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Original Article

Detection of Brain Tumor Using Convolutional Neural Network with Python Django Framework

Suganthy M[1], A.Punitha[2], Raghupathi S[3],DurgaDevi[4]
[1,2,3]*Electronics and Communication Engineering, Vel Tech Multi Tech Dr.RangarajanDr.Sakunthala Engineering College ,Tamilnadu, India.*
[4]*Electronics and Communication Engineering, University of Technology and Applied Science, Ibri, Muscat.*

Abstract: *The largest and most intricate organ in the human body is the brain. Brain tumors, which are collections, lumps, or growth of abnormal tissue in the brain, are the second most common kind of cancer. Brain tumor diagnosis is one of the trickiest problems in medical image processing. Brain tumors can develop in a variety of locations, and the location of the tumor indicates the kind of cells that are causing it, which can aid in the diagnosing process. Treatment is greatly impacted by early discovery. Benign and malignant (cancerous) (non-cancerous) brain tumors are the two primary categories. Gliomas, meningiomas, pituitary tumors, and no tumor are among the other subtypes. Intracranial pressure can rise as a result of malignant or benign tumor development. This is potentially lethal and can harm the brain. There are several methods now in use for classifying and segmenting tumors, but they are all time-consuming and have some drawbacks. In order to get over these restrictions, the recommended technique for magnetic resonance imaging (MRI) tumor detection comprises locating the tumor and classifying it based on its kind and level (glioma, meningioma, pituitary, or no tumor).Tumor classification and identification are made possible by ResNet-50 using multitask classifiers based on the Xception model. Because it performs better than the alternatives, the Convolutional Neural Network (CNN) is constructed in Anaconda using a Jupyter notebook using Keras and Tensorflow employing Deep Learning Techniques. Performance analysis will be done on the acquired result.*

Keywords*: ResNet-50, Xception Model, Anaconda with a Jupyter notebook, Magnetic Resonance Imaging, Convolutional Neural Network, Deep Learning, Medical Image Processing.*

INTRODUCTION

The brain is the biggest and most intricate organ in the human body. It is an amazing three-kilogram organ that controls every physiological function and analyzes information from the external world. It receives and interprets all sensory data, including intelligence, creativity, emotion, and memory. The brain is one of the components of the central nervous system (CNS), which is protected by the skull. Studies predict that in 2020, about 25,000 persons (ten,850 women and 14,100 men) will be found to have primary, life-threatening malignancies of the brain and spinal cord. Brain tumors account for around 90% of all major central nervous system (CNS) fatalities. Worldwide, an estimated 308,000 people were diagnosed with their first brain or spinal cord tumor. In addition, 4,170 children under the age of fifteen may be diagnosed with brain tumors. Brain cancer is the tenth most prevalent cause of mortality for both men and women. 18,280 adult fatalities are expected to result from primary malignant brain tumors (10,700 males and 7,550 women). Primary malignant brain tumors are projected to be the cause of death for 250,329 people globally. A brain tumor is defined as the bulk, growth, or aggregation of abnormal brain cells. Benign and malignant (cancerous) tumors are the two main types of tumors (non- cancerous). It may also be divided into two groups: the primary tumors, which start from within the brain, and the secondary tumors, which usually result from malignancies outside the brain. The symptoms may vary depending on the size and location of the tumor in the brain. A few symptoms include headaches, convulsions, blurred vision, vomiting, and mental problems. Additional indicators include difficulty walking, speech impediments, or unconsciousness.

Early detection of brain tumors can increase survival rates and can be crucial in offering more effective treatment choices. However, because MRI images are often generated during medical practice, manual tumorfractionation[14] is a tedious, challenging, and time-consuming process. Magnetic resonance imaging, or MRI as it is frequently called, is mostly used to detect brain cancers. One of the most important issues in medical image processing is the segmentation[15] of brain tumors using MRI data [11][13]. Furthermore, soft tissue may not be able to clearly define the tumoredges.Using Deep Learning-Based Brain Tumor Detection and Classification, the current method splits the tumor into four primary types and has reached an accuracy of

around 92% precision and a loss rate of close to 7% [1]. We are working to increase this accuracy rate in our work by utilizing several CNN-based multitask categorization techniques.

The suggested procedure for identifying cancers using MRI involves locating the tumor and categorizing it based on its nature. ResNet-50 uses a multitask classifier based on the Xception model to allow tumor categorization. With Tensorflow for Deep Learning and Keras for Jupyter notebooks, the Convolutional Neural Network is implemented in Anaconda.The output is deployed in the Django framework and it will be shown in text format, indicating if the provided picture is Glioma / Meningioma / Pituitary / No Tumor as shown in fig.7. [1][6] due to its greater performance compared to the alternatives.

RELATED WORK

[1]Abdul Hannan Khan and colleagues developed a technique for brain tumor identification based on deep learning. This paper suggests a convolutional neural network (CNN)-based method for identifying brain malignancies from MRI data. The method divides the tumor into four main categories. The Recommended Model works better than the techniques presently in use for the detection and segmentation of brain tumors, with around 92% accuracy and a nearly 7% loss rate.

Aryan SagarMethil [2] proposes a technique named that recognizes brain malignancies in a variety of brain images by utilizing a convolutional neural network and histogram equalization. Experiments were conducted on MRI datasets containing tumors of various shapes, sizes, textures, and locations. A Convolutional Neural Network (CNN) was used for classification. Using this approach produces output with spurious augmentation and an abnormal spike in brightness when the image has a greater pixel density.

With the assistance of the Vector Machine and the K-means Clustering Algorithm, Suresha D. et al. [3] developed a model to use MRI to identify tumors and assess whether or not the brain has tumors. Using this method, they converted the input image to grayscale using binary thresholding and then searched for speckles. The amount of spots that can identify between a brain that is malignant and one that is not is shown. After the feature set has been extracted and characterized using the K-means approach, a support vector machine is trained to identify cancers. The brain abnormalities seen in MRI images are identified by the algorithm. By using this method, tumors may be detected more rapidly and precisely with fewer training sessions needed. This method's main drawback is that it has trouble clustering data when clusters differ in size and density.

Convolutional Neural Network-Based Brain Tumor Detection was proposed by TonmoyHossain et al. [4]. The authors employed a few CNN-based conventional classifiers after developing a technique for brain tumor diagnosis utilizing magnetic resonance imaging (MRI) and the Fuzzy C-Means clustering algorithm. This study's dataset contains a variety of tumor parameters. They originally employed traditional classifiers, namely K-Nearest Neighbor (KNN), Support Vector Machine (SVM), and other algorithms. They performed evaluations with different numbers of layers, but with this 5-layer CNN model, the outcomes were not really remarkable. This approach is not able to fix faulty databases and is quite complex..

PROPOSED SYSTEM

Pre-processing, Training & Testing, and Prediction are the three modules that make up the technique. Figure 1 illustrates the procedures for identifying a brain tumor. Convolutional Neural Network Architecture based on ResNet-50 with Xception model classifier is used in the pre-processing phase to resize, enlarge, and pre-process input photos. To increase accuracy, optimization is carried out using the Adam optimizer or SGD (Stochastic GradientDescent). Once all of the previously stated procedures have been finished, the result is finally reviewed and performed in text format. This design also includes a training and testing dataset. Real-time datasets with over 7000 photos were collected from various sources, such as Github and Kaggle, in order to train and test the system. The entire dataset was divided into training and testing phases, during which time the detection of the photos was tested and trained.

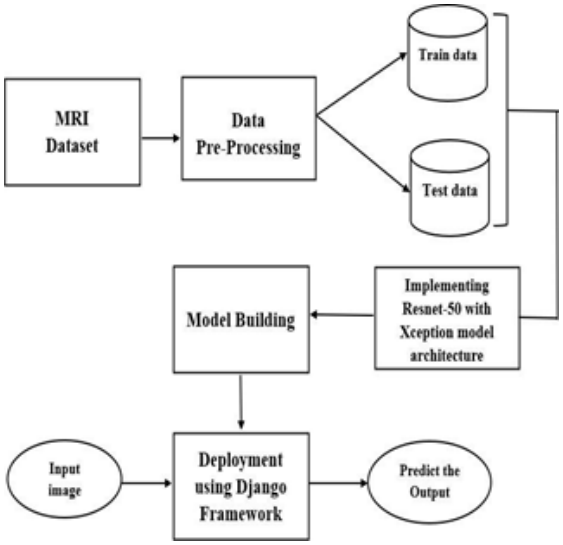

Figure 1: Block diagram for Brain Tumor Detection

A) Pre-Processing Phase

Pre-processing is a crucial step in improving the quality of brain images. The actions in this phase include scaling and expanding the picture. Image enlargement is a commonly used technique to improve the performance of generalized deep neural networks. The two categories of procedures for expansion are : Position enlargement where rescaling [3][5], shear ranging, zoom ranging and horizontal flipping are done.

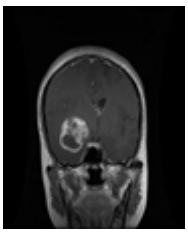

Figure 2: Image after Resizing

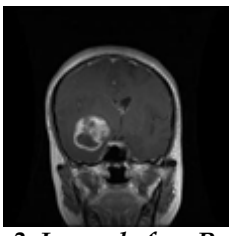

Figure 3: Image before Resizing

Another technique is Colour enlargement. The dataset is brightened, contrasted, and saturated. The procedure of resizing images is crucial for the identification of brain tumors. It is possible for the dataset to become downscaled and more difficult for convolutional neural network architecture to learn the feature needed for detection or classification if the dataset's height and width are not specified. The testing step will require more time. The dataset has to be scaled to a specific width and height. Here, the datasets are saved in the output after being downsized to 224x224, the fixed size of the Resnet-50 architecture. The MRI images of the brain before and after resizing Figs. 2 and 3 are displayed below.

B) Training and Testing Phase

The resized image is captured and loaded for the training and testing phase when the Pre-Processing step is complete. The several MRI datasets are being trained and tested in this phase utilizing Convolutional Neural Network Architectures, such as ResNet-50 with Xception model based multitask classifiers.

Convolutional layers are necessary for CNN, a form of Artificial Neural Network (ANN) [9], to operate. Convolutional neural networks, sometimes known as CNNs, are one of the main subtypes of neural networks used for image categorization and recognition [2][10]. The conventional CNN [4] structure is primarily composed of three layers, which are referred to as the convolutional layer, pooling layer, and fully connected layer. The purpose of the convolutional layer is to extract distinct information from an input picture. This layer performs a mathematical convolution on both the original and the rescaled (224x224) picture. The feature maps are then sent to the layers that follow in order to identify different features in the input picture. A CNN's convolution layer processes the input through a convolution operation before forwarding the result to the following layer. Following the convolution layer is the pooling layer. The primary objective of this layer is to lower the reduced feature map in order to minimize computational expenses. This is achieved by minimizing the connections between the layers that function independently on each feature map. Pool layers are usually used to merge convolutional and totally linked layers. Through the generalization of the features extracted from the convolutional layers, this CNN model allows the network to identify the properties on its own. The fully linked layers, which are the final few layers in a CNN architecture, are frequently positioned before the output layer. The FC layer of this layer receives the anti-aliased input image from the layer before it. After that, the smoothed vector is sent through a number of further FC stages, frequently via a process using mathematical functions. As seen in Fig. 8, connected categorization layers now perform better than single linked layers. Algorithm explanation and optimization are the two steps that make up the training and testing phase.

a) Algorithm Descriptor

CNN, which has been trained on the ImageNet database using Python and the Keras Deep Learning [7][8] toolkit—specifically, ResNet-50 with Xception model—is used in the proposed system.

Resnet with TensorFlow (Transfer Learning): The model may go very deep using a disconnected residual network known as ResNet. ResNet was able to scale up to 152 layers in the training phase without experiencing gradient fading or other fading problems thanks to its innovative architectural design.

One sort of Artificial Neural Network (ANN) that may create networks utilizing residual blocks is the Residual Neural Network (Resnet-50). It consists of two-layer blocks and 34 weighted layers. ResNet-50 is a ResNet variation with 50 deep layers that was trained using at least one million images from the ImageNet database. Batch normalization and double- or triple-layer skips with non-linearities (ReLU) are used in most ResNet models. One method for learning skip weights that typically makes use of an extra weight matrix is Highway Net. In the ResNet-50 design, convolutional blocks are placed in a certain order with average pooling. Softmax is used in the last layer of categorization.

Imagenet: The primary objective of this ImageNet project is to train a model capable of classifying 1000 different types of objects inside an image. For picture recognition, the user can utilize the pre-trained models found in the Keras core library. Models such as ResNet-50, VCG16[12], VCG19, Inception V3, and Xception are included in it.

The Xception Model is a convolutional neural network with 71 layers. Photos may be classified by the pretrained network using 1000 distinct item categories. Images up to 299x299 pixels in size can be accepted by the network. It has an architecture of deep CNN and makes use of depth-wise separable convolutions. Its three main parts are the Entry flow, the Middle flow (which is repeated eight times), and the Exit flow. The input stream is the first channel that data travels through before moving on to the output stream, which is reached after eight repetitions of the intermediate stream. Separable convolutions and batch normalization are used after every convolutional layer.

Using MRI datasets, the algorithm trains and tests the tumor initially. CNN-based classifiers are used to compare the test and training data, and the best result is derived from this data. The multi-task classification based on Convolutional Neural Networks (CNN) [Fig.6] has the ability to detect and classify tumors. The quantity of MRI datasets for different tumor types that were gathered and divided into training and testing phases is displayed in Table I.

Table 1: Input Matrix for the Proposed CNN Classifier

Number of MRI Datasets	Glioma	Meningionma	Pituitary	No Tumour
Training phase	1321	1339	1457	1595
Testing Phase	300	306	300	405
Total Inputs	1621	1645	1757	2000

The tumor's accuracy level will be predicted by the system using optimization techniques. The primary goal of this phase is to increase accuracy as opposed to using the current ones. Table 2 lists the accuracy and loss rate for different epoch settings.

Table 2: Accuracy & Loss (%) for the Training and Testing datasets

Epouchs	Training		Testing	
	Accuracy (%)	Loss (%)	Val-Accuracy (%)	Val-Loss (%)
5	82.0	49.3	84.4	46.6
10	87.1	35.3	89.0	30.0
15	90.0	27.5	91.5	23.4
20	92.1	21.8	92.8	20.3
25	94.0	17.2	95.1	14.7
30	95.0	14.6	95.7	13.3

b) Optimization

One powerful tool for solving difficult problems in the real world is the application of optimization techniques. It provides efficacy, performance assessment, and insight into the impact of alterations in the input data. Using optimizers like Adaptive Moment Estimation (ADAM) and Stochastic Gradient Descent (SGD) [7], the accuracy level of the brain tumor is predicted graphically. Performance analysis will be done on the acquired result.

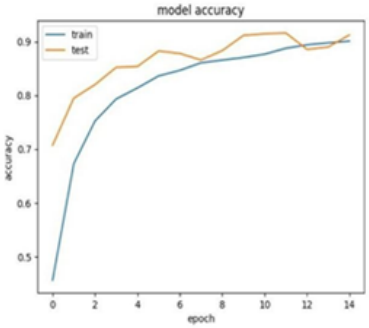

Figure 4: Graph shows the Accuracy rate for the Training and Testing Dataset

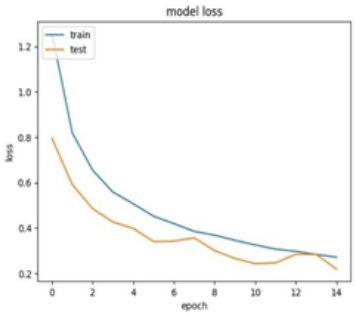

Figure 5: Graph shows the Loss rate for the Training and Testing Dataset

c) Prediction Phase

The taught Deep Learning model is converted into a hierarchical data format file (.h5 file) when the Training and Testing phase is finished. The.h5 file will include the highest accuracy and loss value from the test and training epochs. After that, it is integrated into the Django framework to improve user experience and anticipate output when the user uploads an MRI picture. Whether the picture is a Glioma, Meningioma,

Pituitary, or No Tumor [1] [Fig.7], the output will be presented in Text format, and the accuracy rate will be about 95% for the Training dataset and 95.7% for the Testing dataset, as indicated in Figs. 4 and 5, respectively.

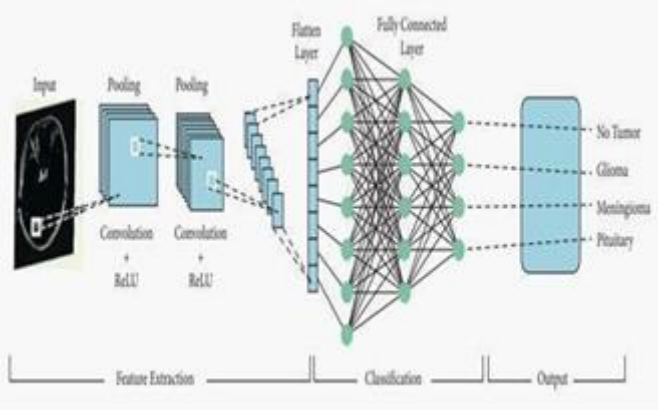

Figure 6: Diagram shows the type of tumors identified using CNN classifier

Figure 7: Brain tumour Type identified from MRI image

SYSTEM IMPLEMENTATION

A. Software Specification

- Windows Python 3.10.6
- PIP
- NumPy 1.23

- Python, a high-level general-purpose interpreted programming language, was designed by Guido Van Rossum in 1991. Due to its advanced programming language, it is utilized for various purposes such as web development, software development, system scripting, and more. Additionally, it is often utilized as a scripting or adhesive language for swift application building and linking pre-existing components. The language structure and object-oriented technique are specifically designed to assist programmers in developing code that is concise and comprehensible for projects of varying scales.
- IP is a versatile tool that serves as both a package manager for python packages or modules, as well as a package management system for installing and managing software packages written in Python..
- OpenCV is an open-source computer vision library that provides Python interfaces for solving computer vision problems. OpenCV supports several deep learning models from frameworks such as Tensorflow, Torch, and PyTorch. It makes use of the Numpy library.
- NumPy is a versatile tool for handling arrays. Additionally, it includes functions for manipulating matrices and performing the Fourier transform in the field of linear algebra. Due to its open-source nature, we have the freedom to employ it. Compared to traditional Python lists, it aims to provide an array object that is significantly quicker, with a potential speed increase of up to 50 times.

- NumPy is a versatile tool for array processing, commonly used in Jupyter Notebook. Additionally, it incorporates matrices and Fourier transform functions that may be utilized in the field of linear algebra. Since it is a project that is freely available for anybody to use, we have the permission to utilize it. The array object it offers is expected to be significantly quicker than normal Python lists, with a potential speed improvement of up to 50 times.
- Tensorflow is a freely available software library that is widely used for differentiable programming and data flow in many tasks. It is compatible with computers that have a single central processing unit (CPU) and graphics processing unit (GPU), as well as mobile devices and huge distributed systems consisting of hundreds of individual units. A symbolic mathematics library utilized for neural network applications in the field of machine learning.
- Keras is a Python-based neural network library that is both free and open source. The tool streamlines the process of generating standard code, offers a cohesive and user-friendly API, and clearly defines user mistakes. Time required for prototyping is decreased. In addition, we provide a range of deployment alternatives to accommodate your specific requirements.

CONCLUSION AND FUTURE SCOPE

A. Conclusion

This paper provided a novel perspective on the classification of brain tumors. In order to enhance the design and performance of Deep Neural Networks and reduce the size of the training data picture, the datasets were first acquired from several sources. Furthermore, a direct approach is proposed to employ a convolutional neural network as a methodical means of categorizing brain tumors. The Xception Model and ResNet-50 classifiers were used to classify various types of brain cancers. The Adaptive Moment Estimation (ADAM) or Stochastic Gradient Descent (SGD) optimizer is employed to improve the accuracy of outputs in advanced applications. The objective of this endeavor is to enhance the level of precision beyond that of the current ones. The prognostic significance of our proposed methodology is demonstrated by its capacity to accurately detect brain tumors in patients.The final result is produced using Anaconda with Jupyter Notebook. The Keras and TensorFlow libraries are utilized inside the Django framework. The output is presented in text format, specifically indicating if the condition is GLIOMA, MENINGIOMA, PITUITARY, or NO TUMOR.The anticipated output has an accuracy of around 95% for the Training Datasets and 95.7% for the Testing Datasets.

B. Future Scope

The proposed method utilizes a Deep Learning Algorithm and applies a Convolutional Neural Network Architecture to accurately detect and classify Brain Tumors. This approach is efficient, time-saving, and dependable for indexing Tumor pictures. Using different Convolutional Neural Network (CNN) designs can enhance the accuracy rate in the future. Additionally, this procedure can also be utilized for ovarian, breast, lung, and skin tumors. Not every work in this development sector is considered flawless; there is room for further enhancement in this program.

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