

**DESIGN AND ANALYSIS OF
EFFECTIVE TECHNIQUES FOR
IDENTIFICATION OF BRAIN TUMOR
IN HUMAN MAGNETIC RESONANCE
IMAGES**

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Summary

This thesis investigates the development of a robust and efficient system for the identification of Brain Tumor (BT) using advanced data science and Artificial Intelligence (AI) techniques. By leveraging the background in web development and software engineering, this research integrates web-based solutions with cutting-edge AI methodologies to facilitate accurate and timely tumor diagnosis. BT is explained as a group of affected brain cells or tumor may be formed in any part of the human body and subsequently thrives to the brain. The affected cells may destroy brain of human body. Therefore, it is necessary to detect tumor at early stage so that it can be cured, but the accurate detection of BT at early stage is still a challenging task for the doctors or specialists. However, with the support of advancement in computer technologies, radiologists may now identify the tumor regions and predict abnormalities in the human brain more effectively. In modern times, the digital diagnosis is very vital and gaining popularity for detection of the tumor at early stage of the human life.

The digital diagnosis contains thousands of Magnetic Resonance Imaging (MRI) images which can be used for the identification of tumor regions as it is bounded into the closed regions which may take shape either regular or irregular. Further, MRI is the dedicated imaging modality, a non-invasive technique extensively used for exhaustive envision of the brain's internal structures. The amalgamation of AI in MRI analysis has become imperative in account of complex and voluminous nature of medical imaging data. Various Machine Learning (ML) and numerical techniques have been employed to locate BT. It is also revealed from the literature that, mostly online available datasets have employed for the detection of BT. Since the detection

of affected tissues is still challenging, therefore, the present research work is an attempt for recognition of BTs in respect of the newly collected Digital Imaging and Communications in Medicine (DICOM) datasets of patients. The entire work shall emphasize on the primary detection of BTs through various numerical techniques and finally AI and ML methods are used for classification of BT in human body at early stage. Wherever are necessary, the proposed techniques have been compared from the results available in the literature using other methods for evaluation. The critical stage of disease diagnosis is a crucial task to avoid severe brain issues. Lots of techniques are developed to discover brain abnormalities through MR images in a precise manner. However, image classification and segmentation are the most challenging and essential tasks for medical images. The main aim of the present work is to minimize the classification error rate in BT segmentation. There is a limitation of using single-modality MRI images for tumor segmentation. Therefore, concept of deep learning and mathematical techniques are investigated using the Mathematical Library (MATLAB) and PYTHON programming language.

The previous study revealed a variety of techniques and models, offering numerous methods for classification. However, some of the studies hindrance, such as a deficit of performance comparison among the models and hence the proposed techniques in the present work are well compared with the existing suitable methods available in the literature. Confirmation of BT is not always a straight forward mechanism to predict the tumor, not accurate and highly rely on the experiences of radiologists. There are crucial diagnostic challenges when there aren't the typical tumbling lesions and limitations arise to medical experts and pathologists may get benefit from computer-oriented interventions. Tremendous attempts have been proposed automatic or semi-automatic techniques for BT identification.

In the present work, the major contribution is to develop algorithm and extract features from the MRI brain images to increase the accuracy for identification of tumor using image processing tools. This process will help to improve early diagnosis and provide faster ways to determine the affected tissues. In the present work, an image of brain is collected from well-known hospitals of India and input to the system where it goes through several algorithms to detect affected area from the brain and extract features like tumor area, position and type, etc. The proposed research has several goals of interest like increasing the speed of computation as well as the accuracy.

The chapter-wise summary is briefly discussed below:

Chapter I Introduction

The first chapter of the thesis shall describe some of the fundamentals related to brain cancer. Numerous of researchers have done work in the field of identification of BT. The recent surge in state-of-the-art computing technologies has led to increased popularity in medical image processing, fostering collaborative research among medical professionals, mathematicians, and computer scientists. The collaboration has resulted in refined methodologies and precise data for detecting tumors using MRI scans. Numerous studies in medical imaging have addressed the prevalence of BT, a common affliction with multifaceted origins. The medical background of the patient is vital for precisely pinpointing the area of interest in the brain affected by the tumor which shall be well presented in this chapter along-with fundamentals of numerical methods, MATLAB and Python programming language.

At the beginning of this study, a wide array of scholarly articles was reviewed to build a robust base. The focus was primarily on publications from the previous five years,

which are comprehensively analyzed in the current chapter. It is quite obvious that the five years research papers shall contain important old research articles, hence a detailed examination of literature relevant to the topics covered in this research was carefully conducted and explained in this chapter.

Chapter II A Comparative Study of Segmentation Techniques for Identification of Brain Tumor from Magnetic Resonance Images

From the literature, it is revealed that identification of accurate position of the BT using MRI is a very challenging task. The tumor orientation, shape and size are having different position in the brain so that, identifying it by the use of various segmentation techniques became more difficult. For handling and analysing of the above-mentioned issue, the research work presented in this chapter is an attempt to propose various segmentation methods using edge-based, threshold and region growing on pre-processed MRI brain images. During the pre-processing stage, filtered images using the median filter function and thereafter skull stripping technique is applied to remove unnecessary border region from the brain. After removing, unnecessary boundary region, the segmentation methods are applied over the pre-processed images. For performance evaluation and analysis, quality metrics are measured to compute the difference between original image and pre-processed image. The quality metrics are computed on the collected MRI brain images and results are presented in the form of tables and graphs.

Chapter III A Fine Tuned Pre-trained Model for Classification of Brain Tumor using Magnetic Resonance Images

Any abnormal growth inside the brain restricted areas can harm humans' health. The challenges may arise for radiologists to classify tumor types because cancers are

heterogeneous. In this way, the manifold collection of cells fosters the prominent molecular squiggle with discriminative levels of sensitivity to treatment. Medical diagnosis has changed and diversified due to deep learning trends, particularly in MRI. This study suggests a binary classification and detection method for the early diagnosis of BT as a solution to this issue.

The pre-trained models like ResNet50, VGG19 and InceptionV3 of transfer learning approach make this possible. The different scenarios were assessed with the help of two classes of tumor. For this the publicly available and collected datasets are tested together. The accuracy rates for the pre-trained models of InceptionV3, ResNet50, and VGG19 produced 99.72%, 98.84% and 94.65%, accuracy respectively. Also ensembled three pre-trained models. The highest performance accuracy in the detection of BT was achieved using Inceptionv3, and VGG19 on testing samples. The results of the proposed method for evaluation outperform those of existing methods.

Chapter IV Interpolation Method for Identification of Brain Tumor from Magnetic Resonance Images

From the review of the literature, it is observed that the newton divided difference interpolation method is still not used for identification of BT using MRI images. Further, it is observed that diagnosing of any disease without manual interaction with great accuracy makes computer science research more demanding, therefore, the research work presented in this chapter is related to identification of BT tissues in the affected patients. For this purpose, data is collected from a well-known Safdarganj Hospital, New Delhi, India, that consulted and contain 2165 DICOM images of a single patient. For this, interpolation technique is used to identify the accurate position of the BT. A system model is developed and implemented by the use of Python

programming language and MATLAB for the identification of affected areas in the form of a contour of a tumor. Also, the desired accuracy and specificity are evaluated using the computed results and also presented in the form of graphs.

Chapter V Finite Element Method for Recognition of Brain Tumor from Magnetic Resonance Images

As we know the radiological imaging is crucial in healthcare as it allows doctors to view inside the body without invasive procedures, aiding in diagnosis and treatment. To understand human brain mechanics and serve as valuable predictive tools, a Finite Element (FE) analysis is essential for advancing the research. This study aims to develop a tumor model using patient specific brain material assignment techniques. The model is constructed through the FEM simulation model, by utilizing Three Dimensional (3D) radiological images. The parameters such as bulk tumor location, size, mass-effect, and tumor edema extent are integrated to emulate the diverse behavior of BT. Through analysis of serial time MRI scans of a human subject with an atypical meningioma tumor type, the study illustrates the model's capability to accurately replicate real deformations with notable efficiency and the interesting computed results are presented through graphs.

Chapter VI MRI Brain Tumor Prediction using Azure Streamlit Framework and Analysis of CNN Activation Functions

The research work presented in this chapter is focused on BT classification, prediction and to increase the performance to locate the tumor region. A Two Dimensional (2D) Convolutional Neural Network (CNN) model is proposed to classify into tumor and non-tumor categories. The method is applied on a collected dataset consisting of 2056 MRI images. The model is implemented using Python

programming language. ReLU and LeakyReLU activation functions are tested with several optimizers. The analysis of the implemented results has been used to gauge performance accuracy. The computed results are presented in the form of tables and graphs. The proposed model in this chapter provides quick, and accurate approach to classify tumor by setting hyper-parameter tuning parameters which helps to the doctor to diagnose patients suffering from tumor and the entire process reduces the computation time.

Chapter VII Classification and Segmentation of MRI Images of Brain Tumor Using Deep Learning and Hybrid Approach

The aim of this chapter is to analyse radiologist's diagnoses using a CNN model using classification and a hybrid approach (threshold and graph based) used for segmentation. The primary goal of this research work is to locate tumor-affected tissues in a more precise and effective manner. The segmentation process partitions the tumor-affected tissues from healthy brain tissues, with practitioners performing this crucial step for clinical aids. The designed deep learning model, based on radiologist's assumptions, undergoes thorough analysis to achieve effective performance and accuracy surpassing existing approaches. The computer results are presented in the form of tables along with comparisons with existing approaches.

Chapter VIII Enhanced Brain Tumor Classification using Ensemble Machine Learning: A Comparative Study on MRI Data

ML has emerged as a pivotal tool in medical imaging, offering significant advancements in the classification of complex datasets, particularly in the domain of neuro-oncology. The comparative analysis of various algorithms such as K Nearest Neighbor (KNN), Linear Regression (LR), Random Forest (RF), Naive Bayes (NB),

and Decision Tree (DT) which provide valuable insights into how these techniques can be optimized for clinical applications.

By addressing issues such as data variability, computational complexity, and model interpretability, the integration of ML models into neuro-oncology holds the potential to enhance diagnostic accuracy, treatment planning, and patient outcomes.

Chapter IX Conclusions and Future Scope of Work

Although the amalgamation of radiologists' assumptions and domain expertise into the model design ensures that it captures clinically relevant features and aligns with medical professionals' expectations. This joint effort, combining deep learning strategies with specialist insights, offers considerable promise for enhancing clinical judgments and patient results in medical imaging. This research establishes groundwork for future progress in the analysis of medical images and the application of deep learning within radiology. By addressing the challenges of tumor detection and localization, it contributes to improve diagnostic accuracy, treatment planning, and ultimately, patient care in clinical practice. By the use of presented work, one can apply other methods like branch and bound method, binary search method, unified method, hybrid method, etc. for precise detection of tumor affected cells in brain as well as other parts of human body even the work may be extended for tumor detections in animals, etc.