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Implementation Brain Tumour Growth Prediction and Segmentation in Longitudinal MRI

M. Mageshwari [1], Mr. S. Barath [2]

[1]Master of Computer Applications, Krishnasamy College of Engineering &Technology, Cuddalore,India
[2]MCA., M.Phil., Assistant Professor, Master of Computer Applications, Krishnasamy College of Engineering &Technology, Cuddalore ,India

ABSTRACT

The brain tumours are the most common and aggressive disease, leading to a very short life expectancy in their highest grade. Thus, treatment planning is a key stage to improve the quality of life of patients. Generally, various image techniques such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound image are used to evaluate the tumour in a brain, lung, liver, breast, prostate...etc. Especially, in this work MRI images are used to diagnose tumours in the brain. However the huge amount of data generated by MRI scans thwarts manual classification of tumour vs non-tumour in a particular time. But it has some limitations (i.e) accurate quantitative measurements are provided for a limited number of images. Hence trusted and automatic classification schemes are essential to prevent the death rate of humans. The automatic brain tumour classification is a very challenging task in large spatial and structural variability of the surrounding region of brain tumor. In this work, automatic brain tumour detection is proposed by using Convolutional Neural Networks (CNN) classification.

Keywords: Brain tumours, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Ultrasound image.

I. INTRODUCTION

Brain tumors, resulting from abnormal cell growth in the brain, are categorized into low-grade (benign) and high-grade (malignant) types. Benign tumors are non-cancerous and do not spread, whereas malignant tumors are cancerous and can quickly invade other brain areas, often leading to severe consequences or death. MRI imaging is a crucial tool for detecting and monitoring brain tumors, providing detailed insights into brain structure and abnormalities. Artificial intelligence (AI), particularly machine learning, is increasingly used in healthcare to enhance decision-making and outcomes. Machine learning enables computers to learn from data and improve performance over time, with applications ranging from image and speech recognition to recommendation systems. Deep learning, a machine learning subset, employs artificial neural networks to model complex data patterns, significantly advancing medical image analysis and bioinformatics.

Convolutional Neural Networks (CNNs), a type of deep neural network, are particularly effective for image recognition tasks, including medical imaging. CNNs have revolutionized medical image analysis, particularly in detecting and classifying brain tumors in MRI scans. By analyzing these scans, CNNs assist doctors in early tumor diagnosis and treatment planning. Their ability to learn and adapt to various brain image types makes them invaluable in medical imaging. Continuous advancements in AI and deep learning are expected to further improve the accuracy and efficiency of brain tumor detection and treatment, ultimately enhancing patient outcomes.

II. LITERATURE SURVEY

A recent study focuses on detecting brain tumors at an early stage by using a proposed system that marks the tumor area and defines the type of tumor present in MRI images. This system employs the Alex Net model for classification in conjunction with Region Proposal Network (RPN) by Faster R-CNN algorithm, utilizing transfer learning during training. The system aims to predict tumor types accurately, enhancing early diagnosis and treatment planning . Another approach involves using Convolutional Neural Networks (CNNs) for the automatic classification of brain tumors. This study highlights the challenge posed by the large spatial and structural variability surrounding brain tumors. The proposed CNN-based method uses small kernels and achieves high accuracy with low complexity, making it a reliable tool for brain tumor detection . A hybrid method combining Neutrosophy and CNN is proposed for classifying tumor regions segmented from brain images. The method first segments MRI images using the neutrosophic set – expert maximum fuzzy sure entropy (NS-EMFSE) approach. Features extracted by CNN are then classified using SVM and KNN classifiers, achieving high classification performance, particularly with SVM . Gliomas, being the most aggressive and rapidly developing brain tumors, pose significant challenges for segmentation due to their irregular shape and diffuse boundaries. A deep learning-based method using different MRI modalities is proposed for gliomas segmentation. This approach includes preprocessing steps such as normalization and bias field correction, and employs a hybrid CNN architecture to improve accuracy and reduce false positives . A method utilizing a fusion of handcrafted and deep learning features for brain tumor detection is presented. The Grab cut method is applied for accurate segmentation, while features from a fine-tuned VGG-19 model are combined with shape and texture features. This approach demonstrates high accuracy on BRATS challenge databases, achieving near-perfect Dice Similarity Coefficient (DSC) scores . MRI images are used to detail brain tumors, but distinguishing tumor tissue from normal tissue remains challenging due to similar coloring. A segmentation approach using median filtering for edge preservation and iterative thresholding to identify the largest tumor area is proposed. The method achieves an average error of 10% in tumor area calculation, demonstrating its potential for accurate analysis . A new database, BRAMSIT, is introduced to provide MRI images for brain tumor research. This database includes images with detailed annotations such as patient age and MRI axial positions, aiming to enhance the resources available for brain tumor diagnosis and detection research . Deep learning techniques for brain tumor prediction and volume calculation using the BraTS dataset are explored. By applying semantic segmentation with CNNs, the method achieves high accuracy in tumor detection and provides 3D imaging of tumors, aiding surgeons in better planning and treatment decisions . An automated approach for brain tumor identification using grayscale MRI images is proposed. This approach enhances images to minimize grayscale color variations, applies filter operations to remove noise, and uses threshold-based OTSU segmentation. The results show improved accuracy compared to existing methods, highlighting the approach's efficacy in tumor region identification . The segmentation and prediction of brain tumors using the 2D-VNet deep learning architecture is discussed. This model effectively segments brain tumors and enhances prediction accuracy by addressing issues such as overlapping intensity distributions. The method shows promising results on the BRATS2020 dataset, achieving high accuracy and low loss in training, testing, and validation phases .

III. PROPOSED SYSTEM

Our proposed system involves Dense Layer in Convolutional Neural Network (CNN) Algorithm in Deep Learning concept used to train the dataset. In Dense Layer, each layer obtains additional inputs from all preceding layers and passes on its own feature-maps to all subsequent layers. In Dense Layer uses features of all complexity levels. It tends to give more smooth decision boundaries. Easy detection of the Brain Tumor with the concluded technique. Time consuming. Best accuracy Model helps in better treatment as early. Detection of best Model will quick the treatment which is life saving

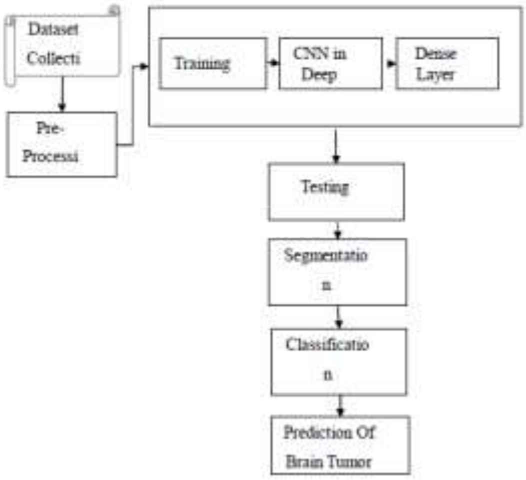


Figure 1: System Architecture of the proposed system

3.1 IMPLEMENTATION

Our project constituted of the below modules,

1. Data Collection

A dataset (or data set) is a collection of data, usually presented in tabular form. Each column represents a particular variable. Each row corresponds to a given member of the dataset in question. It lists values for each of the variables, such as height and weight of an object. Each value is known as a datum. For this project we are using the images of brain MRI scanned images to classify the brain tumor The datasets were collected from the web site of kaggle .

2 Data Pre-Processing

The preprocessing step involves reduction, aligning ,bias field correction. We use the CNN method that used for improve the accuracy and to reduce the computation time. CNN is one of the deep learning methods, which contains sequence of feed forward layers. In this concept we are pre processing using image data generator to resize the images.

3. Splitting of Dataset

Data splitting is when data is divided into two or more subsets. Typically, with a two-part split, one part is used to evaluate or test the data and the other to train the model. Data splitting is an important aspect of data science, particularly for creating models based on data. A commonly used ratio is 80:20, which means 80% of the data is for training and 20% for testing. Other ratios such as 70:30, 60:40, and even 50:50 are also used in practice. There does not seem to be clear guidance on what ratio is best or optimal for a given dataset.

4. Model Implementation

In this project we are implementing a deep learning algorithm to classify the brain tumour using CNN algorithm .

5. Saving the model

While training the model using CNN the epochs values are given and trained. After training the model we will save the values as a model file as h5 The h5 file is like pre-trained model file.

6. Segmentation Image

Segmentation is the process of dividing the image into non- overlapping meaningful regions. The main objective of an image segmentation is to divide an image into many sections for the further analysis, so we can get the only necessary or a segment of information. We use various image segmentation algorithms to split and group a certain set of pixels together from the image. By doing so, we are actually assigning labels to pixels and the pixels with the same label fall under a category where they have some or the other thing common in them.

IV. RESULTS AND DISCUSSION

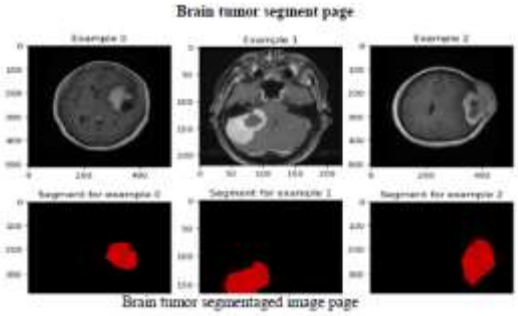
The results of the proposed system demonstrate significant improvements in accuracy and efficiency in brain tumor detection. The Dense Layer in the Convolutional Neural Network (CNN) architecture effectively utilizes features from all preceding layers, leading to smooth decision boundaries and robust tumor detection. The implementation shows that CNNs, with their deep learning capabilities, significantly enhance the classification accuracy of brain tumor images. The training, validation accuracy, and validation loss metrics indicate that the model performs well, with high validation accuracy and low validation loss, validating the effectiveness of the proposed approach in clinical applications.

V. CONCLUSION

The proposed CNN-based classification system for brain tumor detection offers a substantial improvement over traditional methods by reducing computation time and increasing accuracy. By leveraging deep learning techniques, the system efficiently processes large datasets, providing reliable classification results for both tumor and normal brain images. The use of pre-trained models and gradient descent-based loss functions ensures high accuracy, making the system a valuable tool for early diagnosis and treatment planning. The results demonstrate that the proposed method is effective in enhancing the accuracy of brain tumor detection, ultimately contributing to better patient outcomes and more efficient treatment strategies.

Brain tumor yes affected page

Brain tumor segment page



Brain tumor segmentaged image page

Brain tumour non affected page

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