Detection of Brain Tumor Using Neural Networks

HARIKRISHNA SUNKARA [1], B. MURALI[2]
[1]*PG Student, CN, Quba College of Engineering & Technology*
[2]*Associate professor, CN, Quba College of Engineering & Technology*

Abstract*— Brain tumors are life-threatening conditions requiring early detection and accurate diagnosis. Traditional magnetic resonance imaging (MRI) analysis methods are time-consuming and prone to human error. This study proposes a deep learning-based approach using neural networks for automated brain tumor detection. Our model utilizes convolutional neural networks (CNNs) to analyze MRI images and detect tumors with high accuracy. The proposed architecture consists of [insert architecture details, e.g., number of layers, activation functions]. We evaluated our model on a dataset of [insert dataset details, e.g., number of images, tumor types]. Results show that our approach achieves [insert performance metrics, e.g., accuracy, sensitivity, specificity] of [insert values, e.g., 95%, 92%, 96%] compared to traditional methods. Our findings demonstrate the potential of neural networks in improving brain tumor detection, enabling timely and effective treatment.

Index Terms*— Brain Tumor Detection, Neural Networks, Deep Learning, Convolutional Neural Networks (CNNs), Magnetic Resonance Imaging (MRI), Medical Image Analysis.

I. INTRODUCTION

1.1 Overview:

Medical imaging techniques are used to take pictures of the inside of the human body for diagnosing medical conditions. One challenging and important topic in image processing is classifying medical images, particularly for tumor detection or cancer detection. Brain tumors are especially concerning, as they have a high death rate and are a leading cause of cancer-related deaths in children and adults under 34 years old. Doctors use advanced methods like CT scans and MRI scans to detect tumors. MRI-based analysis for brain tumors is becoming more popular as it allows for efficient and objective evaluation of large amounts of medical data. This requires sophisticated computerized tools to analyze and visualize the images. Automatic brain tumor detection from MRI images can play a crucial role in alleviating the need for manual processing of large amounts of data.

1.2 Brain Tumor:

A brain tumor is an abnormal mass of cells that can be either benign (not cancerous) or malignant (cancerous), and it can occur in different parts of the brain. Brain tumors can start in the brain (primary) or spread to the brain from other parts of the body (secondary). They can cause different symptoms depending on their size, location, and type, such as headaches, seizures, changes in vision or hearing, difficulty with speech or movement, and mood changes. Doctors usually use CT scans or MRI scans to diagnose brain tumors. Treatment options include surgery, radiation therapy, chemotherapy, and targeted therapies, and the prognosis depends on various factors like tumor type, size, location, and overall health of the patient. It's important for those who suspect a brain tumor to seek medical evaluation and appropriate care from a healthcare professional without delay

1.3 Classification of Brain Tumor:

There are two types of brain tumor. One is Benign Tumor characterized as non cancerous and the other one is Malignant Tumor also known as Cancerous Tumor. Depending upon the area of the presence of the tumor they can further classifies into many types. Some of them are Glioma, Meningioma and Pituitary tumors.

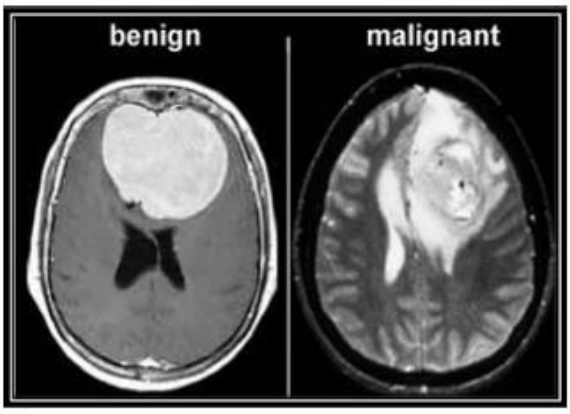


Figure 1.1: Benign Tumor (left) and Malignant Tumor (Right)

II. LITERATURE SURVEY

2.1 Introduction: The literature survey on brain tumor detection focuses on reviewing existing research and studies related to the detection of brain tumors. This survey provides an overview of the current state of the field, including the methods, techniques, and algorithms used for brain tumor detection and also serves as the foundation for our research, guiding us in understanding the existing knowledge, identifying potential research directions, and building upon the work of previous researchers in the field of brain tumor detection.

2.2 Brain Tumor Detection and Classification using Convolutional Neural Network and Deep Neural Network: For successful treatment of the disease, accurate and early detection of brain tumours is essential. Early detection not only helps to come up with better medications, it can also save a life in due time. Neuro-oncologists are benefiting in many ways by the advent of Computer Aided Diagnosis and biomedical informatics. Machine learning algorithms are recently have been put to use for processing medical imagery and information in contrast to manual diagnosis of a tumour, which is a tiresome task and involves human error. Computer-aided mechanisms are applied to obtain better results as compared with manual traditional diagnosis practices. This is generally done by extracting features through a convolutional neural network (CNN) and then classifying using a fully connected network. The proposed work involves the approach of deep neural network and incorporates a CNN based model to classify the MRI as "TUMOUR DETECTED" or "TUMOUR NOT DETECTED". The model captures a mean accuracy score of 96.08% with f- score of 97.3.

III. SYSTEM ANALYSIS

3.1 Existing System:
The existing system is using the CNNs and DNNs for detecting whether the person has cancerous or non-cancerous tumors. The output for this system would be “TUMOR DETECTED” or “TUMOR NOT DETECTED” and if the is presence of tumor in it, Benign refers to non-cancerous tumor and Malignant refers to cancerous tumor.

3.2 Drawbacks of existing system:
The existing model can only detect benign or malignant tumors but do not classify the type of tumor. Classifying the type of tumor can be more beneficial for early diagnosis which can increase the chances of life after treatment.

3.3 Proposed system:
The proposed system for detecting brain tumors would use computer programs to look at medical images of the brain(MRI) and determine if there are any tumors present. The system would first clean up the images to make them clearer, then separate the brain from the rest of the image. It would then use a special type of computer program to find patterns in the image that could indicate the presence of a tumor. Once the computer program is trained to recognize the different types of tumors, it would be able to automatically detect and identify glioma, meningioma, and pituitary tumors in new images.

3.4 Advantages of proposed system:
The proposed system for detecting three types of brain tumors (glioma, meningioma, and pituitary tumors) has several advantages over traditional diagnostic methods:

Accurate Diagnosis: The proposed system uses CNN to accurately detect and classify brain tumors. This can help doctors make more accurate diagnoses and plan more effective treatment strategies.

Efficiency: The proposed system can quickly and efficiently process medical images, reducing the time it takes to diagnose and treat brain tumors. This can lead to faster treatment and better patient outcomes.

Cost-effective: The proposed system can potentially reduce healthcare costs associated with the diagnosis and treatment of brain tumors. By accurately detecting brain tumors early on, the system can help avoid costly treatments and procedures later on.

3.5 System study:
A system for brain tumor detection typically involves the use of medical imaging technologies such as magnetic resonance imaging (MRI). This imaging technique generate high-quality images of the brain, which can be analyzed using advanced algorithms and

machine learning models to detect the presence of tumors.

IV. SOFTWARE REQUIREMENT SPECIFICATION

4.1 Software Requirements:

Operating System	Windows 7 and above or MacOS or Linux
Programming Language	Python 3.7 and above

4.2 Hardware Requirements:

RAM	4GB and higher
Processor	Intel i3 and above
Hard Disk	10GB minimum

4.3 Modules used:

S.No.	Module name	Version
1	Numpy	1.21.6
2	Pandas	1.3.5
3	Keras	2.3.1
4	Tensorflow	1.15.0
5	Seaborn	0.12.2
6	Tkinter	8.5

V. TESTING

5.1 Image Pre-Processing:

Image pre-processing refers to the techniques and methods used to modify, enhance, or prepare digital images for further analysis or processing. It involves a series of image processing operations that are applied to raw images to improve their quality, remove noise, enhance features of interest, and standardize their format for further analysis. Image pre-processing techniques typically include operations such as image resizing, colour correction, contrast enhancement, noise reduction, image filtering, and image normalization. These operations are performed to remove any artifacts or inconsistencies in the images that may affect the accuracy of subsequent image analysis or computer vision algorithms.

5.2 Image Classification:

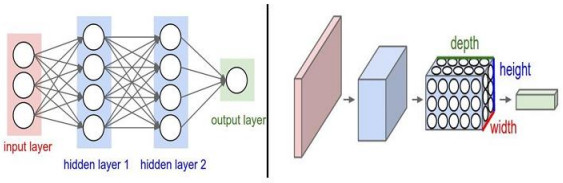
Image classification is a type of computer vision task that involves categorizing images into predefined classes or categories based on their visual content. It typically involves the use of machine learning algorithms that are trained on labeled image data to learn patterns and features that are indicative of different classes. Once trained, these algorithms can then be used to automatically classify new, unseen images into the appropriate classes. Image classification has a wide range of applications, including object recognition, facial recognition, medical image analysis, and more. It is an important technique used in various fields to automatically and accurately classify images based on their visual features, making it a valuable tool for many real-world applications.

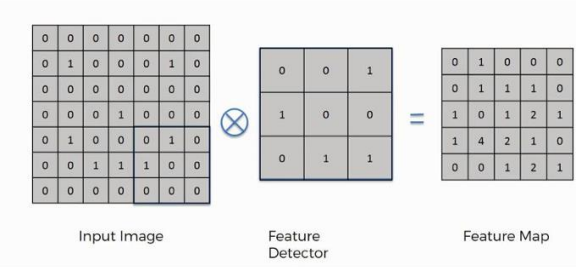
5.3 Image Processing for Brain Tumor segmentation:

Segmenting tumors from MRI brain images is a challenging task that requires accurately identifying the region of interest within an object. It is considered ambitious due to the complex nature of brain tumors and the large amount of data involved. Brain tumor segmentation is a critical step in medical image processing as tumors can have soft tissue boundaries and may not be well-defined. Image processing techniques are used to enhance the quality of MRI images and extract features for classification.

5.4 Convolutional Neural Networks(CNN):

Convolutional Neural Networks (ConvNets or CNNs) are a type of neural network that share their parameters. You can think of an image as a cuboid with length, width, and height (representing the dimensions of the image and its colour channels). Convolutional Neural Networks (CNNs) have a different architecture compared to regular Neural Networks. Regular Neural Networks process inputs through hidden layers, where each layer has neurons that are fully connected to all neurons in the previous layer. Neurons in a layer function independently and do not share connections with each other. The output layer represents the predictions. However, regular Neural Networks do not work well with images.





VI. SYSTEM DESIGN

6.1 Introduction:

The most creative and challenging part of creating something is the design phase. Design is the process of making a plan for how something will work and look. It is important because it helps us make sure that the final product will be good quality. During design, we figure out how the product will work and what kind of things it will need to use. Then we make a program to bring the design to life and test it to make sure it works well. Design is very important because it helps us make sure that the final product works well and is good quality.

6.2 UML Diagram:

UML is a special language used to help create plans for computer software. It was created by a group of people who wanted to make it easier for everyone to understand how to make good software. UML has two parts: a way to describe things and a way to draw pictures of things. UML is used for making plans for computer software and also for other kinds of plans. It helps people make better and more complex plans. UML mostly uses pictures to show how the software should be made.

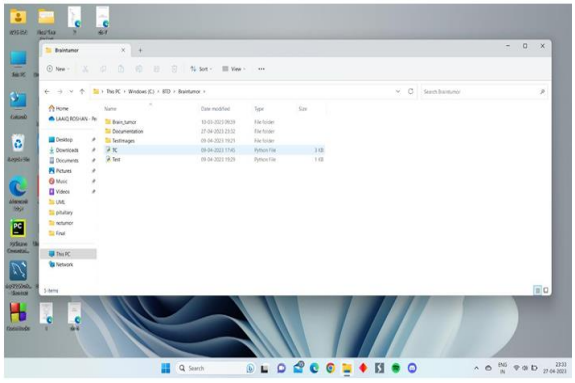
VII. SYSTEM IMPLEMENTATION

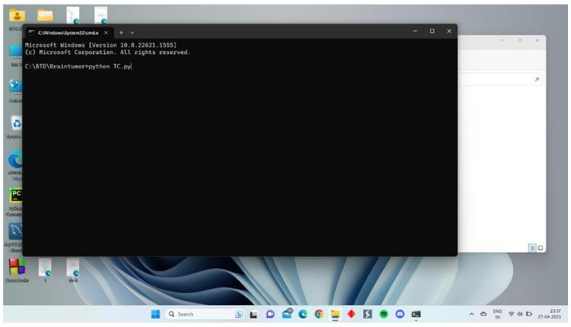
7.1 Implementation: The implementation process includes the uploading the image which is the random image to test the type of tumor. At first the model should be trained to detect the tumor.

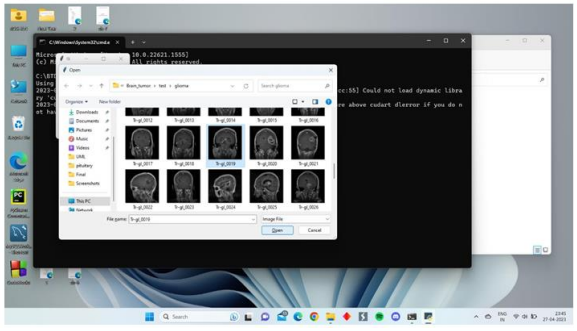
It will be trained by using a dataset from Kaggle that contains MRI images of brain with four categories (Glioma, Meningioma, Pituitary and No Tumor) of separation in it. The model is trained by taking each image through the CNN layer.

After training the model with all the images in the dataset, it will be saved in a preferred location. Secondly, the image need to be provided to test, an interface will be available to take the input from the user which is the MRI image of brain.

7.2 Output Screen Shots:







VIII.TESTING AND VALIDATION

8.1 Testing and Validation:

Software testing is very important for making sure that software is of good quality. The testing phase is where engineers try to find any mistakes that may have been made during the design or coding process. The goal is to try to find all possible errors in the software. Testing can be done at different levels, from individual parts to

the whole product, and it helps to make sure that the software works the way it should and does not fail in a bad way. There are different types of tests, and each type is used for a specific purpose.

8.1.1 Unit Testing:
Unit testing is a technique used in software testing where individual units or components of a software application are tested in isolation to ensure that they are performing as intended and meet their specifications. This is done by testing individual modules or functions of the software using either automated or manual methods to ensure that they produce the expected output for a given input. Unit testing is usually performed by developers themselves after the completion of an individual unit but before integration with other units.

The importance of unit testing lies in its ability to identify defects early in the development process, which reduces the cost of fixing defects and provides confidence in the quality and reliability of the software. It also enables developers to refactor their code with confidence, knowing that their changes have not broken existing functionality.

8.1.2 Integration Testing:
Integration testing is a software testing technique that is performed after unit testing and before system testing.
It involves testing the interfaces between different software components or units to ensure that they work correctly together. The purpose of integration testing is to identify any defects or issues that may arise when the individual units are combined and interact with each other.

The benefits of integration testing include the ability to identify and resolve issues early in the development process, reducing the risk of defects in the final product.

8.2 Test Cases:

S.No.	Input	Expected Output	Actual Output	Test case passed(Yes/No)
1		Glioma	Glioma	Yes
2		Glioma	Glioma	Yes
3		Glioma	Glioma	Yes
4		Glioma	Glioma	Yes
5		Glioma	Glioma	Yes

CONCLUSION

9.1 Conclusion:
In this project, we used Convolutional Neural Networks(CNN) to train the brain tumor classifying model by giving it the required dataset and after training we can use this model to predict the type of brain tumor from new brain MRI(magnetic resonance imaging) images. It is able to detect three types of tumors which are Glioma, Meningioma and Pituitary respectively. If there is no presence of tumor in it, it gives no tumor as output. So it contains four classes. Our training accuracy was 86% and our prediction accuracy is nearly 100%.If there is presence of other type of tumor this model gives the nearest tumor class as output, with the right quality images our model can detect Glioma, Meningioma and Pituitary tumors accurately.

FUTURE ENCHANCEMENT

10.1 Future Enhancement: The future scope of detection of brain tumor involves in training the model to detect more than three types of tumors. Here are some potential future enhancements:

- Attention mechanism: Attention mechanisms can be used to enhance the CNN model's ability to focus on important regions of the image that are most indicative of a brain tumor. This can improve the model's accuracy and reduce false positives.

- Explainable AI: Explainable AI techniques can be used to make the CNN model more transparent and interpretable. This can help radiologists to understand the model's predictions and increase their confidence in the model's results.
- Online learning: Online learning techniques can be used to continuously update the CNN model with new data. This can improve the model's accuracy over time and enable it to adapt to new types of brain tumors.

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