

Brain Tumor Analysis System

AI-Powered Segmentation and Clinical Interpretation

Version 1.0

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1 Introduction

The **Brain Tumor Analysis System** integrates **YOLOv11-segmentation** for tumor detection in brain MRI scans with **Retrieval-Augmented Generation (RAG)** powered by **Mistral-8x7B** (via Groq API). The LLM generates a detailed PDF report containing a comprehensive clinical analysis and treatment recommendations for detected tumors. This document outlines the system's workflow, components, and outputs.

2 System Objectives

- Automate brain tumor segmentation using YOLOv11.
- Generate detailed clinical analysis and treatment recommendations via LLM.
- Produce professional PDF reports for medical and research use.
- Support scalability for future enhancements.

3 System Workflow

The system processes MRI scans through a sequential pipeline:

1. **Input:** MRI scan (.jpg, .png).
2. **Segmentation:** YOLOv11 detects tumors, producing a mask and JSON report.
3. **Validation:** Checks for valid tumor masks.
4. **Report Generation:** Creates JSON report (area, coordinates, confidence) and segmented image.
5. **Interpretation:** RAG retrieves medical context; Mistral-8x7B generates a detailed clinical analysis with treatment recommendations.
6. **Output:** Compiles results into a detailed PDF report via ReportLab.

4 System Components

Component	Technology	Purpose
Segmentation	YOLOv11, OpenCV	Tumor detection and visualization
Knowledge Base	ChromaDB	Stores medical references
LLM Interpretation	Mistral-8x7B, Groq API	Detailed clinical analysis and treatment recommendations
PDF Generator	ReportLab	Creates PDF reports with summaries

Table 1: System Components

5 LLM Output

The LLM (Mistral-8x7B, via Groq API) generates a detailed PDF report containing a comprehensive clinical analysis and treatment recommendations for detected brain tumors. Leveraging

RAG, the LLM retrieves authoritative medical context (e.g., NCI SEER data) to ensure accuracy. The report includes:

- **Clinical Analysis:** Tumor type, size, location, imaging characteristics, and differential diagnosis.
- **Symptoms:** Potential clinical manifestations based on tumor characteristics.
- **Treatment Recommendations:** Actionable steps, such as further imaging, biopsy, specialist referral, or medical management.
- **Epidemiological Context:** Statistics on tumor prevalence and survival rates.
- **References:** Citations to medical sources for credibility.

The PDF report is designed for clinical support, research, and education, requiring validation by a qualified radiologist.

6 Sample Output

Below is a sample of the detailed PDF report generated by the LLM, showcasing the comprehensive clinical analysis and treatment recommendations.

Brain Tumor Analysis Report

Generated: 2025-08-25 14:59 PKT

Findings:

- Tumor Detected: Yes
- Number of Lesions: 1
- Area: 12,345 pixels (3.7% of image)
- Location: Upper-right quadrant
- Confidence: 0.92

Clinical Analysis:

A tumor occupying 3.7% of the brain area was detected in the upper-right quadrant, with a c

Potential Symptoms:

- Headaches (due to increased intracranial pressure)
- Seizures (common in cortical tumors)
- Cognitive impairment (e.g., memory or attention deficits)
- Motor weakness (if parietal lobe is involved)

Treatment Recommendations:

- Order a contrast-enhanced MRI to assess tumor vascularity and refine diagnosis.
- Consider a stereotactic biopsy for histopathological confirmation of tumor type and grade.
- Refer to a neurologist for comprehensive evaluation, including EEG to assess seizure risk.
- Consult a neurosurgeon to evaluate surgical resectability, particularly if symptomatic.
- Initiate anti-seizure medication (e.g., levetiracetam) if seizures are reported.
- Schedule regular imaging (every 6 months) to monitor tumor progression.

Epidemiological Context:

Per NCI SEER data, brain and CNS tumors have an incidence rate of 6.3 per 100,000, with gli

Reference:

NCI SEER Cancer Stat Facts: Brain and CNS Cancers

(<https://seer.cancer.gov/statfacts/html/brain.html>)

Disclaimer:

This is an AI-assisted tool for research and preliminary analysis. All findings and recommen

7 Limitations

- Not intended for clinical diagnosis.
- Dependent on YOLOv11 training data quality.
- Limited to 2D MRI slices (3D support planned).
- Requires validation by a qualified radiologist.

8 Dependencies

Library	Version	Purpose
Ultralytics	11.x	Segmentation
OpenCV	4.x	Image processing
LangChain	0.x	RAG pipeline
ChromaDB	0.x	Vector database
ReportLab	4.x	PDF generation
Groq API	-	LLM inference
Python	3.8+	Runtime

Table 2: System Dependencies

9 Conclusion

The Brain Tumor Analysis System, powered by YOLOv11-segmentation and Mistral-8x7B with RAG, delivers detailed PDF reports with comprehensive clinical analysis and treatment recommendations. Its modular design and professional outputs make it a valuable tool for research and clinical support, with potential for future scalability.

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