(d) Classification Result

## IV. CONCLUSION:

- In this study we have represented a system for detection and classification of brain tumors based on the MRI images using CNN algorithm in Machine learning.
- When MRI image is provided as an input to the proposed system, it gives the result as the MRI image is of Glioma, Meningioma, Pituitary tumor or no tumor.
- The proposed system has accuracy of almost 97% and has error rates as less as 4% for some types of brain tumors..

## REFERENCES


[1] Chinta Someswararao, R Shiva Shankar, Sangapu Venkata Appaji, Vmnssvkr Gupta. "Brain Tumor Detection Model from MR Images using Convolutional Neural Network", 2020 International Conference on System, Computation, Automation and Networking (ICSCAN), 2020

[2] [2] Amin Kabir Anaraki, Moosa Ayati, Foad Kazemi. "Magnetic resonance imaging-based brain tumor grades classification and grading via convolutional neural networks and genetic algorithms", Biocybernetics and Biomedical Engineering, 2018

[3] [3] N. Srivastava, G. Hinton, A. Krizhevsky, I. Sutskever, and R. Salakhutdinov, “Dropout: A simple way to prevent neural networks from overfitting," J. Mach. Learn. Res., vol. 15, no. 1, pp. 1929-1958, 2014.

[4] [4] Nojun Kwak, “Input Feature Selection for Classification Problem”, 2011

[5] [5] S. Goswami and L. K. P. Bhaiya, ‘‘Brain Tumour Detection Using Unsupervised Learning Based Neural Network,’’ in Proc. Int. Conf. Commun. Syst.Netw. Technol. (CSNT), Apr. 2013, pp. 573–577

[6] [6] “Multi-classification of brain tumor images using deep neural network” HOSSAM H. SULTAN, NANCY M. SALEM, AND WALID AL-ATABANY, date of publication May 27, 2019

[7] [7] T. Kesavamurthy, S. SubhaRani, “Pattern Classification Using Imaging Techniques For Infarct And Hemorrhage Identification In The Human Brain” Calicut Medical Journal 2006;4(3).

[8] [8] E. I. Zacharaki, S. Wang, S. Chawla, D. S. Yoo, R. Wolf, E. R. Melhem,and C. Davatzikos, “Classification of brain tumor type and grade using MRI texture and shape in a machine learning scheme," Magn. Reson. Med., vol. 62, no. 6, pp. 1609-1618, Dec. 2009.

[9] [9] L. M. De Angelis, ``Brain tumors," New England J. Med., vol. 344, no. 2, pp. 114-123, Jan. 2001.

[10] [10] Y. LeCun, Y. Bengio, and G. Hinton, ``Deep learning," Nature, vol. 521, no. 7553, p. 436, 2015.