AI-Driven Multi-Class Brain Tumor Segmentation Using TransUNet

Project Presentation

Abstract

- This project focuses on automated multi-class brain tumor segmentation using a hybrid CNN + Transformer model (TransUNet).
- MRI sequences such as T1, T1-CE, T2, and FLAIR are used for tumor region detection. The model improves accuracy, localization, and multi-region segmentation while reducing manual effort.

Problem Statement

- Manual brain tumor segmentation is slow, time-consuming, and prone to human error.
- Many existing AI models struggle with multi-class segmentation (edema, core, enhancing tumor).
- Traditional CNN models fail to capture global context and shape variations.
- MRI variations (noise, intensity changes) reduce segmentation accuracy.

Existing System

- Existing models used for brain tumor segmentation:
- U-Net – strong localization but limited global feature extraction.
- V-Net – 3D segmentation but computationally expensive.
- 3D U-Net – captures spatial depth but training requires high GPU memory.
- CNN-based models – good low-level features but poor long-range dependencies.

Drawbacks of Existing System

- CNNs cannot capture global dependencies due to limited receptive fields.
- Poor performance on complex tumor boundaries.
- Struggle with multi-class segmentation (WT, ET, TC).
- Heavy training time for 3D models.
- Inconsistent performance on noisy MRI scans.

Proposed Solution – TransUNet

- Hybrid architecture: CNN (local features) + Transformer (global context).
- Handles multi-class segmentation more accurately.
- Better tumor boundary detection.
- Robust to MRI variations (noise and intensity changes).
- Faster and more accurate than traditional CNN-only models.

System Workflow

1. MRI Input (T1, T2, FLAIR, T1-CE).
2. Preprocessing – Normalization, Skull Stripping, Noise Removal.
3. TransUNet Model – Feature extraction + Transformer encoding.
4. Multi-Class Segmentation Mask Generation.
5. Visualization & accuracy evaluation.