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Brain Tumor Detection Using Deep Learning and Machine Learning

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Dedications

All praises and much gratitude to almighty Allah, the most compassionate and magnificent, who gave us the power, the courage to work hard and persistence to complete this modest work

We would like to thank our supervisor, **Dr. Hakima Zouaoui**, for allowing us to conduct our research. Also, her generosity, compassion, and the time she spent with us.

Finally, to our dear parents, to all our families, to all those dear to us, to all our friends, we dedicate the culmination of our 22 years of study.

Abstract

Brain tumors, particularly gliomas, are among the most prevalent and aggressive types of brain tumors. Accurate diagnosis and classification of gliomas are crucial for effective treatment planning and patient management.

In this thesis we are focusing on the development of a hybrid model capable of detecting brain tumors and classifying them from MRI images. The model is designed to perform two main tasks : tumor segmentation and tumor grade classification. leveraging the BraTS2020 dataset, which provides a comprehensive collection of MRI scans with annotated tumor regions and corresponding grades. The model integrates a U-Net architecture for precise segmentation of tumor regions in MRI scans and a Support Vector Machine (SVM) classifier for determining tumor grades as High-Grade or Low-Grade Gliomas. The U-Net model is trained to accurately segment the tumor regions from the surrounding healthy brain tissue, while the SVM classifier is trained to classify the segmented tumors into their respective grades based on features extracted from the segmented images.

Keywords : Brain Tumor, Glioma, U-Net, SVM, MRI, BraTS, Tumor Segmentation, Grade Classification.

Résumé

Les tumeurs cérébrales, en particulier les gliomes, comptent parmi les types de tumeurs cérébrales les plus répandus et les plus agressifs. Un diagnostic précis et une classification des gliomes sont essentiels pour une planification efficace du traitement et une gestion optimale des patients.

Dans cette thèse, nous nous concentrons sur le développement d'un modèle hybride capable de détecter les tumeurs cérébrales et de les classifier à partir d'images IRM. Le modèle est conçu pour effectuer deux tâches principales : la segmentation des tumeurs et la classification de leur grade. En s'appuyant sur la base de données BraTS2020, qui fournit une collection complète d'IRM avec des régions tumorales annotées et leurs grades correspondants, le modèle intègre une architecture U-Net pour une segmentation précise des régions tumorales dans les IRM et un classificateur SVM (Support Vector Machine) pour déterminer les grades des tumeurs en gliomes de haut grade ou de bas grade. Le modèle U-Net est entraîné pour segmenter avec précision les régions tumorales du tissu cérébral sain environnant, tandis que le classificateur SVM est entraîné pour classifier les tumeurs segmentées en fonction des caractéristiques extraites des images segmentées.

Mots-clés : Tumeur cérébrale, Gliome, U-Net, SVM, IRM, BraTS, Segmentation des tumeurs, Classification des grades.

ملخص

تُعد أورام الدماغ، وخصوصاًا الأورام الدبقية، من بين أكثر أنواع أورام الدماغ انتشاراً وعدوانية. يُعتبر التشخيص الدقيق وتصنيف الأورام الدبقية أمراً بالغ الأهمية للتخطيط العلاجي الفعّال وإدارة حالة المرضى.

في هذه الأطروحة، نركز على تطوير نموذج هجين قادر على اكتشاف أورام الدماغ وتصنيفها من صور التصوير بالرنين المغناطيسي. تم تصميم النموذج لتنفيذ مهمتين رئيسيتين: تقسيم الأورام وتصنيف درجاتها. يعتمد النموذج على مجموعة بيانات BraTS2020، التي توفر مجموعة شاملة من صور الرنين المغناطيسي مع مناطق الأورام المشروحة والدرجات المقابلة لها. يدمج النموذج بين بنية U-Net لتقسيم دقيق لمناطق الأورام في صور الرنين المغناطيسي ومصنف آلة ناقلات الدعم SVM لتحديد درجات الأورام كأورام دبقية عالية الدرجة أو منخفضة الدرجة. يتم تدريب نموذج U-Net على تقسيم مناطق الورم بدقة عن الأنسجة السليمة المحيطة في الدماغ، بينما يتم تدريب مصنف SVM على تصنيف الأورام المقسمة إلى درجاتها بناءً على الخصائص المستخرجة من الصور المقسمة.

الكلمات المفتاحية: أورام الدماغ، الأورام الدبقية، U-Net، SVM، التصوير بالرنين المغناطيسي، BraTS، تقسيم الأورام، تصنيف الدرجات.

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List of abbreviations

HGG High-Grade Glioma.

LGG Low-Grade Glioma.

MRI Magnetic Resonance Imaging.

SVM Support Vector Machine.

U-Net U-Net Convolutional Neural Network.

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Chapitre 1

General Introduciton

1.1 Introduction

Traditionally, radiologists rely on MRI scans to detect brain tumors, While this method is effective, it also has limitations analyzing hundreds of scans manually is time consuming and prone to human error. That is where technology comes in. With recent advances in artificial intelligence, especially deep learning, we now have powerful tools that can learn from medical images and help with faster and more accurate diagnosis.

In this project, we focus on building a hybrid system to detect brain tumors and determine whether they are low-grade or high-grade. We use a U-Net model for segmenting the tumor regions in MRI images. After identifying these regions, we extract important features and feed them into a Support Vector Machine (SVM) classifier to make the final prediction.

We use the BraTS2020 dataset, focusing on T2-weighted FLAIR images, to train and test our system. Our goal is to create a pipeline that is not only technically sound but also practical and helpful for medical professionals in real-world settings.

1.2 What is a Brain Tumor ?

A **brain tumor** is an abnormal mass of tissue in which cells grow and multiply uncontrollably, without the mechanisms that regulate normal cell behavior. Brain tumors can be broadly categorized into *benign* (non-cancerous) and *malignant* (cancerous) forms, each with varying

levels of severity and progression [1].

Brain tumors are generally divided into two main categories :

- **Primary brain tumors :** These originate in the brain and include common types such as :
  - *Gliomas* – tumors arising from glial cells, which provide support and insulation to neurons [2].
  - *Meningiomas* – tumors that form in the membranes surrounding the brain and spinal cord [3].
  - *Pituitary adenomas* – tumors that develop in the pituitary gland [3].
  - *Medulloblastomas* – fast-growing tumors more commonly seen in children [1].
- **Secondary (metastatic) brain tumors :** These originate from cancers elsewhere in the body (such as the lungs or breast) and spread to the brain [1].

Among gliomas, two major clinical subtypes are often considered for diagnostic and prognostic purposes [2] :

- **Low-Grade Gliomas (LGG) :** Slow-growing tumors that often have a better prognosis.
- **High-Grade Gliomas (HGG) :** Aggressive tumors with rapid progression and poor prognosis.

Accurate detection and classification of these tumor types are essential for clinical decision-making, which has led to the integration of artificial intelligence (AI) and deep learning (DL) methods into medical imaging workflows.

1.3 Objectifs

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1.4 Méthodologie et résultats

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1.5 Structure du rapport

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Chapitre 2

Un guide

Chapitre 3

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Conclusion générale (2 pages max)

Références

[1] National Cancer Institute, “Brain tumors,” https://www.cancer.gov/types/brain, 2024, accessed : 2025-04-15.

[2] D. N. Louis, A. Perry, G. Reifenberger *et al.*, “The 2016 world health organization classification of tumors of the central nervous system : a summary,” *Acta neuropathologica*, vol. 131, no. 6, pp. 803–820, 2016.

[3] Mayo Clinic, “Brain tumor overview,” https://www.mayoclinic.org/diseases-conditions/brain-tumor, 2024, accessed : 2025-04-15.