VISVESVARAYA TECHNOLOGICAL UNIVERSITY

‘JNANA SANGAMA’ BELAGAVI-590 018, KARNATAKA

PROJECT REPORT

ON

“BRAIN TUMOR DETECTION USING CNN”

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE

BACHELOR OF ENGINEERING
IN
COMPUTER SCIENCE & ENGINEERING

Submitted By

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DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

UNDERTAKING

We, **BHARATH KALYAN S [1CG18CS017], MAHADEV [1CG18CS048], HIMAGIRISHA N D [1CG18CS033], DARSHAN G A [1CG18CS025]** the students of **VIII semester B.E. Computer Science and Engineering** of **CHANNABASAVESHWARA INSTITUTE OF TECHNOLOGY, GUBBI, TUMAKURU** declare that Project work entitled **"BRAIN TUMOR DETECTION USING CNN"** has been carried out and submitted in partial fulfillment of the requirements for the award of degree in Bachelor of Engineering in **Computer Science and Engineering** by the Visvesvaraya Technological University during the academic year 2021-2022.

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BONAFIDE CERTIFICATE

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A great deal of time and lot of effort has gone into completing this project report and documenting it. The number of hours spent in getting through various books and other materials related to this topic chosen by us have reaffirmed its power and utility in doing this project.

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ABSTRACT

Brain Tumor segmentation is one of the most crucial and arduous tasks in the terrain of medical image processing as a human-assisted manual classification can result in inaccurate prediction and diagnosis. Moreover, it is an aggravating task when there is a large amount of data present to be assisted. Brain tumors have high diversity in appearance and there is a similarity between tumors and normal tissues thus the extraction of tumor regions from images becomes unyielding

The automatic brain tumor classification is a very challenging task in large spatial and structure variability of the surrounding region of the brain tumor. In this work, automatic brain tumor detection is proposed by CNN. The deeper architecture design is performed by using small kernels where it will classify the brain tumor into 4 types glioma tumor, meningioma tumor, no tumor, and pituitary tumor.

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CHAPTER 1

INTRODUCTION

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. Medical imaging processing refers to handling images by using a computer. This processing includes many types of techniques and operations such as image gaining, storage, presentation, and communication.

The brain tumor is one all the foremost common and, therefore, the deadliest brain diseases that have affected and ruined several lives in the world. Cancer is a disease in the brain in which cancer cells ascend in brain tissues. Conferring to a new study on cancer, more than one lakh people are diagnosed with brain tumors every year around the globe. Regardless of stable efforts to overcome the complications of brain tumors, figures show unpleasing results for tumor patients. To contest this, scholars are working on computer vision for a better understanding of the early stages of tumors and how to overcome them using advanced treatment options.

Magnetic resonance (MR) imaging and computed tomography (CT) scans of the brain are the two most general tests to check the existence of a tumor and recognize its position for progressive treatment decisions. These two scans are still used extensively for their handiness, and the capability to yield high-definition images of pathological tissues is more.

The focus of this project is MR brain image tumor extraction and its representation in a simpler form such that it is understandable by everyone. The objective of this work is to bring some useful information in simpler form in front of the users, especially for the medical staff treating the patient. This work aims to define an algorithm or a system that will result in an extracted image of the tumor from the MR brain image. The resultant image will be able to provide information like the size, dimension, and position of the tumor, and its boundary provides us with information related to the tumor that can prove useful for various cases, which will provide a better base for the staff to decide the curing procedure. Finally, we detect whether the given MR brain image has a tumor or not using Convolution Neural Network and classify the tumor if present.

1.1 PROBLEM STATEMENT

Based on our study on automated brain tumor detection and classification, normally the anatomy of the brain is analyzed by MRI scans or CT scans. Histological grading, based on a stereotactic biopsy test, is the gold standard and the convention for detecting the grade of a brain tumor. The biopsy procedure requires the neurosurgeon to drill a small hole into the skull from which the tissue is collected. There are many risk factors involving the biopsy test, including bleeding from the tumor and brain causing infection, seizures, severe migraine, stroke, coma, and even death. But the main concern with the stereotactic biopsy is that it is not 100% accurate which may result in a serious diagnostic error followed by wrong clinical management of the disease. Tumor biopsy is challenging for brain tumor patients, non-invasive imaging techniques like Magnetic Resonance Imaging (MRI) have been extensively employed in diagnosing brain tumors. Therefore, the development of systems for the detection and prediction of the grade of tumors based on MRI data has become necessary.

1.2 OBJECTIVES

- We aim to develop an automated system for the enhancement and classification of brain tumors that can be used by neurosurgeons and healthcare specialists.

- To develop a system that incorporates image processing, pattern analysis, and computer vision techniques and is expected to improve the sensitivity, specificity, and efficiency of brain tumor detection.

1.3 SCOPE OF PROJECT

This project proposes a system that is used for tumor identification and classification in brain MR images. The main reason for the detection of brain tumors is to provide aid to clinical diagnosis. This provides an algorithm or a system implementation that guarantees the detection processes of a tumor by combining several procedures to provide a foolproof method of tumor detection in MR brain images. Diagnosing Brain tissues share certain features and challenges in treating tumors in the body, but they also present specific problems related to the unique features of the organ in which they live.

The project is mainly useful and focused on the medical field where several users can make use of it. This benefits many patients in identifying their Brain tumor results based on the MRI images that they have; from this, they will get to know whether they have a tumor or not, if present our system can go one step further and classify the type of tumor that the patient has (i.e. Meningioma Tumor, Pituitary Tumor, Glioma Tumor). It also benefits the doctors in determining the tumor and treating their patients well to minimize its effects which may sometime save many lives.

CHAPTER 2

LITERATURE SURVEY

RELATED WORK

In Medical diagnosis, robustness and accuracy of the prediction algorithms are very important, because the result is crucial for the treatment of patients. There are many popular classification and clustering algorithms used for prediction. The goal of clustering a medical image is to simplify the representation of an image into a meaningful image and make it easier to analyze. Several Clustering and Classification algorithms are aimed at enhancing the prediction accuracy of the diagnosis process in detecting abnormalities.

In the literature survey, we provide a summary of the different methods that have been proposed for clustering over from 2018. We have been through 15 papers each of which has a unique approach toward segmentation in some parameter or the other. The summaries of each of the papers are provided below.

- **A. Sivaramakrishnan And Dr. M. Karnan "A Novel Based Approach for Extraction Of Brain Tumor In MRI Images Using Soft Computing Techniques," International Journal Of Advanced Research In Computer And Communication Engineering, Vol. 2, Issue 4, April 2013.**

A. Sivaramakrishnan et al. (2013) [1] projected an efficient and innovative discovery of the brain tumor vicinity from an image that turned into finished using the Fuzzy C-approach grouping algorithm and histogram equalization. The disintegration of images is achieved by the usage of principal factor evaluation is done to reduce the extent of the wavelet coefficient. The outcomes of the anticipated FCM clustering algorithm accurately wwithdrewtumor area from the MR images.

- **Asra Aslam, Ekram Khan, M.M. Sufyan Beg, Improved Edge Detection Algorithm for Brain Tumor Segmentation, Procedia Computer Science, Volume 58,2015, Pp 430-437, ISSN 1877-0509.**

M. M. Sufyan et al. [2] hahaveresented a detection using Earn advanced edge technique for brain-tumor segmentation that mainly relied on Sobel feature detection. Their presented work associates the binary thresholding operation with the Sobel approach and excavates diverse extents using a secure contour process. After the completion of that process, cancer cells are extracted from the obtained picture using intensity values.

- **B.Sathya and R.Manavalan, Image Segmentation by Clustering Methods: Performance Analysis, International Journal of Computer Applications (0975 – 8887) Volume 29– No.11, September 2011.**

Sathya et al. (2011) [3], provided different clusterinalgorithmshm such as K-means, Improvised K-means, C-means, and improvised C-means algorithms. Their paper presented an experimental analysis for massive datasets consisting of unique photographs. They analyzed the discovered consequences using numerous parametric tests.

- **Devkota, B. & Alsadoon, Abeer & Prasad, P.W.C. & Singh, A.K. & Elchouemi, A. (2018). Image Segmentation for Early Stage Brain Tumor Detection using Mathematical Morphological Reconstruction. Procedia Computer Science. 125. 115-123. 10.1016/j.procs.2017.12.017.**

B. Devkota et al. [4] have proposed that a computer-aided detection (CAD) approach is used to spot abnormal tissues via Morphological operations. Amongst all different segmentation approaches existing, the morphological opening and closing operations are preferred since it takes less processing time with the utmost efficiency in withdrawing tumor areas with the least faults.

- **K. Sudharani, T. C. Sarma and K. Satya Rasad, "Intelligent Brain Tumor lesion classification and identification from MRI images using a K-NN technique," 2015 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT), Kumaracoil, 2015, pp. 777-780. DOI: 10.1109/ICCICCT.2015.7475384**

K. Sudharani et al. [5] presented a K- nearest neighbor algorithm to the MR images to identify and confine the hysterically full-fledged part within the abnormal tissues. The proposed work is a sluggish methodology but produces exquisite effects.

- **Kaur, Jaskirat & Agrawal, Sunil & Renu, Vig. (2012). A Comparative Analysis of Thresholding and Edge Detection Segmentation Techniques. International Journal of Computer Applications. vol. 39 .pp. 29-34. 10.5120/4898-7432.**

Jaskirat Kaur et al. (2012) [6] defined a few clustering procedures for the segmentation process and executed an assessment of distinctive styles for those techniques. Kaur represented a scheme to measure selected clustering techniques based on their steadiness in exceptional tenders. They also defined the diverse performance metric tests, such as sensitivity, specificity, and accuracy.

- **Li, Shutao, JT-Y. Kwok, IW-H. Tsang and Yaonan Wang. "Fusing images with different focuses using support vector machines." IEEE Transactions on neural networks 15, no. 6 (2004): 1555-1561.**

J.T. Kwok et al. [7] delivered wavelet-based photograph fusion to easily cognizance of the object with all focal lengths as several vision-related processing tasks can be carried out more effortlessly when wholly substances within the images are bright. In their work, Kwok et al. investigated different datasets, and the results in ts show that the presented work is extra correct as it does not get suffering from evenness at different activity stages computations.

- **M. Kumar and K. K. Mehta, "A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method," International Journal of Computer Technology and Applications, ISSN: 2229-6093, Vol. 2, Issue 4, PP. 855-859 August 2011.**

Kumar and Mehta [8] proposed the texture-based technique in this paper. They highlighted the effects of segmentation if the tumor tissue edges aren't shrill. The performance of the proposed technology may get unwilling results due to those edges. The texture evaluation and seeded region approach turned into executed inside the MATLAB environment.

- **Mahmoud, Dalia & Mohamed, Eltaher. (2012). Brain Tumor Detection Using Artificial Neural Networks. Journal of Science and Technology. 13. 31-39.**

Dalia Mahmoud et al. [9] presented a model using Artificial Neural Networks for tumor detection in rain images. They implemented a computerized recognition system for MR images withing the use of Artificial Neural Networks. That was observed that after the Elman community was used during the recognition system, the period time and the accuracy level were high, in comparison with other ANNs systems. This neural community has a sigmoid characteristic which elevated the extent of accuracy of the tumor segmentation.

- **Marroquin J.L., Vemuri B.C., Botello S., Calderon F. (2002) An Accurate and Efficient Bayesian Method for Automatic Segmentation of Brain MRI. In: Heyden A., Sparr G., Nielsen M., Johansen P. (eds) Computer Vision — ECCV 2002. ECCV 2002. Lecture Notes in Computer Science, vol 2353. Springer, Berlin, Heidelberg.**

L. Marroquin et al. [10] presented the automated 3d segmentation for brain MRI scans. Using a separate parametric model in preference to a single multiplicative magnificence will lessen the impact on the intensities of a GA brain. A brain atlas is hired to find non-rigid conversion normal to the usual brain. This transformation is further used to segment the brain from non-brain tissues, computing prior probabilities and finding automatic initialization,n, and finally applying the MPM-MAP algorithm to find out optimal segmentation. Major findings from the study show that the MPM-MAP algorithm is comparatively more y robust than EM in terms of errors while estimating the posterior marginal. For optimal segmentation, the MPM-MAP algorithm involves only the solution of linear systems and is therefore computationally efficient.

- **Minz, Astina, and Chandrakant Mahobiya. "MR Image Classification Using Adaboost for Brain Tumor Type." 2017 IEEE 7th International Advance Computing Conference (IACC) (2017): 701-705.**

Astina minz et al. [11] implemented an operative automatic classification approach for images image that projected the usage of the AdaBoost gadget mastering algorithm. The proposed system includes three main segments. Pre-processing has eradicated noises in the datasets and converted images into grayscale. Median filtering and thresholding segmentation are implemented in the pre-processed image.

- **Monica Subashini.M, Sarat Kumar Sahoo, "Brain MR Image Segmentation for TumorDetection using Artificial Neural Networks," International Journal of Engineering and Technology (IJET), Vol.5, No 2, Apr-May 2013.**

Monica Subashini and Sarat Kumar Sahhave[12] have suggested a technique for detecting the tumor commencing the brain MR images. They also worked on different techniques, which include pulse-coupled network networks and noise removal strategies for reinforcing the mind MRI in mages and backpropagation network for classifying the brain MRI images from tumor cells. They observed image enhancement and segmentation of the usage of their proposed technique, and the backpropagation network helps in the identification of a tumor in a brain MR image.

- **S. Li, J.T. Kwok, I.W Tsang, and Y. Wang, —Fusing Images with Different Focuses using Support Vector Machines, Proceedings of the IEEE transaction on Neural Networks, China, November 2007.**

Li et al. [13] report that edge detection, image segmentation, and matching are not easy to achieve in optical lenses that have long focal lengths. Previously, researchers have proposed many techniques for this mechanism, one of which is wavelet-based image fusion. The wavelet function can be improved by applying a discrete wavelet frame transform (DWFT) and a support vector machine (SVM). In this paper, the authors experimented with five sets of 256-level images. Experimental results show that this technique is efficient and more accurate as it does not get affected by consistency verification and activity level measurements. However, the paper is limited to only one task related to fusion, and dynamic ranges are not considered during the calculation.

- **H. Yu and J.L. Fan, —Three-level Image Segmentation Based on Maximum Fuzzy Partition Entropy of 2-D Histogram and Quantum Genetic Algorithm, Advanced Intelligent Computing Theories, and Applications. With Aspects of Artificial Intelligence. Lecture Notes in Computer Science, Berlin, Heidelberg 2008.**

H. Yu et al. [14] state that image segmentation is used for extracting meaningful objects from an image. They propose segmenting an image into three parts, dark, grey, and white, Z-function and s-function are used for the fuzzy division of the 2D histogram. Afterward, QGA is used for finding a combination of 12 membership parameters, which have a maximum value. This technique is used to enhance image segmentation and the significance of their work is that three-level image segmentation is used by following the maximum fuzzy partition of 2D Histograms. QGA is selected for the optimal combination of parameters with the fuzzy partition entropy. The proposed method of fuzzy partition entropy of 2D histogram generates better performance than the one-dimensional 3-level thresh holding method. Somehow, a large number of possible combinations of 12 parameters in a multi-dimensional fuzzy partition are used, and it is practically not feasible to compute each possible value; therefore, QGA can be used to find the optimal combination.

- **P.S. Mukambika, K Uma Rani, "Segmentation and Classification of MRI Brain Tumor," International Research Journal of Engineering and Technology (IRJET), Vol.4, Issue 7, 2017, pp. 683 – 688, ISSN: 2395-0056**

Mukambika et al. [15] propose a sed methodology for the subsequent stage's classification of the tumor, whether it is present or not. Their proposed work represents the comparative study of strategies used for tumor identification from MR images, namely the Level set approach, discrete wavelength transforms, (DWT), and K-method segmentation algorithms. After that phase, feature extraction is done by allowed SVM classification.

CHAPTER 3

SYSTEM ANALYSIS

3.1 EXISTING SYSTEM

Brain tumor detection is one of the most difficult tasks in the analysis of medical images. Globally brain tumors become a very big reason for human death. By using image processing early the detection of tumors is possible. MR images are considered because it gives a clear structure of the tumor. In these, they have proposed systems with a novel mechanism for detecting tumors from MR images by applying machine learning and deep learning algorithm, ms, especially with the CNN model anime of image processing techniques.

After the literature survey, it has been observed that most of the authors have used the most common algorithms and techniques like KNN-technique, Edge detection, and segmentation techniques, support vector machine, Artificial Neural Network (KNN), Ada Boost algorithm, and Quantum genetical, algorithms and many more.

Drawbacks of these existing systems:

- Hardware Dependency of Artificial Neural requires requires processors with parallel processing power, by their structure.
- Since KNN is a distance-based algorithm, the e cost of calculating the distance between a new point and each existing point is very high which in turn degrades the performance of the algorithm.
- The structure of Convent aims to mitigate over-fitting, you generally need a large amount of data for a convolutional neural network to work effectively.
- Some of these systems have lower layer counts which makes them less accurate while detecting tumors from high-resolution MRIs.
- Many of these systems concentrate only on the binary classification of the MRIs, i.e. they will just detect the brain tumor.
- The lack of systems that classify the detected brain tumor into its respective type is more useful and needed.

- Classification of the tumor is equally important with its detection because detection alone will not be of any help. The tumor severity and its treatment are explicitly dependent on the type of tumor that a person has.

3.2 PROPOSED SYSTEM

The proposed system uses the deep learning technique CNN to effectively identify and classify the tumor based on the MRI images. We chose a deep learning technique like CNN because of its superior performance when it comes to image processing and classification. Convolution Neural Networks are well reputed in image classification on different datasets over time thus proving their superiority compared to other techniques. This system has three phases, Data pre-processing, Model selection and training g the selected model, and last the testing of the model and its accuracy evaluation. During the first phases, data is preprocessed to extract the MRIs to continue the further processes. This dataset is stored in our local machine, these images are accessed through their paths and these images are augmented. In augmentation, more images are produced using existing images by rotating their angles, changing brightness, zooming, etc. so that we have enough data to train the model. This data is split into training data and testing data which will be used to train our model and test its accuracy respectively. The model that we have used is EfficientNet-B3 which is based on a convolution neural network and with minimal layers and parameters, it is proven to be efficient thus giving its name. After training the model, it is tested on the test data to evaluate its efficiency and performance. Finally y, the MRI image is fed into the trained model to predict its result which is either tumor detected or not, if detected our system will classify the detected tumor into one of its types i.e., either Meningioma Tumor or Pituitary Tumor or Glioma Tumor.

CHAPTER 4

SYSTEM DESIGN

The design of the system deals with how the system is developed. It explains the flow functionalities in brief. The section contains system data flow diagram. The flowchart and Sequence Diagram are described below.

4.1 System Architecture

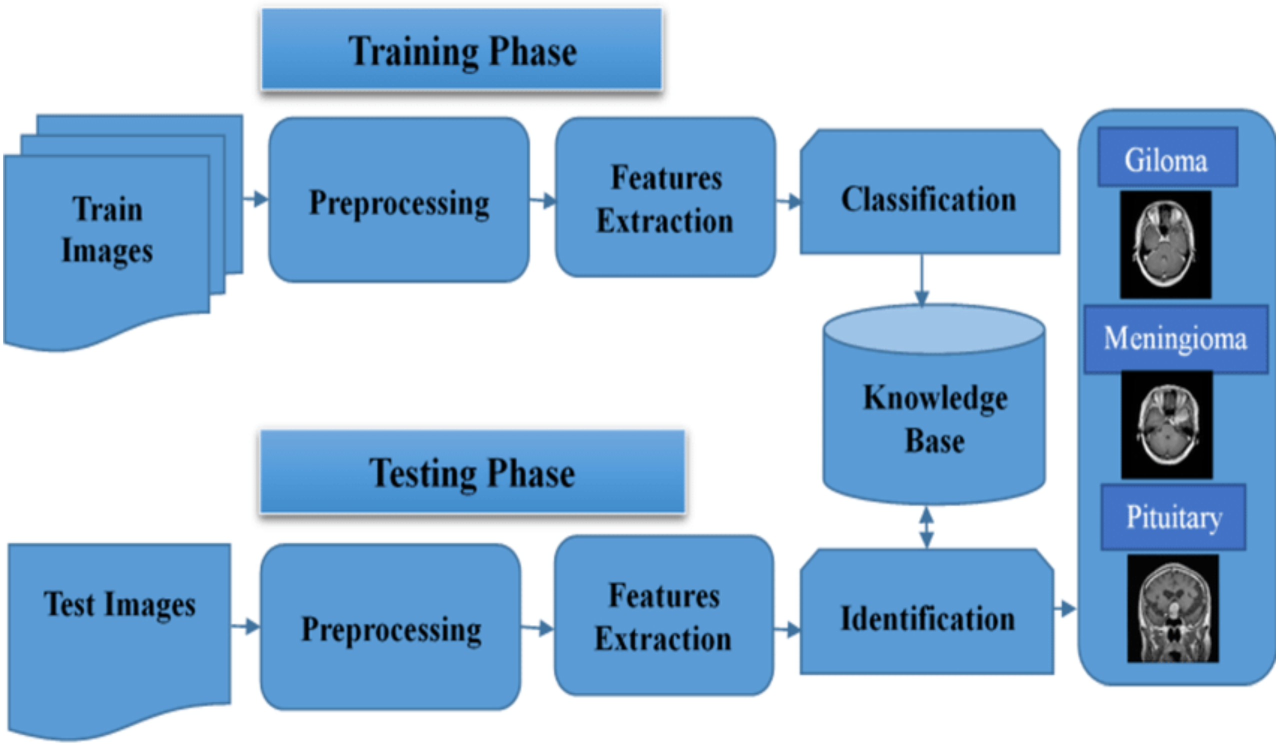


Fig 4.1 System Architecture of the proposed system.

4.2 Flowchart:

A flowchart is a type of diagram that represents an algorithm, work, flow, or process. The flowchart can also be defined as a diagrammatic representation of an algorithm (step by step approach to solving a task).

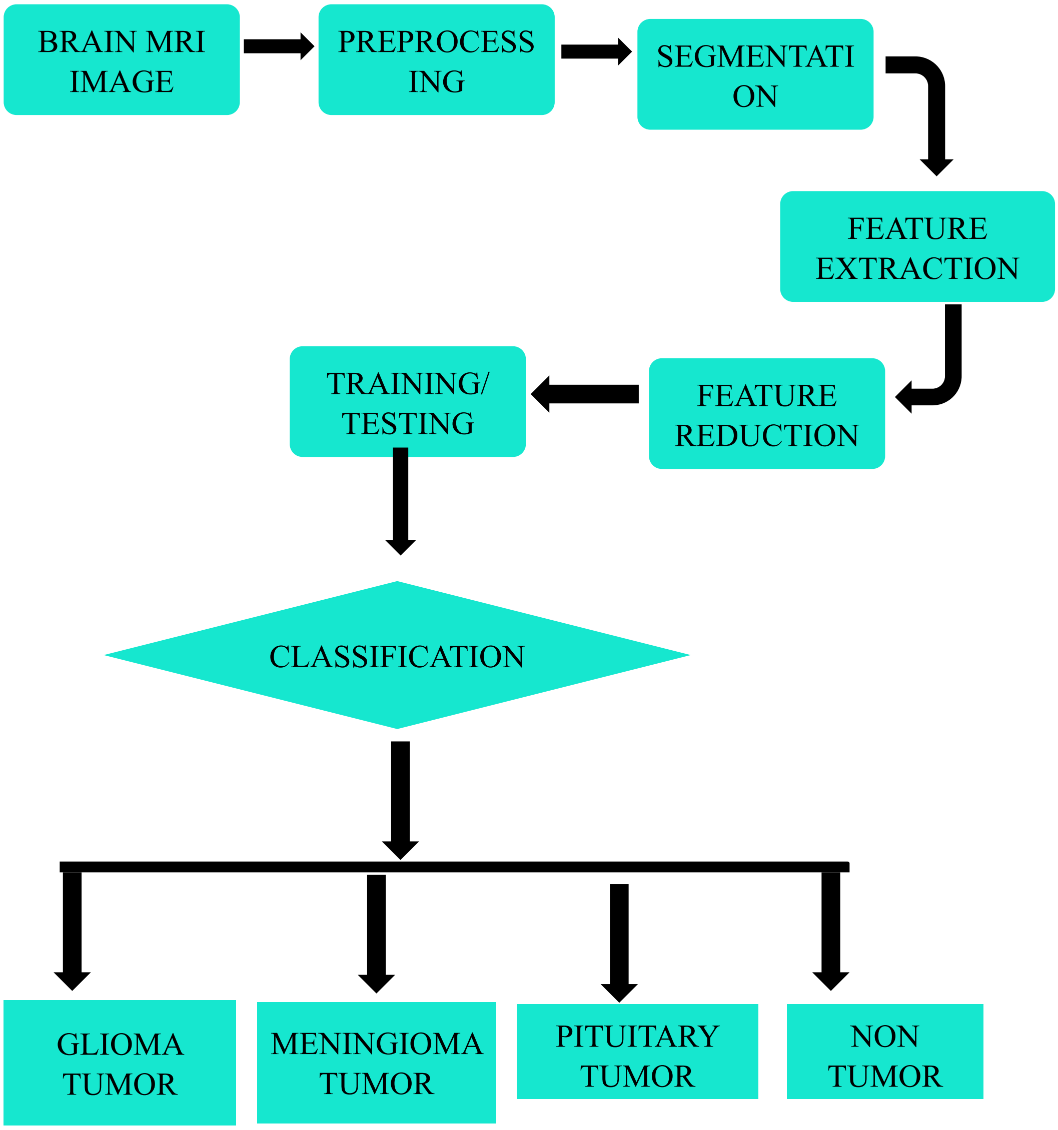


Fig 4.2 Flowchart of the proposed system.

4.3 Use Case Diagram:

Use cases are used during the analysis phase of a project to identify system functionality. They separate the system into actors and use cases. Actors represent roles that are played by users of the system. Users may be humans, other computers, or even other software systems.

Use case diagrams are used to gather the requirements of a system including internal and external influences. These requirements are mostly design requirements. Hence, when a system is analyzed to gather its functionalities, use cases are prepared and actors are identified.

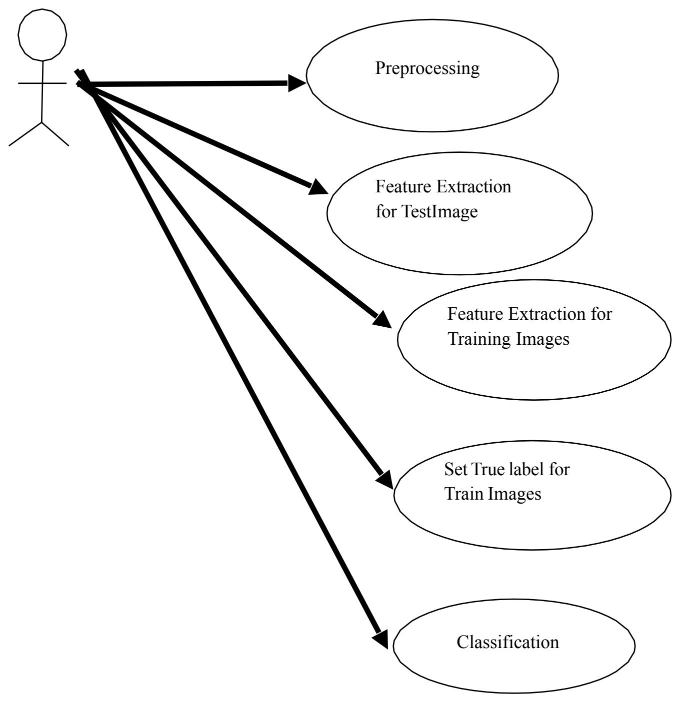


Fig 4.3 Use Case Diagram of the proposed system.

4.4 Sequence Diagram of f proposed system:

A sequence diagram shows object interactions arranged in a time sequence. It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario. Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development. Sequence diagrams are sometimes called event diagrams or event scenarios. A sequence diagram shows, as parallel vertical lines (lifelines), different processes or objects that live simultaneously, and, as horizontal arrows, the messages exchanged between them, in the order in which they occur

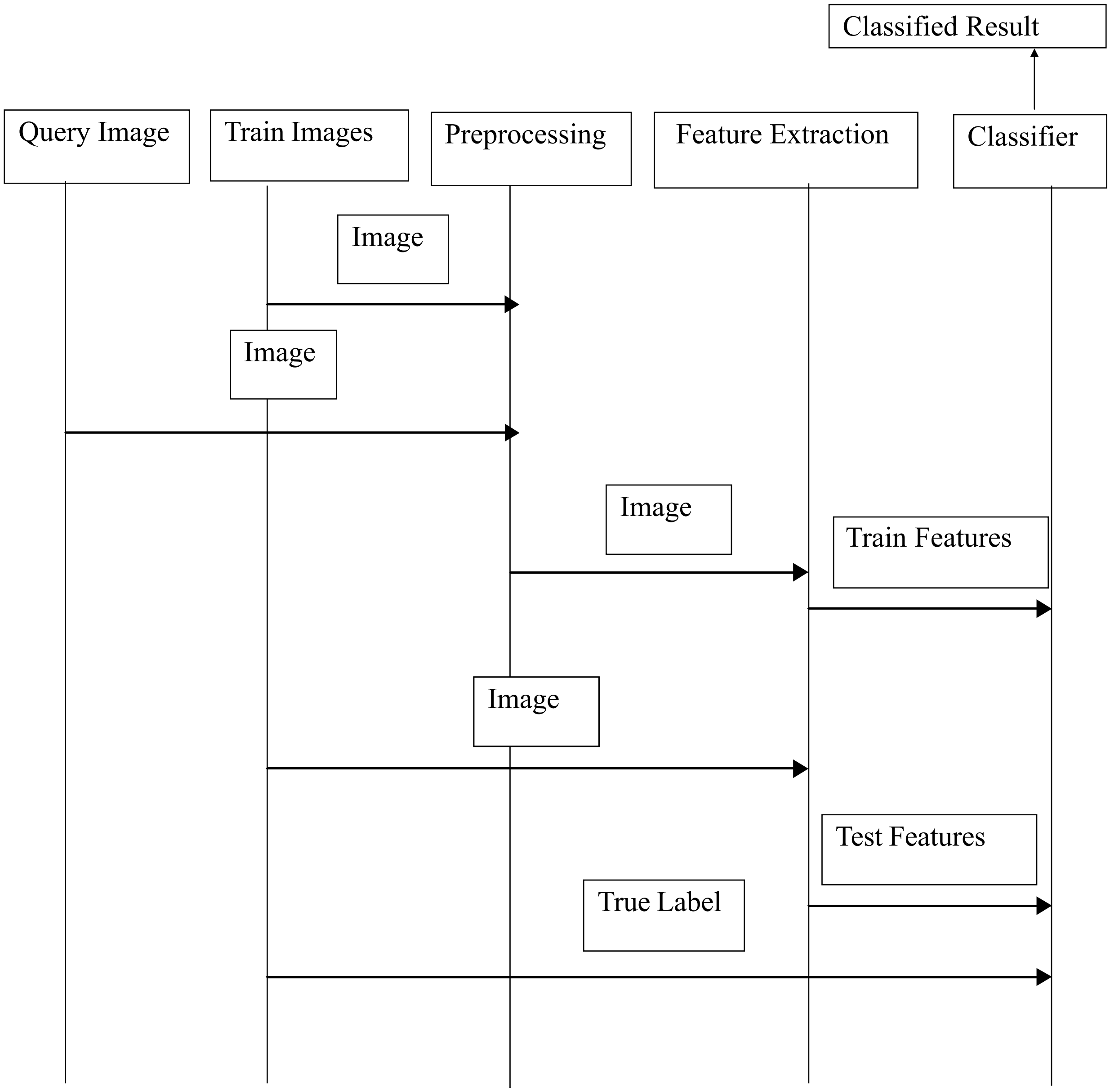


Fig 4.4 Sequence Diagram of the proposed system.

CHAPTER 5

IMPLEMENTATION

5.1 IMPORTING LIBRARIES:

- **Numpy:** NumPy is the fundamental package for scientific computing in Python. Numpy is a Python library that provides a multidimensional array object, various derived objects (such as masked arrays and matrices), and an assortment of routines for fast operations on arrays, including mathematical, logical, shape manipulation, sorting, selecting, I/O, discrete Fourier transforms and much more.
- **Pandas:** Pandas is a Python package providing fast, flexible, and expressive data structures designed to make working with “relational” or “labeled” data both easy and intuitive. It aims to be the fundamental high-level building block for doing practical, real-world data analysis in Python.
- **Matplotlib:** Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python.
- **Seaborn:** Seaborn is a library for making statistical graphics in Python. It builds on top of matplotlib and integrates closely with Pandas. Its plotting functions operate on data frames and arrays containing whole datasets and internally perform the necessary semantic mapping and statistical aggregation to produce informative plots. Its dataset-oriented, declarative API lets you focus on what the different elements of your plots mean, rather than on the details of how to draw them.
- **Scikit-learn:** Scikit-learn (also known as sklearn) is an open-source machine learning library that supports supervised and unsupervised learning. It also provides various tools for model fitting, data pre-processing, model selection, model evaluation, and many other utilities.
- **TensorFlow:** TensorFlow is an end-to-end open-source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries, and community resources that lets researchers push the state-of-the-art in ML and developers easily build and deploy ML-powered applications.

5.2 IMAGE DATASET

- The dataset used in our project is downloaded from an open-source dataset provider in Kaggle. The dataset consists of around 3264 MRIs each of which is either non-tumorous MRIs or Meningioma Tumor or Pituitary Tumor or Glioma Tumor images. These images are distributed among their respective folders which is helpful while accessing these images for training and testing processes. Below figures 5.1, 5.2, 5.3, and 5.4 shows some of the images belonging to Non-tumorous, Glioma Tumor, Meningioma Tumorous, and Pituitary Tumorous MRIs respectively.

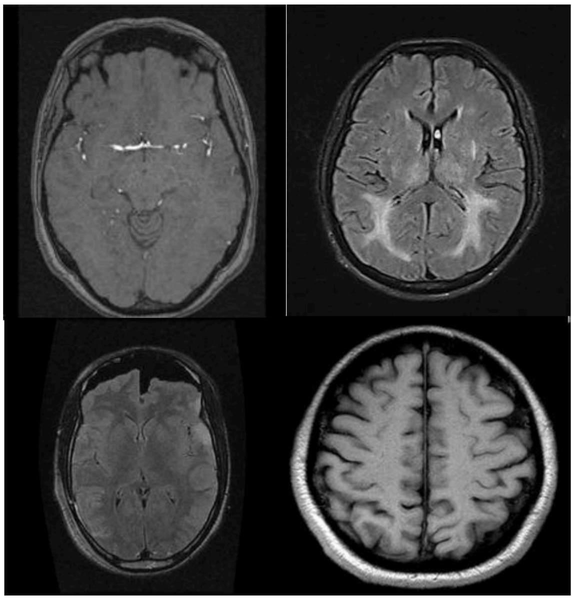


Fig 5.1 Non-Tumorous MRIs.

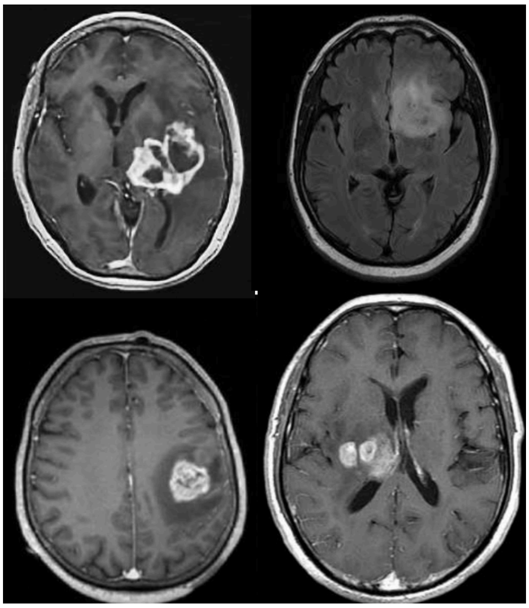


Fig 5.2 Glioma Tumor MRIs

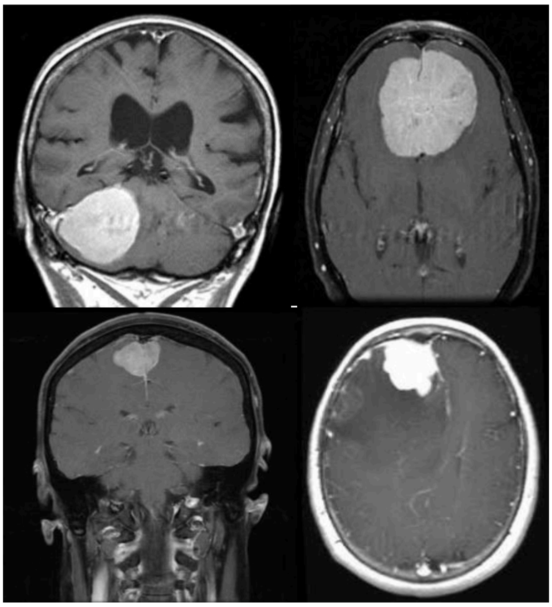


Fig 5.3 Meningioma Tumor MRIs.

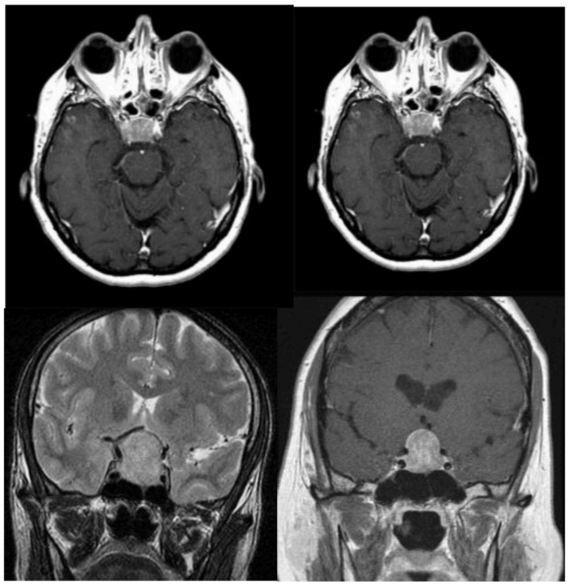


Fig 5.4 Pituitary Tumor MRIs

5.3 IMAGE PREPROCESSING:

The Brain MRI image dataset has been downloaded from Kaggle. The MRI dataset consists of around 1900 MRI images, including normal, benign, and malignant. These MRI images are taken as input to the primary step. Pre-processing is an essential and initial step in improving the quality of the brain MRI Image. The critical steps in pre-processing are the reduction of impulsive noises and image resizing. In the initial phase, we convert the brain MRI image into its corresponding gray-scale image. The removal of unwanted noise is done using the adaptive bilateral filtering technique to remove the distorted noises that are present in the brain picture. This improves the diagnosis and also increases the classification accuracy rate

IMAGE ACQUISITION FROM DATASET:

In image processing, image acquisition is done by retrieving an image from the data set for processing. It is the first step in the workflow sequence because without an image no processing is possible. The image that is acquired is completely unprocessed. Here we process the image using the file path from the local device.

CONVERT THE IMAGE FROM ONE COLOR SPACE TO ANOTHER:

There are more than 150 color-space conversion methods available in OpenCV. For color conversion, we use the function cv2.cvtColor(input_image, flag) where flag determines the type of conversion. In our work, we convert the input image into a gray-scale image.

FILTERS:

In image processing, filters are mainly used to suppress the high frequencies in the image. Median

Filter:

It is a non-linear filtering technique used to remove noise from the images. It is performed by sorting all the pixel values from the window into numerical order and then replacing the pixel being considered with the median pixel value. This filter removes the speckle noise and salt and pepper noise through 'ON' and 'OFF' of pixels by white and dark spots.

Bilateral filter:

It is also a non-linear, noise-reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels. This weight is based on the Gaussian distribution. Bilateral filtering smooth images while conserving edges utilizing a nonlinear grouping of neighboring image pixels. This filtering technique is simple, local, and concise. It syndicates a grey level grounded on their likeness and the symmetrical nearness and chooses near vales to farther values in both range and domain.

IMAGE ENHANCEMENT:

Image enhancement is a technique used to improve image quality and perceptibility by using computer-aided software. This technique includes both objective and subjective enhancements. This technique includes points and local operations. The local operations depend on the district input pixel values. Image enhancement has two types: spatial and transform domain techniques. The spatial techniques work directly on the pixel level, while the transform technique works on Fourier and later on the spatial technique.

Edge detection is a segmentation technique that uses border recognition of strictly linked objects or regions. This technique identifies the discontinuity of the objects. This technique is used mainly in image study and to recognize the parts of the image where a huge variation in intensity arises.

SOBEL FILTER:

The Sobel filter is used for edge detection. It works by calculating the gradient of image intensity at each pixel within the image. It is widely used in image analysis to help locate edges in images. The Sobel operator is used for segment purposes. This technique can be dependent on the central difference which tends toward the central pixels on average. This technique can be expressed as 3 × 3 matrices to the first derivative of the Gaussian kernel. It combines smoothing and differentiation. For Sobel edge detection the gradient of the image is calculated for each pixel position in the image

1. We calculate two derivatives:

An **a. Horizontal changes**: This is computed by convolving I with a kernel Gx witan h odd size. For example, for a kernel size of 3, Gx would be computed as:

Gx = [[-1 0 +1]

[-2 0 +2]

[-1 0 +1]]

b. Vertical changes: This is computed by convolving I with a kernel Gy a with an odd size. For example, for a kernel size of 3, Gy would be computed as:

Gy = [[-1 -2 -1]

[0 0 0]

[+1 +2 +1]]

2. At each point of the image we calculate an approximation of the gradient in that point by combining both results above:

G=(G2 x+G2 y) 1/2

3. Although sometimes the following simpler equation is used:

G=|Gx|+|Gy|

After the completion of the pre-processing, the image will be free from the noises, but we still need to enhance the image since the obtained image is smoothened, edges may not be preserved, and the image will be dull. To overcome all these, we used edge detection called the Sobel filtering technique. The whole thing is done by calculating the gradient of image intensities at each pixel within the image. It is widely used in image analysis to help locate edges in images. It will also enhance the darker areas of the image, slightly increase cont, fast, and as sharp as possible.

MORPHOLOGICAL OPERATIONS:

Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors.

The Morphological techniques are also used with segmentation techniques. The morphological action is normally performed on binary images. It processes the operations based on shape and it has wide use in the image processing operation. Erosion and Dilation are two methods of morphological operations used in this proposed work. We perform both Erosion and dilation operations used together.

Two main steps of the erosion and dilation morphological operation are opening and closing. The first step is the opening of the MRI binary image. The main work of the opening operation is to open up that which is present in between objects and connect that to a small collection of pixels. After the sett of the bridge, the erosion was again restored to actual size using dilation. If the binary image has been opened then the subsequent opened same structured elements have not affected that image. After completing the opening operations next step is the closing operation. Based on the closing operation while keeping the original region sizes, the erosion and dilation can handle different holes in the image region. Dilation and Erosion are the basic morphological operations. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries.

5.4 BUILDING OF MODEL

CONVOLUTIONAL NEURAL NETWORK

Classification is the best approach for the identification of images like any kind of medical imaging. All classification algorithms are based on the prediction of the image, where one or more features and that each of these features belongs to one of several classes.

An automatic and reliable classification method Convolutional Neural Network (CNN) will be used since it is robust in structure which helps in identifying every minute detail. A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm that can take in an input image, assign importance to various aspects/ objects in the image, and able differentiate one.

The preprocessing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNet can learn these filters/characteristics.

A ConvNet can successfully capture the spatial and temporal dependencies in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and the reusability of weights. In other words, the network can be trained to understand the sophistication of the image better. The role of the ConvNet is to reduce the images into a form that is easier to process, without losing features that are critical for getting a good prediction.

For this step, we need to import Keras and other packages that we're going to use in building the CNN. Import the following packages:

- Sequential is used to initialize the neural network.
- Convolution2D is used to make the convolutional network that deals with the images.
- MaxPooling2D layer is used to add the pooling layers.
- Flatten is the function that converts the pooled feature map to a single column that is passed to the fully connected layer.

• Dense adds the fully connected layer to the neural network.

SEQUENTIAL:

• To initialize the neural network, we create an object of the Sequential class.

• classifier = Sequential () 4.3.2

CONVOLUTION:

• To add the convolution layer, we call the add function with the classifier object and pass in Convolution2D with parameters. The first argument is feature_detectors which is the number of feature detectors that we want to create. The second and third parameters are dimensions of the feature detector matrix.

• We used 256 feature detectors for CNNs. The next parameter the is input shape which is the shape of the input image. The images will be converted into this shape during pre-processing. If the image is black and white it will be converted into a 2D array and if it is colored it will be converted into a 3D array.

• In this case, we'll assume that we are working colored images. Input_shape is passed in a tuple with the number of channels, which is 3 for a colored image, and the dimensions of the 2D array in each channel. If you are not using a GPU it's advisable to use lower dimensions to reduce the computation time. The final parameter is the activation function. Classifying images is a nonlinear problem. So, we use the rectifier function to ensure that we don't have negative pixel values during computation. That's how we achieve non-linearity.

• classifier.add (Convolution2D (256, 3, 3, input_shape = (256, 256, 3), activation='relu'))

POOLING:

• The Pooling layer is responsible for reducing the spatial size of the convolved feature. This is to decrease the computational power required to process the data through dimensionality reduction. Furthermore, it is useful for extracting dominant features which are rotational and positional invariant, thus maintaining the process of effectively training the model.

- There are two types of Pooling: Max Pooling and Average Pooling. Max Pooling returns the maximum value from the portion of the image covered by the Kernel. On the other hand, Average Pooling returns the average of all the values from the portion of the image covered by the Kernel. Generally, we use max pooling.

- In this step we reduce the size of the feature map. Generally, we create a pool size of 2x2 for max pooling. This enables us to reduce the size of the feature map while not losing important image information.

- classifier.add (MaxPooling2D (pool_size= (2,2)))

FLATTENING:

- In this step, all the pooled feature maps are taken and put into a single vector for inputting the in-text layer.

- The Flatten function flattens all the feature maps into a single long column.

- classifier.add (Flatten ())

FULLY CONNECTION:

- The next step is to use the vector we obtained above as the input for the neural network by using the Dense function in Keras. The first parameter is output which is the number of nodes in the hidden layer. You can determine the most appropriate number through experimentation. The higher the number of dimensions the more computing resources you will need to fit the model. A common practice is to pick the number of nodes in powers of two.

- classifier. Add (Dense (output = 64))

- The next layer we have to add is the output layer. In this case, we'll use the sigmoid activation function since we expect a binary outcome. If we expected more than two outcomes, we would use the SoftMax function.

- The output here is 1 since we just expect the predicted probabilities of the classes.

- classifier.add (Dense (output=1, activation='sigmoid'))

Efficient Net-B3:

EfficientNet is a convolutional neural network architecture and scaling method that uniformly scales all dimensions of depth/width/resolution using a compound coefficient. Unlike conventional practice that arbitrary scales these factors, the EfficientNet scaling method uniformly scales network width, depth, and resolution with a set of fixed scaling coefficients. Since model scaling does not change layer operators Fˆi in the baseline network, having a good baseline network is also critical. They have evaluated their scaling method using existing ConvNets, but to better demonstrate the effectiveness of the scaling method, they have also developed a new mobile-size baseline, called EfficientNet.

The EfficientNet-B3 model used has around 390 layers with 10,875,999 trainable parameters, 87,303 non-trainable params which all together 10,875,999 Total params. These layers are constructed out of multiple modules and these modules are meshed together to form the EfficientNet-B3 model which is demonstrated in the pictures below.

Fig 5.5 System Architecture of EfficientNet-B3.

CHAPTER 6

MODEL TESTING

Testing of the model is conducted with the test data images to evaluate the trained model's performance. Some of the test images and their prediction results are demonstrated in the given table.

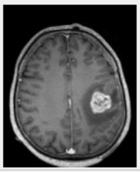
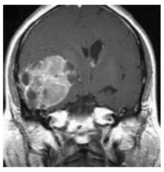
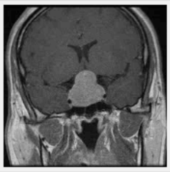
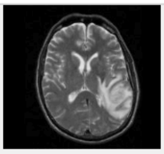
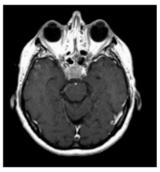
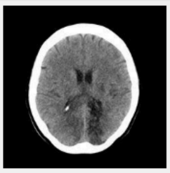
INPUT IMAGE	ACTIUAL RESULT	PREDICTED RESULT	TEST RESULT
	Glioma Tumor	Glioma Tumor	Correct Prediction
	Meningioma Tumor	Glioma Tumor	Incorrect Prediction
	Pituitary Tumor	Pituitary Tumor	Correct Prediction
	No Tumor	Pituitary Tumor	Incorrect Prediction
	Glioma Tumor	Meningioma Tumor	Incorrect Prediction
	Pituitary Tumor	Pituitary Tumor	Correct Prediction
	No Tumor	No Tumor	Correct Prediction

Table 6.1 Table comparing test results and the predicted result by our model.

CHAPTER 7

RESULTS

7.1 Loss and Accuracy plot for training the model

The model is trained for around 40 epochs during which the loss of the model gradually decreases to a point where for any further epochs there won't be any change in the loss value. Likewise, the accuracy of the model, the accuracy the model increases with the increasing number of epochs. The plot of this same is represented in figure 7.1 where the number of epochs is along the x-axis and the values of these accuracies and losses over the corresponding epochs are along the y-axis.

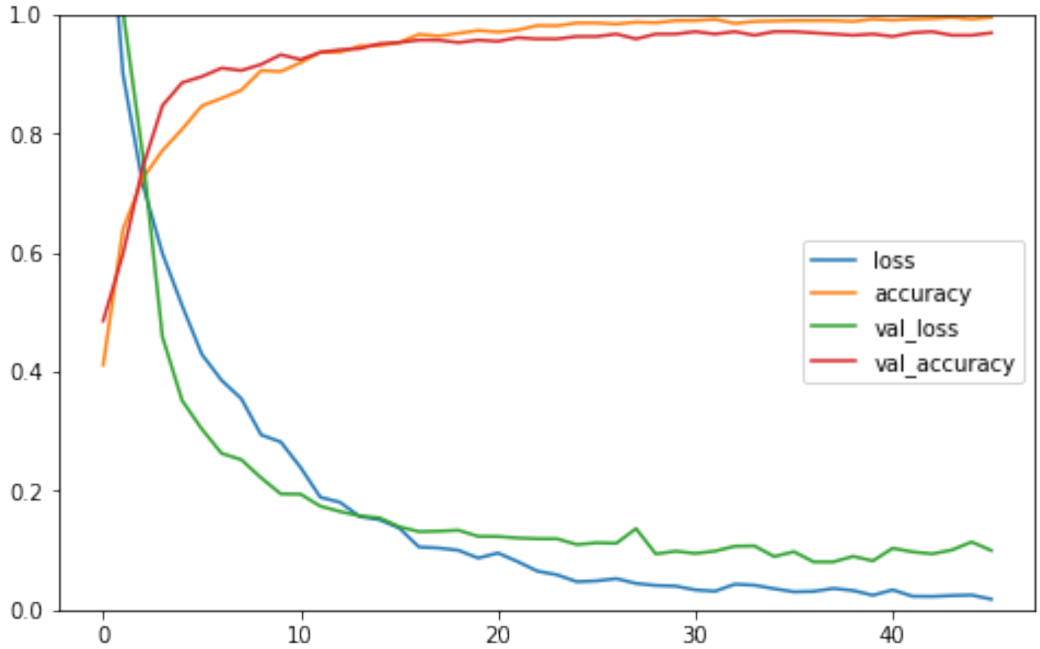


Fig 7.1 Loss and Accuracy plot over the training period.

7.2 Confusion Matrix

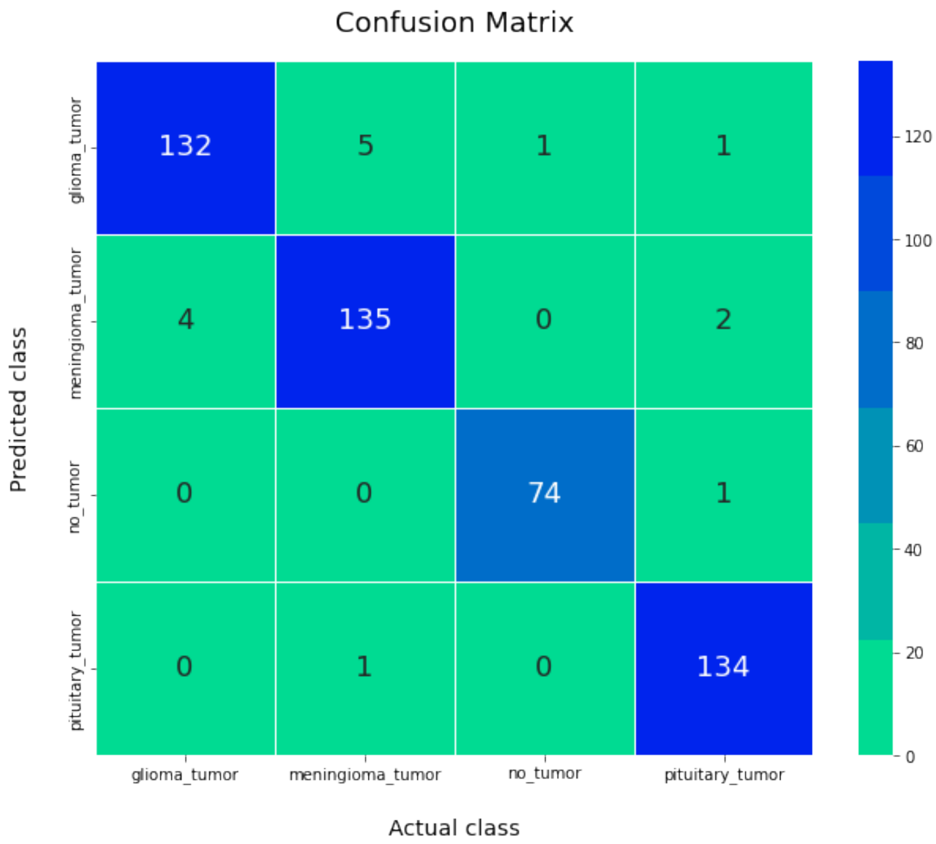


Fig 7.2 Confusion matrix for prediction.

After training, the model is tested with the test images for which the classes are predicted. Based on these predicted classes and the actual classes a confusion matrix is drawn. From the above matrix, out of 139 Glioma tumor images 5, 1, and 1 were incorrectly classified as Meningioma, Non-tumorous, and Pituitary tumor respectively. Out of 141 Meningioma tumor images 4 and 2 images were incorrectly classified as Glioma tumor and Pituitary tumor respectively. Out of 75 Non-tumor images 1 was incorrectly classified as a Pituitary tumor and lastly out of 135 Pituitary images 1 was misclassified as a Meningioma tumor. The remaining images in each of these classes were correctly classified which can be seen diagonally with a dark blue shade in the above figure.

7.3 Classification report

	precision	recall	f1-score	support
glioma_tumor	0.97	0.95	0.96	139
meningioma_tumor	0.96	0.96	0.96	141
no_tumor	0.99	0.99	0.99	75
pituitary_tumor	0.97	0.99	0.98	135
accuracy			0.97	490
macro avg	0.97	0.97	0.97	490
weighted avg	0.97	0.97	0.97	490

Fig 7.3 Classification Report

The above classification report shows the precision, recall, and f1-score with supporting images for each class. With 490 images the model is around 97% accurate while predicting and classifying.

7.4 Model Accuracy

```
16/16 [==============================] - 17s 924ms/step - loss: 0.0807 - accuracy: 0.9694
Accuracy: 96.938777
```

Fig 7.4 Accuracy of the Model.

When the trained model is tested on the test date, an accuracy of 96.9388% and with a loss of 0.08073 is obtained.

CHAPTER 8

CONCLUSION

We proposed a computerized method for segmenting and identifying a brain tumor using the Convolution Neural Network. The input MR images are read from the local device using the file path and converted into grayscale images. These images are pre-processed using an adaptive bilateral filtering technique for the elimination of noises that are present inside the original image. The binary thresholding is applied to the de-noised image, and Convolution Neural Network segmentation is applied, which helps in figuring out the tumor region in the MR images. The proposed model obtained an accuracy of 97% and yielded promising results without many errors and much less computational time.

It is observed on extermination that the proposed approach needs a vast training set for better accurate results, in the field of medical image processing, the gathering of medical data is a tedious job, and, in a few cases, the datasets might not be available. In all such cases, the proposed algorithm must be robust enough for accurate recognition of tumor regions from MR Images. The proposed approach can be further improvised through cooperating weakly trained algorithms that can identify the abnormalities with minimum training data and also self-learning algorithms would aid in enhancing the accuracy of the algorithm and reduce the computational time.

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