

AI system for brain tumors

Alaa Mohammed Hassan

Abstract:

Brain tumors can be a major cause of psychological and physical problems, so early and accurate identification and diagnosis greatly contribute to successful treatment. Therefore, we used deep learning to detect and classify brain tumors in MRI scans using a large collection of brain tumor images of various types. This is crucial for rapid treatment.

In this thesis, medical images are processed using CNN, which yields excellent results in image classification and segmentation. U-Net is used to accurately map tumor boundaries, YOLOv7 for rapid tumor detection and identification, and the VGG16 model and Adam optimizer are also employed.

This thesis discusses deep learning methods for diagnosing brain tumors using artificial intelligence, obtaining results in minutes or less, thus saving time and effort and providing accurate results that assist the physician in making informed decisions.

Key Word:

Brain tumors , deep learning ,CNN , MRI , classification , Kaggle .

Introduction:

The brain is the central organ responsible for all bodily activities and issuing commands with the help of nerve cells. The human brain is incredibly complex, regulating numerous biological functions, such as decision-making and command issuing. Many diseases can affect the brain, including stroke, epilepsy, migraines, Alzheimer's disease, Parkinson's disease, and brain tumors.

Brain tumors are abnormal growths of brain cells that accumulate to form masses. These tumors can be benign or malignant and cause various problems and disrupt vital functions. Brain tumors are among the most serious diseases, requiring precise and rapid detection methods.

There are several symptoms associated with brain tumors, whether benign or malignant, including cognitive decline and problems caused by pressure on the optic nerve. However, the most common symptom is headache. A tumor can cause various problems leading to impaired

hearing, smell, or vision, and may even cause weakness or paralysis in an arm or leg, or in some cases, coma.

Benign tumors are the least harmful type of tumor. It does not develop or spread, and rarely recurs after removal. On the other hand, a malignant tumor consists of cancerous cells that spread rapidly and cause significant functional problems. Brain tumors are classified into categories such as pituitary tumors, meningiomas, and gliomas. For example, the pituitary gland is located at the base of the brain. Its function is to regulate the secretion of hormones from other glands in the body, such as hormones that regulate metabolism, water and salt balance, growth, blood pressure, skin pigmentation, and others. It also controls the hormones of other body glands, such as the adrenal and thyroid glands. When a tumor forms in this important and sensitive area, its effect will not be limited to the pituitary gland; it will directly or indirectly affect other glands in the body, causing significant disruption to their function and hormone secretion.

Most diagnostic methods rely on the neurologist and radiologist's evaluation of images. This is a complex and time-consuming process that can lead to inaccuracies and errors. This is in addition to traditional biopsy techniques, which are also painful, time-consuming, and prone to inaccuracy.

Effective treatment planning depends on rapid and accurate diagnosis. For example, benign tumors can be treated with complete surgical excision, while malignant tumors are treated with radiation, chemotherapy, or both.

With the rapid development of medical imaging technologies, such as magnetic resonance imaging (MRI) and computed tomography (CT), which play a vital role in disease detection and diagnosis, early detection of tumors has become crucial. This facilitates early treatment and, God willing, increases the likelihood of survival.

Artificial intelligence has revolutionized the detection and diagnosis of brain tumors, making it invaluable to neurologists. Healthcare researchers have used a range of deep learning algorithms, such as CNN and U-Net, to aid in diagnosis. Furthermore, methods based on the YOLOv7 model have been improved, enhancing detection accuracy, as have the VGG16 model and the Adam optimizer. This is made easier by the availability of huge amounts of medical imaging data for analysis, such as Kaggle.

Motivation:

Neurologists face many difficulties and challenges in diagnosis. Sometimes a tumor may be very small and its symptoms unclear, delaying detection and treatment.

Furthermore, sometimes it is difficult for the doctor to determine the type of tumor using MRI scans and a biopsy is required, which involves surgery in a sensitive area of the brain. This requires significant time and effort to achieve the desired result.

Therefore, I chose this project because it combines artificial intelligence and medicine, helping doctors to make extremely accurate and rapid diagnoses using various algorithms for classifying MRI images.

Objective:

Neurologists and radiologists face numerous challenges in diagnosing brain tumors using various imaging techniques.

This project aims to help physicians achieve highly accurate diagnoses using deep learning algorithms (CNNs) and MRI image classification. These algorithms can reveal tumors of all sizes, even the smallest, with high precision and pinpoint their location within the brain.

This allows physicians to analyze thousands of images in just a few minutes, significantly reducing human error during diagnosis. This contributes to faster decision-making and the selection of the most appropriate treatment, thus increasing the patient's chances of survival, God willing. This is our ultimate goal.

Related Work:

Recent years have witnessed remarkable progress in the use of artificial intelligence in the accurate and rapid diagnosis of brain tumors. This has prompted researchers to conduct studies analyzing MRI images to detect tumorous areas and classify them into different categories. These studies indicate the use of strategies based on the deep convolutional

neural network framework (CNN), which employs multiple layers and variables to accurately identify brain cancer.

The researchers in [1] proposed a model designed to divide MRI images depicting brain tumors into two categories. The model (CNN + Adam) demonstrated excellent performance, achieving 98% accuracy, in addition to feature extraction (VGG16). They processed 3,000 MRI images downloaded from (Kaggle), despite the challenges they encountered in ensuring compatibility between the medical record systems (EHR) and (AI). These challenges were resolved by developing interfaces that scan (AI) with (EHR) for information exchange and integration.

This model, as described in the paper [2], is distinguished by its classification, detection, and localization of brain tumors. It utilizes a fully automated model employing the DL&YOLOv7 algorithm to minimize false positives and losses, and integrates SPPF + BiFPN components to address the challenge of small tumors. The total dataset for the various categories comprised 10,288 Kaggle MRI images. The model demonstrated superiority in detecting gliomas, meningiomas, and pituitary tumors in the brain, achieving a verification accuracy of 99.5%.

Reference [3] presents the identification and classification of brain tumors into four types using a deep learning-based hierarchical classification system. MATLAB software was used for intelligent detection using CNNs, and the initial function involved a RELU layer on 3264 Kaggle MRI images. The model achieved an accuracy of 92.13%, and the images were processed using intermediate filtering to remove noise with a multi-layered hierarchical classification.

In this study [4], the researchers proposed comparing different DL models, based on various types of neural networks (CNN, ANN, TL), to identify and classify brain tumors. They used ANN, CNN (ReLU), and TL algorithms from the Keras library on 3190 Kaggle MRI images. The results showed that CNN outperformed ANN in classifying medical images, achieving 90% accuracy. The best TL model was VGG16, achieving the highest accuracy among all models at 94%.

Brain tumors were classified using deep learning (CNN) and x-ray analysis (XAI) techniques, as described in the paper [5], which significantly outperformed the Grad-Cam model, which focused on and highlighted tumors. The model achieved 99% accuracy in the first dataset and 95% in the second. Methods such as XAI Shap and LIME were used to verify local interpretations and model decisions, and to test the model's results. The model demonstrated accuracy and balance, but it was trained and tested using only MRI images, and the results may be unsatisfactory with other imaging techniques such as computed tomography. The dataset used was created by Nikparvar and included 7023 images, while the second dataset, NeuroMRIs, included 3264 images.

In this research [6] , GoogleNet and AlexNet were used as learning networks for feature extraction, but the results were unsatisfactory. Therefore, a hybrid approach was employed, combining them with other networks (AlexNet-SVM and AlexNet-KNN) to improve verification and testing accuracy. The study utilized a dataset compiled from various sources (Figshare, SARTAJ, and Br35h) containing 2880 MRI images. The KFold data splitting technique was used, and the results showed that AlexNet-KNN exhibited higher verification and testing accuracy compared to GoogleNet, with the hybrid networks achieving accuracy rates of 96.9% and 98.6%, respectively.

Dataset:

This thesis presents a dataset of magnetic resonance imaging (MRI) images for brain tumor classification, downloaded from the Kaggle website. The first dataset, titled "Brain Tumor Classification (MRI)," contains 2656 images of type (JPG) and is divided into two categories: training and testing. Each category is further divided into four sections: pituitary tumor, glioma, no tumor, and meningioma.

The second dataset contains (10560) images, also divided into four sections, and is of type (JPG,PNG)

	Group 2	Group 1		
		Training	Testing	Total
Glioma	3754	826	100	4680
Meningioma	2343	247	127	2717
No- tumor	1757	327	104	2188
Pituitray	2706	827	98	3631
Total	10560	2227	429	13216

Graduation project timeline:

A timeline for completing the project in ten weeks, with focus and attention to the supervisor's instructions and observations.

Week 1:

Reviewing research and studies similar to the research topic.

Identifying the motivation for choosing this project and setting the objectives.

Writing the research paper (abstract, introduction, motivation, objectives).

Week 2:

Identifying data sources (Kaggle, Subreddit, ICCR).

Identifying the type of images required (MRI, CT).

Cleaning the data (removing blurry images, standardizing formats).

Adding edits to the research paper.

Week 3:

Data preprocessing (normalization, noise reduction, image resizing).

Data segmentation (Training, Testing, Validation).

Writing the research methodology and data processing methods used.

Week 4:

Choosing the appropriate template (VGG16, N-Net, YOLOv7).

Installing libraries and starting to write code.

Testing a small sample.

Week 5:

Train the model on the complete dataset.

Monitor the model, adjust parameters, and avoid errors overfitting .

Record the latest results.

Week 6:

Improving the model and using new techniques and parameters (activation parameters, learning rate).

Comparing the performance of different models and new techniques and selecting the best one.

Adding modifications to the research paper and writing about the latest techniques used.

Week 7:

Training the model using the best parameters.

Applying the model to a test dataset.

Evaluating the model using metrics such as (Precision , accuracy).

Writing the results in the research paper.

Week 8:

Compare the results with previous studies.

Review and organize the code.

Edit the results in the research paper and add new sections.

Week 9:

Reviewing the research paper and editing and organizing all sections.

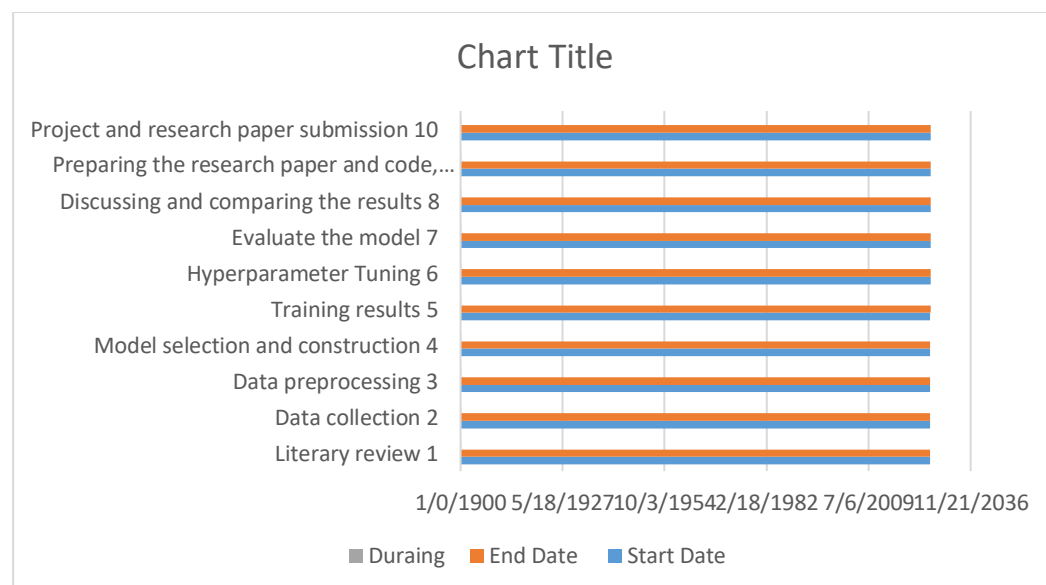
Organizing the code and ensuring it runs without problems.

Week 10:

Preparing the PowerPoint presentation.

Reviewing the research paper.

Reviewing the final code and ensuring it is error-free, God willing.



Reference:

- [1] Brahim S. , Dardouri S. & Bouallegue R, (2024)Brain tumor detection using a deep CNN model: *Applied Computational Intelligence and Soft Computing* [Brain Tumor Detection Using a Deep CNN Model - Ben Brahim - 2024 - Applied Computational Intelligence and Soft Computing - Wiley Online Library](#)
- [2] Abdusalomov ,A. , Mukhiddinov M.& Whangbo ,T.(2023)Brain Tumor Detection Based on Deep Learning Approaches and Magnetic Resonance Imaging [Brain Tumor Detection Based on Deep Learning Approaches and Magnetic Resonance Imaging - PMC](#)
- [3] Khan,AB ., Abbas,S., Khan,M., Farooq ,U., Khan , W.,Siddiqui , SH. & Ahmad ,A.(2022) Intelligent model for brain tumor identification using deep learning: *Applied Computational Intelligence and Soft Computing* [Intelligent Model for Brain Tumor Identification Using Deep Learning - Khan - 2022 - Applied Computational Intelligence and Soft Computing - Wiley Online Library](#)
- [4] Kadam,A., Bhuvaji,S.& Deshpande,S. (2021)Brain Tumor Classification using Deep Learning Algorithms: *International Journal for Research in Applied Science & Engineering Technology (IJRASET)* [Brain-Tumor-Classification-Using-Deep-Learning-Algorithms/Research Paper.pdf at master · SartajBhuvaji/Brain-Tumor-Classification-Using-Deep-Learning-Algorithms · GitHub](#)
- [5] Iftikhar,SH., Anjum, N., Siddiqui,AB., Ur Rehman , M. & Ramzan ,N. (2025) Explainable CNN for brain tumor detection and classification through XAI based key features identification: *Brain Informatics* [Explainable CNN for brain tumor detection and classification through XAI based key features identification | Brain Informatics](#)
- [6] AlTahhan ,F., Khouqeer ,GH. , Saadi,S., Elgarayhi ,A.&Sallah ,M. (2023) Refined Automatic brain tumor classification using hybrid convolutional neural networks for MRI scans [Refined Automatic Brain Tumor Classification Using Hybrid Convolutional Neural Networks for MRI Scans](#)