**Brain Tumor Classification**

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**ABSTRACT**

This paper focuses on brain tumors: abnormal growths of tissue within the brain that continues to grow in size this being a worrying factor to medical practitioners since these can occur and cause serious neurological damage or even death. Accurate staging and the correct identification of the stage of the cancer are vital to planning the appropriate management programmes which can entail surgery, radiotherapy or chemotherapy. The traditional way of analyzing the scans involves the use of MRI images on the human brain, which is very exhaustive and direly prone to a high level of human interims, which emphasize the need for automation.

This project explores the development of a deep learning-based system for brain tumor detection and classification by leveraging the strengths of three well-known models: U-Net, ResNet, and AlexNet. Here, U-Net is used for segmentation of tumor from MRI images and for classifying the identified tumor into Glioma, Meningioma and other residual classes using ResNet and AlexNet. To this end, the system utilizes two datasets that are publicly accessible with a view to enhancing diversification and model assessment. The advantage of the proposed methodology is that it unites the two stages, segmentation and classification, which results in high accuracy, reliability and efficiency of the algorithm.

The results suggest that the work developed presents significant results when adopting the proposed integrated approach to illustrate the potential of helping medical practitioners to diagnose the presence of brain tumors rapidly and accurately. In addition to presenting new contributions to the evaluation of medical image analysis, this study also develops a framework that can be used to attempt further studies and implementations in the clinical environment.

**INTRODUCTION**

They are one of the worst kinds of diseases, which can affect people of different age. These tumors of the brain are abnormal formations which interfere with regular brain activity; and mostly result in severe repercussions or even death. The diagnosis and especially the classification of brain tumors in the initial stages are essential to enhance the results in medical treatment. Nevertheless, preprocessing of brain MRI scans involves a huge amount of time and effort, as well as potential errors when completed hurriedly or by a non-expert. Hence, there is a very strong rationale for the development of automated techniques for faster and accurate tumor diagnosis.

In the last few years, deep learning has introduced completely novel approaches to medical imaging, especially in image segmentation and classification. Among all such neural networks, the researchers recognize convolutional neural networks (CNNs) as being most effective in analyzing patterns of the medical images. This project aims to develop a comprehensive system for brain tumor detection and classification by employing three leading deep learning models: U-Net, ResNet, and AlexNet.

U-Net: Specifically employed in the biomedical image segmentation, U-net is exploited to identify and remodel the tumor-related regions in MRI scans accurately.

ResNet and AlexNet: These architectures are used to solve this problem of categorizing the sliced tumor regions into different types by using their primary components of feature extraction and hierarchical frameworks.

Two independent datasets of brain MRI are used for the purpose of enhancing the reliability and versatility of the project. The images are preprocessed in which they undergo image resizing and normalization as well as data augmentation. Evaluating the results based on a variety of metrics, it was shown that the proposed system outperforms the benchmark approach in terms of segmentation quality and classification reliability, suggesting potential value for clinical applications.

Implementing these sophisticated models into one pipeline helps this study meet the two objectives of segmentation and classification while cutting time spent on diagnosis and boosting precision. In addition, the project also enlights the capabilities of deep learning in changing the traditional role of diagnostics in medicine to more advanced level of automation in delivering health care services.

**OVERVIEW**

Its main objective is to develop and apply a machine learning system to diagnose and categorize brain tumor from MRI scan images. The framework combines the cutting-edge deep learning segmentation networks that perform segmentations and classifications reflecting on the challenges of the medical image analysis field.

Objectives

* To come up with the segmentation model that will be able to segment the tumor from MRI images.
* In order to segment and further categorise different areas of the tumor to offer a more specific diagnosis.
* To assess the effectiveness of the proposed models with more about comprehensive metrics and to check the performance of the proposed models with different datasets.

**Methodology**

The project workflow is divided into the following stages:

* Dataset Collection and Preparation: Two datasets of brain MRI scans accessible to the public are employed. Some of these datasets include; labelled images of the different types of tumours including; glioma, meningioma, no tumour cases. The datasets are then resized to 128x128, normalized and thus augmented to meet deeper learning models specification.
* Tumor Segmentation Using U-Net: In this study, an implementation of the U-Net architecture, commonly used in biomedical imaging, is used to segment the tumor region from MRI images. By using annotated data for training, the model is capable of accurately extracting the tumor regions to aid the subsequent classification.
* Feature Extraction and Classification: When the tumor regions have been segmented, the images are analyzed with the use of ResNet and AlexNet. These CNN architectures are learned and optimized on the dataset for distinguishing glioma, meningioma and other types of tumors. The models make use of their deep hierarchy of feature extraction techniques in order to yield high classification rates.
* Evaluation and Analysis: As will be shown later on, the performance of the system is assessed using for instance:
* Segmentation accuracy through the Dice Coefficient.

The four runs to measure classification performance are – Accuracy, Precision, Recall, and F1-Score.

Validation is performed to check the stability of the solution obtained in the study.

Key Contributions

* The application of U-Net, ResNet, and AlexNet as one pipeline for diagnosing brain tumor.
* The inclusion of two datasets for increased external validity and to avoid model training on the testing set.
* An evaluation and discussion in context to the performance of models, with regard to the spheres of success and scope for enhancement.

This project, which aims at accomplishing work on segmentation and classification correspondingly, provides a tool that radiologists and other medical staff can use with confidence. For instance, it exposes how deep learning can complement the conventional approaches to diagnosis and give rise to advanced inventions in imaging medication.

**Description of Dataset:**

**Dataset 1:**

* The dataset have been downloaded from Kaggle under the [link](https://www.kaggle.com/datasets/masoudnickparvar/brain-tumor-mri-dataset).
* This dataset contains 7,023 MRI images of human brains, classified into four categories: glioma, meningioma, no tumor, pituitary. Such images are indispensable for creating models designed for the diagnosis and differentiation of brain tumors.
* The dataset is a combination of three different sources: For the purpose of this paper we used datasets such as figshare, SARTAJ, and Br35H datasets. For testing it has 1,311 images and various categories contains different number of images.
* Each of the images varies in dimension, so any images fed into the model must go through size adjustment and the preprocessing steps of cropping and marginal erasing to optimize model performance based on the sizes of the images.
* The presented dataset is designed for multiple target classification tasks, such as tumor detection, tumor classification (malignant and benign), and tumor localization in the brain. The main goal is to help in the diagnosis process of which is particularly important for finding out the right course of treatment.

**Dataset 2:**

* The dataset have been download from Mendeley Data from the given [link](https://data.mendeley.com/datasets/mk56jw9rns/1) .
* It is the Bangladesh Brain Cancer Data which contains 6056 MRI Images of different type of Brain Tumors.
* It contains 2004 images of Glioma , 2004 images of Meningioma and 2046 MRI images of Brain Tumor.
* Each image is of 512\*512 pixels for facilitating various algorithms of Machine Learning.
* The total size of the dataset is around 148 Megabytes which neither too small nor too large for a neural network to perform its work on.

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