CereVis: A Novel Multimodal Comprehensive Surgical Assistance System for Brain Tumors Utilizing Machine Learning for Pre-Operative Planning and Intra-Operative Surgery

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Annually, brain tumors affect 90,000 people nationwide, and have 5-year survival rates as low as 5%. Surgery, the most popular treatment, hinges on accurate pre-operative planning & detection, where traditional methods are lacking. Outdated surgical technology and inaccurate segmentation lead to a 52-62% recurrence rate for tumor subtypes called gliomas. Additional challenges arise during surgery when the surgeon's tumor view is restricted, making it difficult to distinguish borders. This project aims to create a low-cost, comprehensive surgical assistance system using machine learning to reduce the recurrence of brain tumors, with a focus on gliomas. CereVis presents 1 model for detection, 3 for pre-operative planning, and 2 for surgery. Using a Support Vector Machine, CereVis uses highly correlated RNAs identified through RNA-Seq data found in an ELISA to detect potential GBM. The Tumor Classification Model distinguishes pituitary tumors, meningiomas, and gliomas. The Glioma Classification Model categorizes gliomas' grades and types between oligodendrogliomas, astrocytomas, and glioblastomas 1-4. CereVis's core is the 3D Segmentation Model, achieving a 99.631% wIoU for precise tumor delineation. An intra-operative system of CereVis employs three scalpel detection models, with accuracies from 90% to 97.6%, providing real-time 3D tracking of the scalpel. Lastly, CereVis includes a system regulating laser temperature during laser ablation brain surgery through Adaptive Dynamic Programming. Additional implications of the segmentation model include monitoring the medication effects of size-reducing drugs. CereVis has the potential to revolutionize brain tumor removal by serving as a pre-operative planner that properly informs surgeons and assists them during surgery.

Awards Won:
Fourth Award of $500