Brain Tumor Detection Using MRI

Burra Raju[1], Kondeti Bhavya[2], Thelu Pavani[3], Namani Srividhya[4], Bandi Santhosh[5]

[1] *Electronics & communication , Jyothishmathi institute of technology and science*
[2] *Electronics & communication , Jyothishmathi institute of technology and science*
[3] *Electronics & communication , Jyothishmathi institute of technology and science*
[4] *Electronics & communication, Jyothishmathi institute of technology and science*
[5] *Electronics & communication , Jyothishmathi institute of technology and science*

---***---

ABSTRACT - Detecting and classifying tumors in brain MR images is crucial for early diagnosis and effective treatment. Early detection improves long-term survival rates. This paper presents a new approach for accurate brain tumor segmentation and classification. First, the MR images are enhanced using an anisotropic diffusion filter. Then, an active contour model is applied to detect the tumor, providing smooth and precise contours. For classification, features from the tumor images are extracted using 2-D Daubechies wavelet transform (DWT), and the feature dimensions are reduced with Independent Component Analysis (ICA). Finally, a trained Support Vector Machine (SVM) with different kernels (KSVM) is used to classify tumors as benign or malignant.

Key Words: Brain Tumor Detection, Magnetic Resonance Imaging (MRI), Deep Learning, Convolutional Neural Networks (CNN), Image Segmentation, Tumor Classification , Medical Imaging, Computer-Aided Diagnosis

1. INTRODUCTION

Brain tumor detection is a critical aspect of neuro-oncology, requiring accurate and timely diagnosis for effective treatment planning. Magnetic Resonance Imaging (MRI) is a widely used imaging modality for brain tumor detection due to its high soft-tissue contrast and spatial resolution. However, manual analysis of MRI images can be time-consuming and prone to human error. Recent advances in deep learning and artificial intelligence have shown promise in improving the accuracy and efficiency of brain tumor detection. This project aims to leverage these advances to develop an efficient and accurate brain tumor detection system using MRI scans.

2. LITERATURE SURVEY:

Brain tumor detection using MRI has been extensively studied in recent years, with numerous applications of machine learning and deep learning techniques. Convolutional Neural Networks (CNNs) have shown remarkable effectiveness in detecting brain tumors from MRI images, achieving high accuracy rates. Transfer learning has also been explored, where pre-trained CNN models are fine-tuned for brain tumor detection, reducing the need for large datasets. Segmentation techniques, such as U-Net and SegNet, have enabled accurate tumor localization. Multi-modal MRI analysis has been found to improve detection accuracy by integrating information from multiple MRI sequences. However, challenges associated with deep learning-based approaches, including data quality, class imbalance, and model interpretability, need to be addressed. Overall, these studies demonstrate the potential of machine learning and deep learning techniques for improving brain tumor detection accuracy and efficiency.

3. PROBLEM STATEMENT:

The detection and diagnosis of brain tumors from MRI images is a complex and challenging task that requires high accuracy and efficiency. Current manual detection methods are time-consuming, labor-intensive, and prone to human error, which can lead to delayed diagnosis and treatment. Moreover, the variability in tumor size, shape, location, and appearance, as well as the similarity between tumor and normal tissue, can make it difficult for radiologists to accurately detect and diagnose brain tumors. Furthermore, the increasing number of MRI scans and the growing demand for accurate diagnoses pose a significant burden on healthcare systems. Therefore, there is a pressing need for a reliable, automated system that can accurately detect brain tumors from MRI images, enabling timely and effective treatment planning, improving patient outcomes, and reducing the workload of radiologists.

4. EXISTING SYSTEM:

The existing systems for brain tumor detection using MRI largely fall into two categories: manual and automated. Manual diagnosis relies on expert radiologists to analyze MRI scans visually, which is time-consuming, prone to human error, and inconsistent across observers. To address these challenges, automated systems have been developed using traditional machine learning algorithms such as Support Vector Machines (SVM), K-Nearest Neighbors (KNN), and Random Forests, often combined with feature extraction methods like wavelet transforms, texture analysis, or histogram-based techniques. However, these systems require manual preprocessing and hand-crafted features, limiting their adaptability. More recent systems leverage deep learning, particularly Convolutional Neural Networks (CNNs), for end-to-end tumor classification and segmentation. Models such as U-Net, VGGNet, and ResNet are widely used in research and have shown superior performance on benchmark datasets like BRATS. Despite the progress, many existing systems are limited by data dependency, high computational requirements, and lack of explainability, which restricts their clinical adoption.

5. PROPOSED SYSTEM:

The proposed system aims to automatically detect and segment brain tumors from MRI images using deep learning techniques, with a focus on improving accuracy, speed, and consistency in diagnosis. The system will involve several stages: image preprocessing (including skull stripping, normalization, and resizing), followed by feature extraction using Convolutional Neural Networks (CNNs). A deep learning model—such as U-Net or a custom CNN—will be trained on labeled MRI datasets like BRATS to learn the spatial and structural features of tumors. The model will then classify or segment tumor regions in new, unseen images. The system will be built using Python and frameworks like TensorFlow or PyTorch, and can be deployed in a user-friendly interface for radiologists to review results. By integrating AI into the diagnostic workflow, the proposed system aims to support medical professionals with a reliable second opinion and enhance the early detection and treatment planning of brain tumors.

6. SOFTWARE REQUREMENTS:

Python

Libraries:

NumPy / Pandas,

OpenCV,

scikit-learn

Matplotlib / Seaborn

Development environment:

Jupyter Notebook

Google Colab

7. BLOCK DIAGRAM:

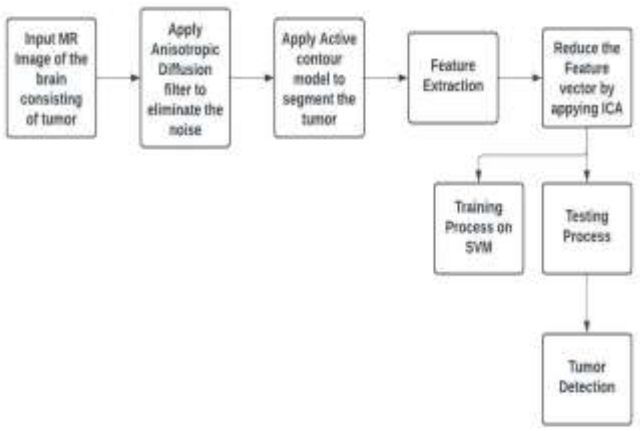

Fig: proposed block diagram

8. SCOPE OF THE PROJECT:

1. Develop an automated system for brain tumor detection using MRI images.

2. Preprocess MRI data to improve image quality and consistency.

3. Apply deep learning models like CNN or U-Net for tumor segmentation.

4. Train and test the model using datasets such as BRATS.

5. Evaluate model performance using standard accuracy metrics.

6. Provide a foundation for future clinical applications

9. CONCLUSION:

Brain tumors especially the malignant ones are considered almost incurable and fatal. The need for early detection arises from the fact that brain tumors can have symptoms that do not seem to be alarming at first. The most common symptom of brain ailments is a headache which worsens over time in the case of brain tumors. Hence there are lots of cases where the fatality from brain tumor increased due to the diagnosis not being done early. Brain tumor diagnosis begins with an MRI scan which is followed by studying a tissue sample for determining the type of tumor. MRI scan can also reveal additional details such as the size of the brain tumor. This paper presents a novel method involving image processing techniques for image manipulation which would aid our CNN model to classify tumor and non-tumor images better. Image Processing techniques helped us solve the illumination issues and brought the tumor into focus. Data augmentation was used to reduce the chances of overfitting, as it artificially expands the size of a training dataset, thus bringing out an improvement in the performance and the ability of the model to generalize. Transfer learning is also used as a pre-trained model, ResNet101v2 was used as the base model, upon which further training was applied to tune our task. The system recorded an adequate accuracy of 97.94% with an excellent training recall of 98.55 % and validation recall of 99.73%.

10. RESULT:

An input image of a brain MRI image containing tumor is to be selected. Fig. 13.1 shows a grey scale MRI image of brain with tumor. The input image is 256*256 pixels image and 8-bit grey scale.

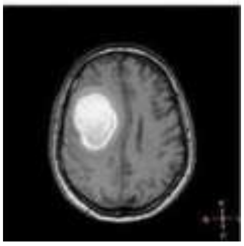

Fig. Input Image

The MRI image consists of noises such as Gaussian Noise, salt and pepper noise and speckle noise. These noises are removed by applying Anisotropic filter which incorporates preservation of important surface features like sharp edges and corners by applying direction dependent smoothing.

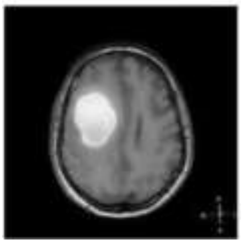

Fig. Filtered Image

The filtered image is converted to a binary image using thresholding. This is used to select the area of interest, i.e., tumor in the image.

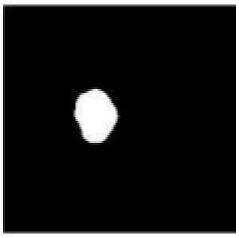

Fig. Tumor Alone

	Accuracy (%)	Precision (%)	Recall (%)	F1 Score (%)	
Training Set	97.94	98,76	98.55	98.65	98.65
Validation set	99.33	99.45	99.73	99.59	
Testing Set	95	100	90	94.74	

Table : Metrics values

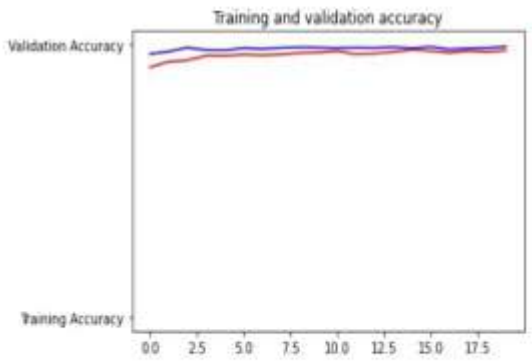

Figure a: Accuracy

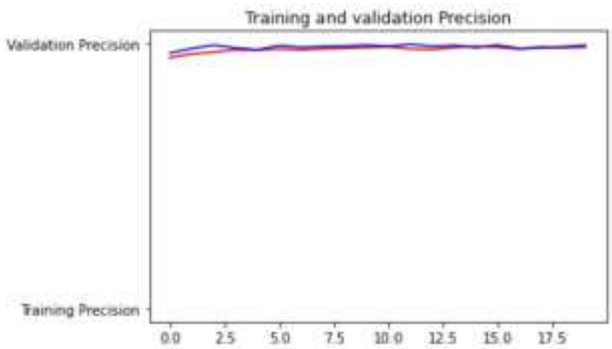

Figure b: Precision

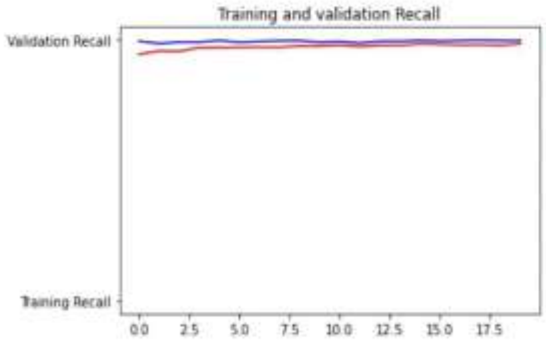

Figure c: Recall

11. REFERENCES:

1. M. H. O. Rashid, M. A. Mamun, M. A. Hossain and M. P. Uddin, "Brain Tumor Detection Using Anisotropic Filtering, SVM Classifier and Morphological Operation from MR Images," 2018 International Conference on Computer, Communication, Chemical, Material and Electronic Engineering (IC4ME2), 2018, pp. 1-4, doi: 10.1109/IC4ME2.2018.8465613.

2. A.Islam, S. M. S. Reza, K. M. Iftekharuddin, "Multifractal Texture Estimation for Detection and Segmentation of Brain Tumors" IEEE Transactions on Biomedical Engineering, Vol. 60 Issue: 11, pp. 3204- 3215, 27 June 2013.

3. A. Nandi, "Detection of human brain tumour using MRI image segmentation and morphological operators" IEEE International Conference on Computer Graphics, Vision and Information Security (CGVIS), 2015

4. Bajaj, Chandrajit & Xu, Guoliang. (2003). Anisotropic diffusion of surfaces and functions on surfaces. ACM Trans. Graph.. 22. 4-32. 10.1145/588272.588276.

5. "IEE Colloquium on 'Morphological and Nonlinear Image Processing Techniques' (Digest No.1993/145)," IEE Colloquium on Morphological and Nonlinear Image Processing Techniques, 1993, pp. 0_1-.

6. Reddy, Ummadi & Dhanalakshmi, Pandluri & Reddy, Pallela. (2019). Image Segmentation Technique Using SVM Classifier for Detection of Medical Disorders.