INFO8010: Brain Cancer Detection Project Proposal

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I. INTRODUCTION

For this project, we propose to build a deep learning system that can detect brain cancer from MRI scans. Our system will process MRI images to determine the type of cancerous tissues, to assist radiologists with in-depth diagnosis. We will explore different deep learning architectures such as Convolutional Neural Networks, multi-head Transformers and AlexNet-based CNNs to achieve high accuracy. Additionally, we aim to extend the project with a user interface for easy usage and visualize the location of detected tumors within the MRI scans.

II. OBJECTIVES

- Develop a brain cancer detection system that processes MRI images and classifies them into one of the three classes: *Brain Glioma, Brain Meningioma, or Brain Tumor*.
- Explore and compare different architectures: CNN, multi-head Transformer, and AlexNet-CNN.
- (Nice-to-have) implement a user interface and Detect and highlight the specific region affected by cancer in the MRI image (could change architecture for that).

III. DATA AND METHODOLOGY

A. Data

We will use the **Bangladesh Brain Cancer MRI Dataset**, available at `https://www.kaggle.com/datasets/orvile/brain-cancer-mri-dataset`. This dataset consists of 6056 MRI images, uniformly resized to 512x512 pixels, categorized into three classes:

- Brain Glioma: 2004 images
- Brain Meningioma: 2004 images
- Brain Tumor: 2048 images

The images were collected from various hospitals across Bangladesh [1].

B. Methodology

1. Data Processing

- Preprocessing MRI images (resizing, normalization).
- Augmenting the data to increase variability and robustness.
- Splitting into training (80%), validation(10%), and testing(10%) sets.

2. Model Architecture

We will explore and compare the following options:

- **PRIMARY Option**: Simple CNN - Stack of convolutional and pooling layers followed by dense layers as propsed by [2] but with 3 classes.
- **Option 2**: Multi-head Transformer - Transformer encoder applied to image patches.
- **Option 3**: AlexNet-CNN - Based on the classic AlexNet architecture adapted for MRI images.

3. Evaluation

- loss error is just the cross entropy for the tree classes
- Accuracy, Precision, Recall, F1-score for classification performance.
- ROC-AUC curve analysis.
- (Optional) Intersection over Union (IoU) if region detection is implemented.

C. Infrastructure and Resources

- **Hardware**: A GPU-enabled machine for faster model training and evaluation(already allocated).
- **Environment**: Google Colab Pro or a dedicated GPU server.
- **Libraries**: PyTorch for model implementation, and probably OpenCV for image processing (optional).

[1] Rahman, Md Mizanur (2024), "Brain Cancer - MRI dataset", Mendeley Data, V1, doi: 10.17632/mk56jw9rns.1.

[2] Manali Gupta, Sanjay Kumar Sharma, G. C. Sampada, 12 October 2023, https://doi.org/10.1155/2023/2002855.