Smart Glasses for Brain Tumor Detection and Description from MRI Image

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Introduction

Brain tumors are diagnosed through MRI images, but real-time detection and detailed description pose significant challenges, increasing the burden on medical professionals. This project designs an AI-based smart glass to enable real-time brain tumor detection using YOLOv11 and tumor description generation via Grok3 API. The design aims for patient-centered healthcare innovation in radiology, integrating lightweight hardware. As a result, the smart glass achieves a total weight of 68g, total power consumption of 9.6W, and maximum usage time of 4.7 hours, enhancing practicality in medical settings.

Methodology

The smart glass design combines computer vision and natural language processing for real-time brain tumor detection and description.

Why YOLOv11?

As Ultralytics' latest model, YOLOv11 excels in medical imaging (e.g., MRI) for brain tumor detection, achieving mAP@0.5 scores of 99.48 on the Br35H dataset and real-time FPS of 10-15, chosen for its superior accuracy and efficiency compared to previous models like YOLOv8.

Why Grok3 API?

As xAI's advanced LLM, it specializes in generating natural language descriptions from medical data, detailing tumor size, location, and risk with response times under 100ms, enhancing medical analysis accuracy.

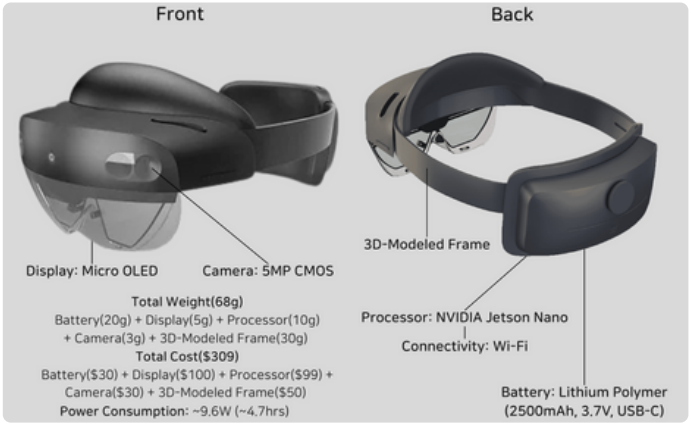
Application

The smart glasses provide real-time, hands-free tumor detection and description during surgery. Surgeons can access MRI scans and receive instant AI-generated tumor details (size, location, risk) through augmented reality overlays, enhancing precision. The wireless, lightweight design ensures hygiene and allows surgeons to focus on the procedure without interacting with external devices. The system also logs data for post-surgery analysis and patient records.

Hardware specifications rationale

Category	Specification/ Model	Description
Processor	NVIDIA Jetson Nano	Provides GPU acceleration for efficient YOLOv11 inference.
OS	Ubuntu	Ensures stable operating system support.
Battery	2500mAh Li-Po (20g)	Lightweight design with 4.7-hour runtime; chosen over wired power for
Camera	5MP CMOS	Features HDR for clear MRI image capture under hospital lighting
Display	Sony ECX339A	AR overlay for detection results, 1280×720 resolution, 1500 nits
Wireless	Wi-Fi 802.11ac	High bandwidth (433Mbps) for Grok3 API calls and data
Total Weight	68g	Ultra-light for extended wear.
Power Consumption	9.6W	Optimized for long battery life.

Smart Glass Design



Usage Instructions

1. Upload an MRI image or capture via webcam (Fig. 1.1, 2.1).
2. Analyze the image to view detection results (Fig. 1.1, 2.1)
3. Review highlighted tumor areas (Fig. 1.2, 2.2)

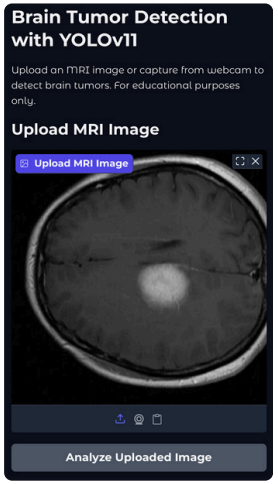


Fig. 1.1

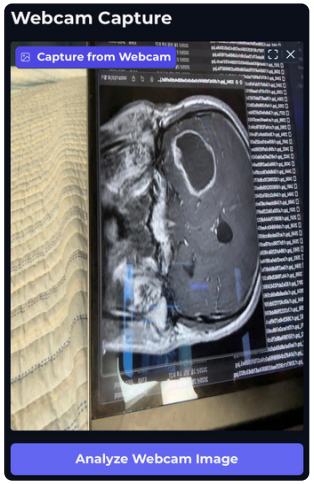


Fig. 2.1

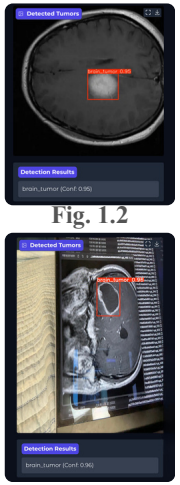


Fig. 1.2

Fig. 2.2

Results

The use of YOLOv11-Large has demonstrated significantly excellent performance in detecting brain tumors. Performance has been validated on a smartphone, not Smart Glass, at this stage. The following Design will enable real-time capture for the Smart Glass, excluding the direct upload feature to the device itself.

Advantages

- **Improved precision:** AR overlays display tumour location and surrounding structures, guiding the surgeon for greater accuracy during surgery
- **Hands-free operation:** Surgeons can focus on the procedure, accessing critical information without needing to interact with external devices
- **Reduced contamination risk:** The wireless, lightweight design eliminates cables and bulky equipment, helping maintain a sterile environment.
- **Enhanced mobility:** Surgeons can move freely within the operating room

Limitations

- **Battery life:** 4-7 hour battery may not be sufficient for long surgeries, requiring recharging
- **Reliability in complex cases:** The AI model may misinterpret more complex cases, leading to potential false positives/negatives.
- **Wi-FI dependency:** They system relies on stable Wi-Fi connection for real-time data, may be unreliable
- **Display limitations:** The micro OLED display might not provide the level of detail needed for certain detailed imaging.
- **Weight and comfort:** The glasses may feel bulky during long surgeries, potentially causing discomfort.

Future Work

Future work includes further lightweighting YOLOv11 (via pruning and quantization) to reduce power consumption by 20% and replacing Grok3 API with an offline LLM to eliminate network dependency.

Additionally, hospital trials will validate accuracy, with expansion to multi-modal data (CT, X-ray) for broader applicability. Integration with wearable healthcare systems for real-time patient monitoring is planned. Future developments may increase functionality by including 3D maps and instance segmentation (Fig. 3) for more precise navigation during surgery.

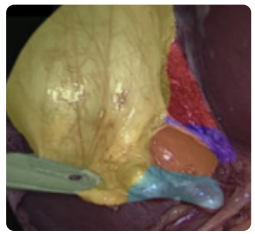


Fig. 3

Conclusion

This project innovates brain tumor detection and description through AI smart glasses, improving accuracy and efficiency in radiology diagnostics. The selected specifications (battery, Wi-Fi, etc.) emphasize mobility and practicality for patient-centered healthcare. It sets a direction for future medical AI.

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