Hamdard University
Department of Computing
Final Year Project

Brain Tumor Detection And Classification Using Deep Learning (FYP-007/FL24)

Software Requirements Specifications

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Definition of Terms, Acronyms, and Abbreviations

Term	Description
MRI	Magnetic Resonance Imaging
CT	Computed tomography
CNN	Convolutional Neural Network
DL	Deep Learning
AI	Artificial Intelligence
ROI	Region of Interest
GPU	Graphics Processing Unit
TPU	Tensor Processing Unit

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1. Introduction

Brain tumors are abnormal growths of cells within the brain that can be benign (non-cancerous) or malignant (cancerous). Early detection and accurate classification of brain tumors are crucial for timely medical intervention and improved patient outcomes.[1] Traditional methods of tumor detection and classification often rely on invasive procedures, such as biopsies, and may have limitations in terms of accuracy and speed. In recent years, the advent of deep learning techniques has revolutionized medical image analysis, offering promising solutions for the automated detection and classification of brain tumors.[19] Deep learning, a subset of machine learning, involves the use of artificial neural networks inspired by the human brain to recognize

1.1 Purpose of Document

This document outlines the requirements, functionalities, and design constraints for the development of Brain Tumor Detection And Classification Using Deep Learning . It serves as a guide for developers, testers, and stakeholders to understand the system specifications and ensure a successful implementation.

1.2 Intended Audience

The detection and classification of brain tumors using traditional methods often require significant time, expertise, and resources, leading to delayed diagnoses, increased costs, and varying levels of accuracy. Patients may face delayed treatment, medical professionals are burdened with extensive manual analysis, and healthcare providers struggle to optimize resources effectively. This project aims to address these challenges by leveraging deep learning techniques to enhance efficiency, accuracy, and accessibility in brain tumor detection and classification.

Audience:

- **Project Team**: Tasked with developing and implementing the deep learning model and system.
- **Supervisors**: Monitoring project milestones and ensuring the solution meets medical and technical standards.
- **End-users**: Including radiologists, medical professionals, and patients who will benefit from improved diagnostic tools and outcomes.

2. Overall System Description

2.1 Project Background

The diagnosis of brain tumors is often time-consuming and requires significant expertise. Our goal is to simplify this process by using deep learning to assist medical professionals in accurately detecting and classifying tumors efficiently.

2.2 Problem Statement

The manual detection and classification of brain tumors from medical imaging is time-consuming, prone to human error, and requires significant expertise. This leads to delays in diagnosis, inconsistent results, and challenges in providing timely treatment. There is a need for an automated, efficient, and accurate system to assist medical professionals in identifying and classifying brain tumors.

2.3 Project Scope

The following significant elements will be a part of the project:

1. Enhancing the accuracy and efficiency of brain tumor detection and classification.
2. Developing a deep learning model to analyze medical imaging data effectively.
3. Providing an automated system to assist medical professionals in diagnosing brain tumors.
4. Enabling classification of tumor types for better treatment planning and patient care.
5. Reducing the time required for diagnosis by streamlining the imaging analysis process.

2.4 Not In Scope

1. Manual verification of brain tumor diagnoses by radiologists.
2. Predicting patient recovery or treatment outcomes based on tumor classification.

2.5 Project Objectives

The primary objective of this project is to develop a deep learning-based system for accurate and efficient brain tumor detection and classification using medical imaging. The system aims to reduce diagnostic time, enhance accuracy, and provide consistent results, supporting medical professionals in making informed treatment decisions. Additionally, the project seeks to deliver a user-friendly interface to ensure seamless integration into existing diagnostic workflows.

2.6 Stakeholders & Affected Groups

- Healthcare Providers (Doctors/Clinicians)
- Patients
- Regulatory Authorities

2.7 Operating Environment

- **Browsers**: Chrome, Firefox, Safari.
- **Devices**: Desktop, laptop, tablet, and smartphone

2.8 System Constraints

- Must function on multiple browsers without additional software.
- Support for up to 500 concurrent users.
- Limited storage and processing capacity.
- Constraints on data privacy and compliance regulations.
- Initial lack of extensive user feedback for system optimization.

2.9 Assumptions & Dependencies

- Access to high-quality medical imaging data.
- Availability of cloud infrastructure for data storage.
- Collaboration with medical professionals for validation.
- Dependency on continuous internet connectivity.

3. External Interface Requirements

3.1 Hardware Interfaces

- Processor: 3.0 GHz or higher
- RAM: 16 GB minimum
- Storage: 500 GB SSD

- Client Requirement

  - Any modern device with internet connectivity and web browser support.

3.2 Software Interfaces

- Backend: Python (Flask/Django)
- Machine Learning Framework: TensorFlow/PyTorch
- Database: PostgreSQL

- Frontend

  - Framework: React.js
  - UI Library: Material-UI

3.3 Communications Interfaces

- Communication over HTTPS for secure data transmission.
- RESTful APIs for integration with medical imaging tools and classification models.
- WebSocket support for real-time updates and notifications.

4. System Functions / Functional Requirements

4.1 System Functions

Ref #	Functions	Category	Attribute	Details & Boundary Constraints
R1.1	User registration and login for doctors, patients, and administrators	Evident	Response time	User registration should complete within 5 seconds
R1.2	Upload and analyze medical imaging data	Evident	Data storage	System should support image uploads in standard formats (DICOM, JPEG, PNG)
R1.3	Brain tumor detection and classification	Evident	Processing speed	Detection and classification should complete within 30 seconds per image
R1.4	Viewing and managing diagnosis results	Hidden	System availability	Accessible 24/7 with minimal downtime
R1.5	User authentication and role management	Evident	Security	Multi-factor authentication (MFA) should be implemented for access control
R1.6	Real-time updates and notifications	Hidden	Integration support	Supports integration with healthcare messaging systems for notifications

4.2 Use Cases

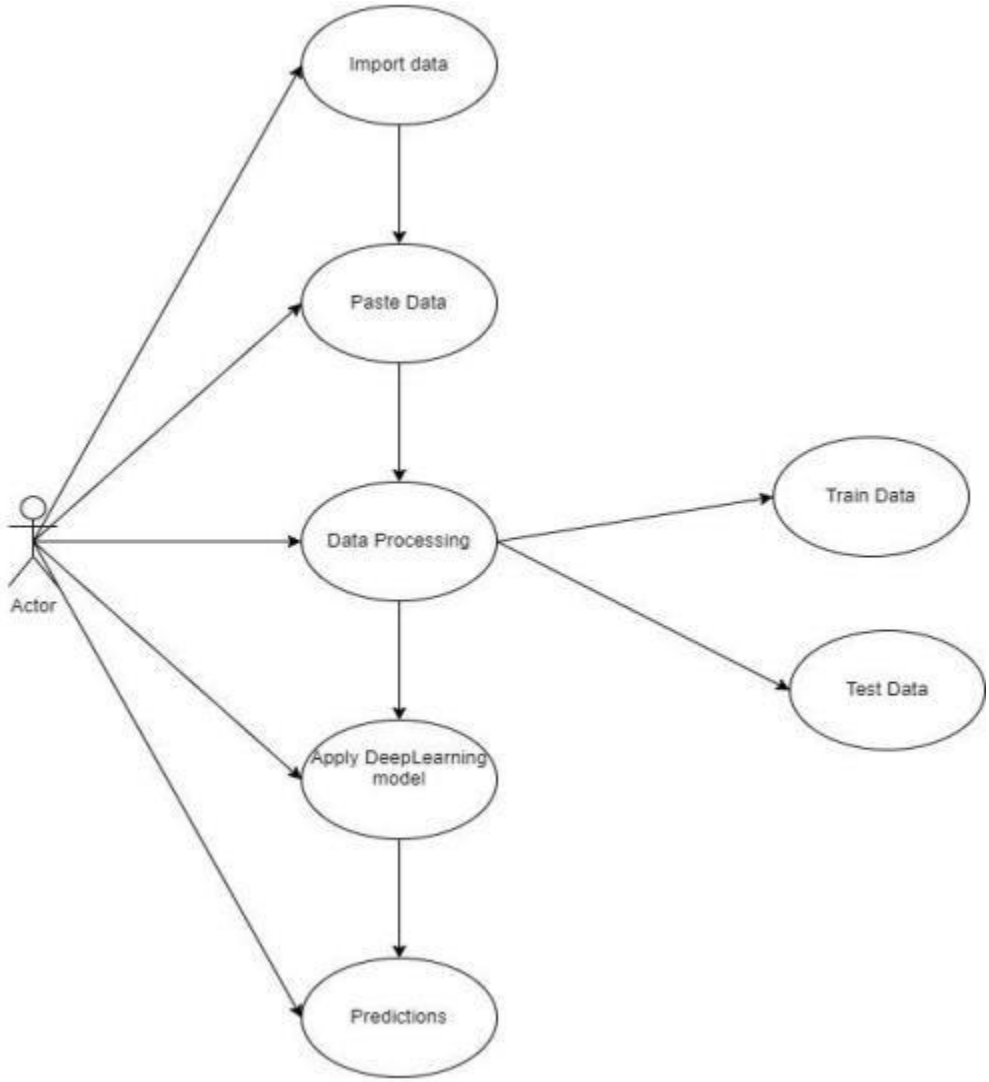
The following are the key actors in the system:

5. **Patients**: Individuals who seek a diagnosis and treatment based on medical imaging data.
6. **Doctors/Clinicians**: Medical professionals who interpret the system's diagnostic results and make decisions on treatment.
7. **System Administrators**: Personnel responsible for managing the system, including user roles, data security, and system maintenance.
8. **Developers**: Individuals involved in the creation, maintenance, and enhancement of the deep learning model and the system infrastructure.

8.1.1 List of Use Cases

Use Case #	Name	Brief Description
UC1	Account Registration / Login	Users can create or log into their accounts securely.
UC2	Upload Medical Imaging Data	Users can upload medical images for analysis.
UC3	Tumor Detection & Classification	Detects and classifies brain tumors from medical images.
UC4	View Diagnosis Results	Displays tumor detection results to doctors and clinicians.
UC5	Manage User Roles	Administrators can assign and manage user roles.
UC6	Real-Time Notifications	Sends updates to users about their diagnosis results.

8.1.2 Use Case Diagram



8.1.3 Description of Use Cases

Section: Main
Name: Account Registration / Login
Actors: Patients, Doctors, Administrators
Purpose: To allow users with a secure account to access the system.
Description: Users can create an account or log in using valid credentials.
Cross References: Functions: R1.1
Pre-Conditions: User must have a valid email and password for login or registration.
Successful Post-Conditions: Upon a successful login, the user is taken to their dashboard.
Failure Post-Conditions: Login fails, and an error message is displayed.

Typical Course of Events

Actor Action	System Response
1. User enters registration details or login credentials.	System verifies credentials and redirects to the appropriate dashboard.
2. Incorrect credentials are provided.	System displays an error message and asks the user to retry or reset the password.

Section: Main
Name: Upload Medical Imaging Data
Actors: Patients, Healthcare Providers
Purpose: To allow patients or healthcare providers to upload medical images for analysis.
Description: Users can upload medical images in supported formats (e.g., JPEG, PNG, DICOM).
Cross References: Functions: R1.2
Pre-Conditions: User must be logged into the system.
Successful Post-Conditions: The image is successfully uploaded and stored in the database.
Failure Post-Conditions: An error message is displayed if the upload fails or the file format is invalid.

Typical Course of Events

Actor Action	System Response
1. User selects an image file and clicks upload.	System validates the file format and stores the image in the database.
2. An unsupported file format is selected.	System displays an error message and asks the user to re-upload the image.

Section: Main
Name: Tumor Detection & Classification
Actors: Patients, Doctors
Purpose: To detect and classify brain tumors from uploaded medical images.
Description: The system analyzes the uploaded images to identify and classify brain tumors.
Cross References: Functions: R1.3
Pre-Conditions: Valid medical image uploaded for analysis.
Successful Post-Conditions: Tumor detection and classification results are displayed.
Failure Post-Conditions: Error message is displayed if the analysis fails or the image quality is insufficient.

Typical Course of Events

Actor Action	System Response
1. User uploads medical image for analysis.	System processes the image and classifies the tumor type.
2. Image is not suitable for analysis (low quality).	System notifies the user about the issue and requests a better-quality image.

Section: Main
Name: View Diagnosis Results
Actors: Doctors, Patients
Purpose: To allow users (doctors) to view the results of tumor detection and classification.
Description: Doctors can view the detailed tumor detection and classification results.
Cross References: Functions: R1.4
Pre-Conditions: A tumor detection analysis must have been completed.
Successful Post-Conditions: Diagnosis results are displayed for review.
Failure Post-Conditions: Error message is displayed if the results are not available.

Typical Course of Events

Actor Action	System Response
1. Doctor requests to view the diagnosis results.	System retrieves and displays the tumor classification results.
2. Results are not available.	System displays an error message and notifies the doctor of the issue.

Section: Main
Name: Manage User Roles
Actors: Administrators
Purpose: To enable administrators to assign and manage user roles (e.g., doctors, patients).
Description: Administrators can assign roles and manage user access permissions.
Cross References: Functions: R1.5
Pre-Conditions: Administrator must be logged into their account.
Successful Post-Conditions: User roles are successfully assigned and access is granted.
Failure Post-Conditions: Error message is displayed if the role assignment fails.

Typical Course of Events

Actor Action	System Response
1. Administrator selects a user and assigns a role.	System updates the user's role and grants the appropriate access.
2. Role assignment fails.	System displays an error message and requests corrective action.

Section: Main
Name: Real-Time Notifications
Actors: Patients, Doctors
Purpose: To send real-time updates to users about diagnosis results or system updates.
Description: The system sends real-time notifications about diagnosis or system updates.
Cross References: Functions: R1.6
Pre-Conditions: A relevant event (e.g., diagnosis update) must trigger a notification.
Successful Post-Conditions: Notification is sent to the user's device.
Failure Post-Conditions: Error message is displayed if the notification fails to send.

Typical Course of Events

Actor Action	System Response
1. System detects a new update or result.	System sends a real-time notification to the relevant user.
2. User does not receive the notification.	System retries sending the notification or logs an error.

9. Non - Functional Requirements

9.1 Performance Requirements:

The system must be capable of supporting up to 500 concurrent users without experiencing performance degradation. User actions, such as uploading data or accessing results, should be completed within 5 seconds. Additionally, image processing and tumor detection should be finished within 3 minutes for typical medical images to ensure timely and efficient operation.

9.2 Safety Requirements

The system must ensure the safety of medical images and personal data both during transmission and while stored in the system. Automatic backups should be conducted daily to prevent any data loss. Furthermore, the system should implement fail-safe mechanisms to guarantee that no medical data is lost in the event of processing or system errors.

9.3 Security Requirements

Security is a top priority for the system. All data transfers should be encrypted using SSL/TLS protocols to ensure secure communication. Multi-factor authentication (MFA) must be used for administrative access to the system, while sensitive medical data should be stored with AES-256 encryption to protect patient privacy. Additionally, user sessions should automatically expire after 30 minutes of inactivity to prevent unauthorized access.

9.4 Reliability Requirements

The system should maintain an uptime of 99.9% or higher, excluding any scheduled maintenance. It must also handle any hardware or software failures gracefully, ensuring minimal disruption to the user experience. To maintain reliability, redundancy should be implemented for critical system components, such as image processing services, to avoid single points of failure.

9.5 Usability Requirements

The system interface must be designed to be intuitive, with a clean and simple layout that ensures ease of navigation for all users. It should be fully responsive, allowing access from desktop computers, tablets, and smartphones. Additionally, the system should provide a help section to assist users in understanding the key features and how to use the platform effectively.

9.6 Supportability Requirements

To aid in system maintenance and troubleshooting, the system should provide detailed and clear error messages. Comprehensive logs of significant events should be maintained to facilitate quick resolution of issues. Moreover, the system must allow for easy updates, especially for medical imaging algorithms and database management, through an admin panel that is both user-friendly and efficient.

9.7 User Documentation

The system must come with a comprehensive user manual that explains the processes of registration, image upload, result viewing, and user role management. This documentation should be available in both English and any relevant local languages. Additionally, quick start guides and video tutorials should be provided to help new users get up to speed quickly with the system's functionalities.

These non-functional requirements address the need for high performance, safety, security, reliability, usability, supportability, and clear user documentation to ensure a smooth, efficient, and secure user experience while meeting regulatory and operational standards.

10. References

[1]Abbas, N., Saba, T., Mehmood, Z., Rehman, A., Islam, N., & Ahmed, K. T. (2019). An automated nuclei segmentation of leukocytes from microscopic digital images. Pakistan Journal of Pharmaceutical Sciences.

[2]Abbas, N., Saba, T., Mohamad, D., Rehman, A., Almazyad, A. S., & Al-Ghamdi, J. S. (2018). Machine aided malaria parasitemia detection in Giemsa-stained thin blood smears. Neural Computing and Applications.

[3]Abbas, N., Saba, T., Rehman, A., Mehmood, Z., Kolivand, H., Uddin, M., & Anjum, A. (2019). Plasmodium life cycle stage classification-based quantification of malaria parasitaemia in thin blood smears. Microscopy Research and Technique.

[4]Gurbinà M., Lascu M. and Lascu D. 2019 Tumor Detection and Classification of MRI Brain Image using Different Wavelet Transforms and Support Vector Machines 2019 42nd International Conference on Telecommunications and Signal Processing (TSP) (Budapest, Hungary)

[5]Dvorak P., Kropatsch W. and Bartusek K. 2013 2013 36th International Conference on Telecommunications and Signal Processing (TSP) (Rome) Automatic detection of brain tumors in MR images

[6]Ezhilarasi R. and Varalakshmi P. 2018 Tumor Detection in the Brain using Faster R-CNN

[7]A survey on cancer detection via convolutional neural networks: Current challenges and future directions 2024, Neural Networks.

[8]Analysis of Swin-UNet vision transformer for Inferior Vena Cava filter segmentation from CT scans 2023, Artificial Intelligence in the Life Sciences.

[9]Transfer learning architectures with fine-tuning for brain tumor classification using magnetic resonance imaging 2023 Healthcare Analytics.

[10] Raja N, Rajinikanth V, Fernandes SL, Satapathy SC (2017) Segmentation of breast thermal images using Kapur's entropy and hidden Markov random field. J Med Imaging Health Inf 7:1825–1829.

[11] Rajinikanth V, Madhavaraja N, Satapathy SC, Fernandes SL (2017) Otsu's multi-thresholding and active contour snake model to segment dermoscopy images. J Med Imaging Health Inf 7:1837–1840.