40 Glaucoma Detection Using Advanced Image Segmentation Techniques

소속 정보컴퓨터공학부 분과 C 팀명 EPA 참여학생 Aldo Sigfrido Calderoni Echeverri, Mahboubeh Bagheri , 배민준 지도교수 황원주

Project Introduction

Introduction

- **Glaucoma** is a progressive eye disease affecting the optic nerve and is a leading cause of blindness.
- Early detection through **optic nerve head (ONH) analysis** is crucial.
- **Cup-to-Disc Ratio (CDR)** is an important metric used in diagnosing glaucoma.
- The need for **automated segmentation** arises from the challenges of manual segmentation.

Objective

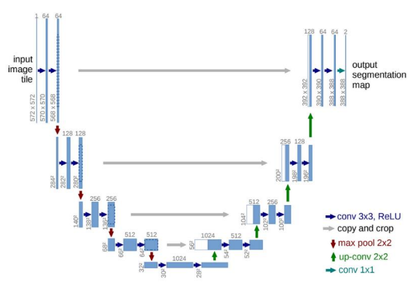
- Develop a **machine learning-based system** for automatic segmentation of optic cup and disc to measure the **Cup-to-Disc Ratio (CDR)** for early glaucoma diagnosis.

Model Architecture

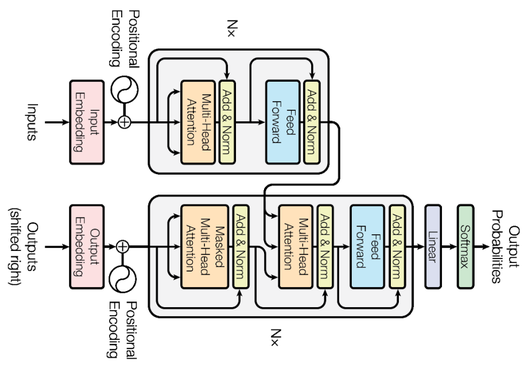
Base Architecture:

- **DC U-Net:** Combines dense connectivity with the U-Net encoder-decoder design, allowing for efficient feature reuse and precise region identification, particularly beneficial for limited datasets.

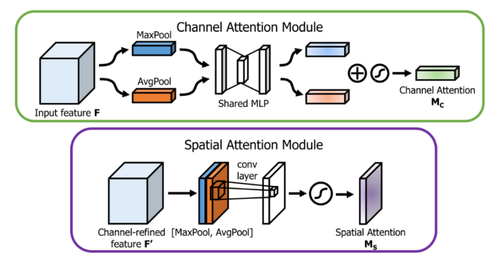
U-Net



Transformer



CBAM



Encoder Enhancements:

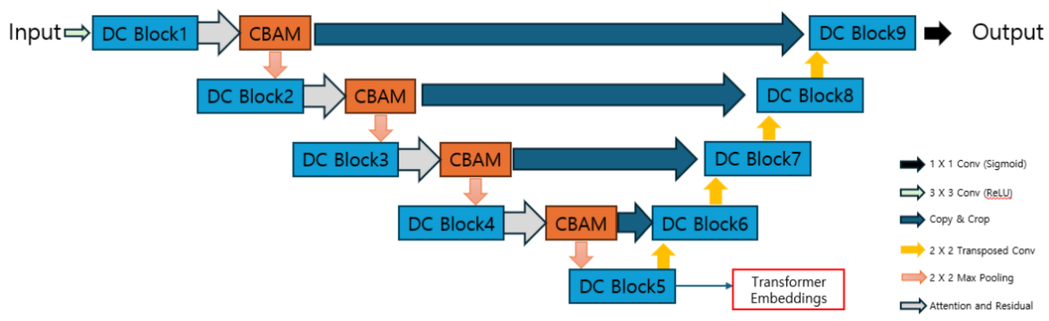
- **DC Blocks:** Utilize dilated convolutions to expand the receptive field and capture multi-scale information efficiently.
- **CBAM:** An attention mechanism that focuses on informative regions through channel and spatial attention.

Transformer Integration:

- **Patch Embedding**: Divides feature maps into patches for transformer processing.
- **Transformer Blocks:** Multi-head attention captures global context, and feed-forward networks improve representation and stability.

Decoder Enhancements:

- **Skip Connections:** Concatenate encoder features with decoder layers to retain spatial information.
- **Up-sampling:** Transposed convolutions progressively restore spatial dimensions.
- **Output:** A final convolutional layer with softmax activation generates pixel-wise class probabilities for segmentation.



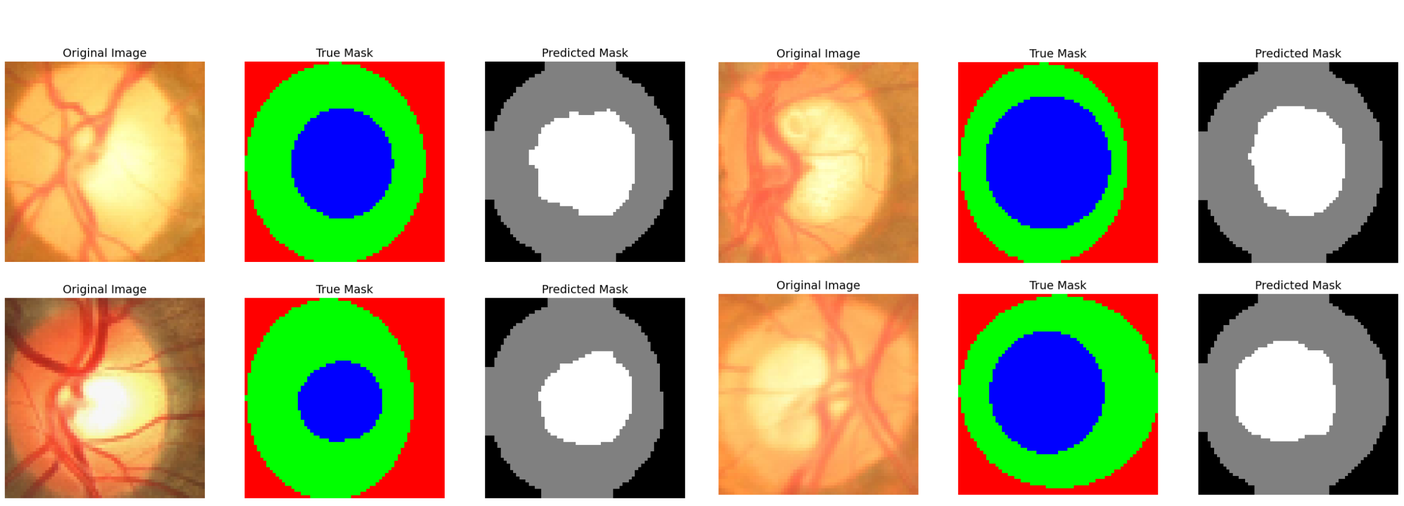
Application of CBAM and a hybrid of the DC-UNet with a Transformer-based mode

Results and Conclusion

- **Results:**

We evaluated our model against U-Net using accuracy, Intersection over Union (IoU), and Dice coefficient, and the results indicated:

Models	Pixel-Accuracy	IoU	Dice Coefficient
U-Net	0.9001	-	-
U-Net with CBAM	0.9064	0.8289	0.8812
ResUNet (Used ResNet34)	0.9001	0.7928	0.8722
DC-UNet with CBAM	0.8756	0.7788	0.8467
SegNet with CBAM	0.9043	-	-
TransDC-UNet with CBAM	0.8498	0.7403	0.7765



- **Conclusion:**

This research presented advanced techniques for glaucoma segmentation but did not achieve accuracy improvements over U-Net. Notable contributions include the integration of CBAM and transformer blocks, which enhance feature attention and capture long-range dependencies.

Future Directions:

- Increase the dataset size, as 2,000 samples were insufficient.
- Explore new preprocessing and data augmentation methods to enhance model performance.