BRAIN TUMOR DETECTION TECHNIQUE USING DEEP LEARNING FOR MEDICAL DIAGNOSIS

NUR ANISSYA BINTI SETIA BUDI

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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BRAIN TUMOR DETECTION TECHNIQUE USING DEEP LEARNING FOR MEDICAL DIAGNOSIS

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This report is submitted in partial fulfilment of the requirements for the Bachelor of [Computer Science (Artificial Intelligence)] with Honours.

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FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I hereby declare that this project report entitled

BRAIN TUMOR DETECTION TECHNIQUE USING DEEP LEARNING FOR MEDICAL DIAGNOSIS

is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT : Nur Anissya Date : 03/07/2023

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I hereby declare that I have read this project report and found this project report is sufficient in term of the scope and quality for the award of Bachelor of [Computer Science (Artifical Intelligence)] with Honours.

SUPERVISOR : Date : 13/9/2023

(PROFESSOR MADYA GS. DR. ASMALA BIN AHMAD)

DEDICATION

I would like to congratulate and thank the following people for their invaluable contributions to the successful production of my final year report. I would want to dedicate this report, first and foremost, to my family, who have been a constant source of support and encouragement during my academic path. Their unfailing faith in me has helped me accomplish this milestone, and I will be eternally grateful for their love and wisdom.

I would like to express my heartfelt gratitude to my supervisor, Professor Madya Gs. DR. Asmala bin Ahmad, for their invaluable guidance and mentorship. His knowledge, patience, and constant comments were important in moulding this report and my general development as a student.

I am grateful to the Universiti Teknikal Malaysia Melaka staff members, whose devotion to teaching and commitment to excellence provided me with a solid academic foundation. Their passion for their different disciplines has inspired and encouraged a love of learning in me that will guide me in my future aspirations.

I would like to thank my classmates and friends for their support and camaraderie during this adventure. Their thought-provoking debates, joint efforts, and unwavering friendship have made this experience memorable and pleasurable.

I would like to thank the participants and organisations that generously shared their time and knowledge with me, allowing me to collect significant data and insights for this research. Their contributions have significantly improved the overall quality of this work. Last but not least, thank you for being a part of my journey.

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ABSTRACT

This final year report focuses on the development of deep learning-based brain tumour detection algorithms for medical diagnosis. The fundamental goal of this study is to overcome the difficulties in manually recognising and classifying brain tumours using MRI data. To do this, cutting-edge deep learning models such as VGG16, InceptionV3, ResNet50, and Xception are used to identify brain tumours and determine the best model for accurate detection.

The project makes use of a dataset of 3000 MRI pictures separated into training, testing, and validation sets. The models are trained on the training data set, and their performance is measured using measures like accuracy, time, and loss. This enables for a thorough comparison and evaluation of the models performance in detecting brain tumours.

This project findings contribute to the field of medical diagnostics by shedding light on the performance and applicability of deep learning algorithms for brain tumour identification. The test results will aid in determining the best effective model for reliably detecting brain tumours, allowing for early detection and timely action.

Overall, the goal of this project is to increase the accuracy and efficiency of brain tumour diagnosis by utilising deep learning techniques. The findings of this study have the potential to have a substantial impact on medical diagnosis and lead to better patient care.

ABSTRAK

Laporan tahun akhir ini memberi tumpuan kepada pembangunan algoritma pengesanan tumor otak berasaskan pembelajaran mendalam untuk diagnosis perubatan. Matlamat asas kajian ini adalah untuk mengatasi kesukaran dalam mengenal pasti dan mengklasifikasikan tumor otak secara manual menggunakan data MRI. Untuk melakukan ini, model pembelajaran mendalam yang canggih seperti VGG16, InceptionV3, ResNet50 dan Xception digunakan untuk mengenal pasti tumor otak dan menentukan model terbaik untuk pengesanan tepat.

Projek ini menggunakan set data 3000 gambar MRI yang dipisahkan kepada set latihan, ujian dan pengesahan. Model dilatih pada set data latihan, dan prestasinya diukur menggunakan ukuran seperti ketepatan, masa dan kehilangan. Ini membolehkan perbandingan dan penilaian menyeluruh terhadap prestasi model dalam mengesan tumor otak.

Penemuan projek ini menyumbang kepada bidang diagnostik perubatan dengan memberi penerangan tentang prestasi dan kebolehgunaan algoritma pembelajaran mendalam untuk pengecaman tumor otak. Keputusan ujian akan membantu dalam menentukan model berkesan terbaik untuk mengesan tumor otak dengan pasti, membolehkan pengesanan awal dan tindakan tepat pada masanya.

Secara keseluruhannya, matlamat projek ini adalah untuk meningkatkan ketepatan dan kecekapan diagnosis tumor otak dengan menggunakan teknik pembelajaran mendalam. Penemuan kajian ini berpotensi memberi impak yang besar terhadap diagnosis perubatan dan membawa kepada penjagaan pesakit yang lebih baik.

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CHAPTER I: INTRODUCTION

1.1 Introduction

A brain tumour can occur at any age. The precise cause of brain tumours is unknown to scientists and physicians. Ionizing radiation exposure and a family history of brain tumours are risk factors. Treatment options are determined by the type of diagnosis. Surgery, radiation therapy, and chemotherapy are all options for treatment. A brain tumour is an abnormal growth of cells inside the cerebrum or skull; some are beneficial, while others are harmful. Treatment options vary depending on the type, size, and location of the tumors.

The brain is the most complicated organ in the human body, with billions of cells and connections known as synapses. According to the World Health Organisation (WHO), around 10 million fatalities from brain cancer would be documented in 2020, making it the second-leading cause of mortality worldwide (Can, 2022). Cancer is regarded as the most lethal and destructive disease due to its numerous characteristics, low survival rate, and aggressive nature. Misdiagnosed brain tumours result in inefficient medical therapy, lowering the patient's odds of life.

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1.2 Problem statement

The detection of brain tumours is inaccurate and slow, which delays diagnosis and treatment. This may be difficult for medical officers who have heavy workloads and work long hours. In this project, a brain tumour diagnosis delays MRI time. Slow MRI image analysis can cause tumour diagnosis to be delayed and worsen patient outcomes. Delays in diagnosis may necessitate additional tests or procedures, increasing healthcare costs and resource consumption. This can also put a strain on healthcare providers and cause patients' diagnoses and treatments to be delayed. Deep learning models are used to analyse MRI images for brain tumour diagnosis to reduce delay and improve healthcare system efficiency. By identifying the most accurate and efficient deep learning model, this project could help to speed up brain tumour diagnosis and improve patient outcomes.

Table 1. 1: Summary of Problem Statement

PS	Problem Statement
PS1	The current inaccurate and slow detection of brain tumors, coupled with delays in MRI image analysis, adversely affects diagnosis and treatment, leading to worsened patient outcomes, increased healthcare costs, and strained healthcare providers.

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1.3 Project Question

Table 1. 2: Summary of Project Question

PQ	Project Question
PQ1	How can we effectively discriminate between brain tumor and non-tumor cases? Is it possible to achieve brain tumor detection without expert involvement? Which deep learning model is the most suitable for addressing this particular problem?

1.4 Project Objective

Table 1. 3:Summary of Project Objectives

PS	PQ	PO	Project Objective
PS1	PQ1	PO1	To implement the performance of multiple deep learning models for classifying brain images.
		PO2	To evaluate the performance of the deep learning models based on accuracy, loss, and processing time.
		PO3	To provide recommendations on the most effective deep learning model for classifying brain images as tumors or non-tumors.

1.5 Project Scope

1. Classify brain images as either tumor or non-tumor.
2. The performance of the models will be assessed based on metrics such as accuracy, loss, and computational time.
3. Multiple deep learning models will be employed to perform the analysis and classification.

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1.6 Project Contribution

Table 1. 4: Summary of Project Contribution

PS	PQ	PO	PC	Project Contribution
PS1	PQ1	PO1	PC1	Proposed a model that can accurately determine whether the brain has a tumor or not
		PO1	PC2	Proposed a model that can accurately classify brain tumors.

1.7 Report Organization

Chapter 1: Introduction

This chapter discusses the project's background, problem statement, objective, scope, project contribution, and about the detection of brain tumor.

Chapter 2: Literature Review

This chapter discusses a summary of previous works that are relevant to the project. This chapter also discusses which models are appropriate for this project.

Chapter 3: Project Methodology

This chapter discusses the process and methodology for the entire project, from the beginning to the end.

Chapter 4: Design

This chapter discusses the design to solve the problem as well as all of the requirements for this project.

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Chapter 5: Implementation

This chapter discusses the environment setup, including which software and libraries will be used for this project.

Chapter 6: Testing

This chapter discusses the testing system and the results. In this chapter, the results will be compared, and the best model will be chosen.

Chapter 7: Project Conclusion

This is the chapter that summarizes the entire project and discusses the project's limitations as well as future work.

1.8 Conclusion

This chapter is research has the potential to increase the efficiency and accuracy of brain tumour diagnosis, potentially leading to improved patient outcomes. To improve the performance of deep learning models for brain cancer diagnosis, more research and development are required, such as employing larger datasets and improved model architectures.

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CHAPTER II: LITERATURE REVIEW AND PROJECT METHODOLOGY

2.1 Introduction

Tumors in the medical field refer to malignant or benign neoplasms, which can affect humans in over two hundred distinct ways. According to the American Cancer Society, a brain tumour is a severe disease that impairs brain function due to the abnormal growth of brain tissue. Consequently, the National Brain Tumor Foundation (NBTF) has observed a 300 percent increase in brain tumor-related deaths over the past three decades. Therefore, early detection and prompt treatment of brain tumours are crucial to the survival rate of these patients. However, brain tumour biopsies are more complicated than those of other organs because they require surgery. Owing to these distinctive features, MRI deemed an indispensable and efficacious tool for the accurate diagnosis, monitoring, and management of the disease.

In this chapter, I will delve deeper into the specifics of this project, including the brain affected by tumors and the algorithms that will be implemented. The data presented in this chapter has been sourced from a variety of online publications, such as journals and papers, which were published between 2020 and 2022. We meticulously read and compared each article I came across to ensure the accuracy of the information. To achieve optimal results, I also conducted a comprehensive review of the references.

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After documenting all the important and relevant articles and journals, I discovered that deep learning, machine learning, and a variety of other classification techniques were used to categorise brain tumours for this project. Different models have been applied because they are better suited to different situations. It has been determined through careful analysis that the application of these advanced technologies will significantly enhance the classification process' precision and effectiveness. I hope that by implementing these innovative strategies, I can contribute to the ongoing efforts to improve the diagnosis and treatment of brain tumours.

2.2 Related Work

Alanazi et al. (2022) developed a transfer deep-learning model for the early diagnosis and classification of brain tumors based on MRI images. The model demonstrated high accuracy in differentiating between tumor and non-tumor images, as well as in classifying tumor subclasses including pituitary, meningioma, and glioma. By utilizing transfer learning, the researchers re-adjusted the weights of a 22-layer isolated convolutional-neural-network (CNN) model to classify brain MRI images into tumor subclasses. The developed transfer-learned model achieved an accuracy of 95.75% for MRI images from the same machine and demonstrated its adaptability and reliability by achieving an accuracy of 96.89% when tested with brain MRI images from a different machine. This deep-learning framework holds promise in assisting doctors and radiologists in the early diagnosis of brain tumors.

Younis et al. (2021) conducted a study on brain tumor analysis using deep learning and the VGG-16 model. Their methodology achieved high accuracy in detecting brain tumors from MRI images, with the VGG-16 model reaching an accuracy of 98.5%. The study highlights the potential of deep learning techniques, particularly the VGG-16 model, for accurate brain tumor detection (Younis et al., 2021).

Saeedi et al. (2021) conducted a study on MRI-based brain tumor detection using convolutional deep learning methods and machine learning techniques. Their research focused on diagnosing different types of brain tumors, including glioma, meningioma, and pituitary gland tumors, as well as healthy brains. The proposed 2D Convolutional Neural Network (CNN) demonstrated high accuracy in classifying brain tumors, with a training accuracy of 96.47% and average recall of 95%. The study also compared various machine learning methods, highlighting the effectiveness of the 2D CNN in diagnosing brain tumors. The findings suggest that the proposed network can be a valuable tool for radiologists and physicians in clinical systems for brain tumor detection (Saeedi et al., 2021).

In this final project, the classification of brain tumors and healthy brain tissue based on MRI scans was simplified using deep learning technique (Anissya et al., 2023). The aim was to expedite and improve the diagnosis of brain tumor cases, which typically involve distinguishing between two main categories: brain tumor and brain non-tumor.

2.2.1 Brain Tumor

Brain tumors characterized by uncontrolled growth of brain tissue inside the skull, pose a significant health threat. They can be benign or malignant, with malignant tumors exhibiting rapid growth and potential spread. Approximately 70% of brain tumors are benign, while the remaining 30% are malignant. Among the various types of brain tumors, meningioma, glioma, and pituitary tumors are the most common (Behin et al., 2003). Meningioma tumors, originating from the meninges, affect the brain and spinal cord, while glioma tumors arise from glial cells, particularly astrocytes. Astrocytoma, a low-risk glioma tumor, progresses slowly, whereas high-risk glioma represents a more aggressive form of brain tumor (Behin et al., 2003). Furthermore, based on Chatterjee et al. (2022), a brain tumour is a mass or cluster of abnormal cells in the brain, which has the possibility of becoming life-threatening because of its ability to invade neighbouring tissues and also form metastases.

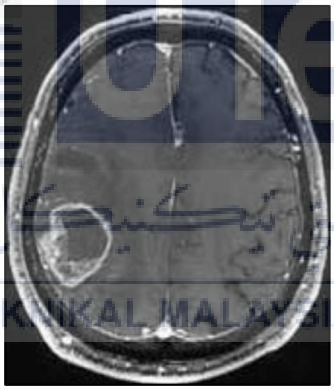

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Figure 2. 1: Brain Tumor (Singh Raghaw et al. 2023)

2.2.2 Non-Tumor

The term "normal brain" or "non-tumor brain" refers to a healthy brain The term "healthy brain" refers to a state of optimal functioning and well-being of the brain. In the context of the study conducted by Chen et al. (2021), a healthy brain is defined as a life-long, multidimensional, dynamic state encompassing cognitive, emotional, and motor domains. It is supported by physiological processes and can be objectively measured and subjectively experienced. A healthy brain is influenced by various eco-biopsychosocial determinants and is free from disorders or

dysfunction. The concept of a healthy brain is crucial in the context of brain health promotion, disease prevention, and maintaining overall well-being. (Chen et al., 2021).

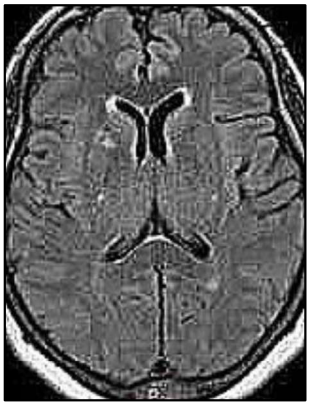

Figure 2. 2: Non-Tumor (Singh Raghaw et al. 2023)

2.3 Critical Review of Current Problem and justification

The current problem in brain tumor detection is the inaccuracy and inefficiency of diagnostic methods. Commonly used to detect brain tumours, magnetic resonance imaging (MRI) and computed tomography (CT) scans may not always provide clear and definitive results. In some instances, tumours may be overlooked or misdiagnosed, resulting in treatment delays and potentially detrimental outcomes for patients. In addition, the interpretation of imaging results is highly dependent on the expertise of radiologists, and there may be variations in interpretation and reporting among healthcare providers. Therefore, there is a need for more precise and dependable methods of brain tumour detection, such as advanced imaging techniques and algorithms based on artificial intelligence, which can improve diagnostic accuracy and reduce errors. Additionally, there is a need for improved integration and collaboration between healthcare providers to ensure that patients with brain tumours receive timely and effective treatment. The research paper that I used to research further details is Kumar et al. (2021) Hussain S., Anwar M. S, (2017) Rehman et al. (2022) and Osman et al. (2023).

For machine learning technique, Kumar et al. (2021) proposed an automatic brain tumor classification system using the K-nearest neighbour algorithm to classify MRI images as abnormal or normal. The fuzz C-means clustering technique is used for tumor region segmentation. The

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