MLP-based Unet for segmentation of carotid artery from transverse view images

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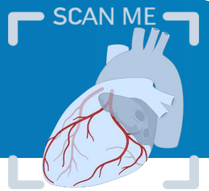
SCAN ME



سدرة للطب
Sidra Medicine

Introduction

Carotid artery is major artery transporting blood to the brain. Plaque buildup in the artery can be asymptomatic and if left untreated can lead to ischemic stroke. Automated ultrasound analysis can improve the diagnosis of carotid artery conditions.

We propose a method to localize the carotid artery which can be used to identify the lumen area & characterize it for plaque deposits using ultrasound images. An MLP based Unet is utilized for segmentation of the lumen boundary from transverse view images producing higher accuracy, dice and IoU (Intersection of union) compared to existing approaches.

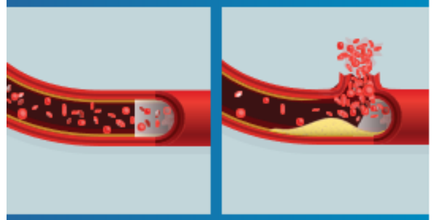


Figure 1. **Healthy artery and unhealthy artery with plaque formation & rupture.**

Method

UneXt[1], an MLP based Unet is utilized in this approach for efficient segmentation of carotid artery lumen area. It has an early convolutional stage and an MLP stage in the latent stage, with a tokenized MLP block that efficiently tokenizes and projects the convolutional features. Shifting the channels of the inputs also improves its performance by focusing on learning local dependencies. UneXt uses skip connections between various levels of encoder and decoder as shown in Figure 2.

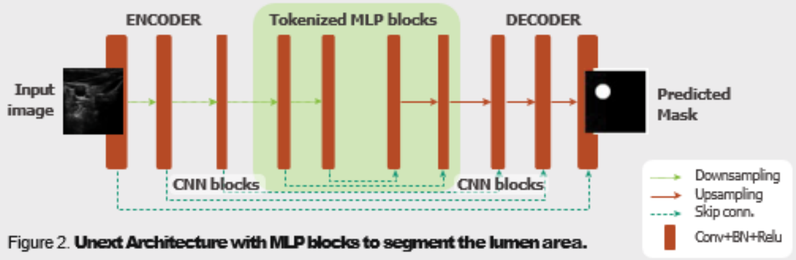


Figure 2. **Unext Architecture with MLP blocks to segment the lumen area.**

Materials

Table 1: **Dataset Description**

Device Description	#of images	US type
Toshiba	433	B-mode
Ultrasonix	558	B-mode

Table 1. is the set of transverse mode dataset used sourced from SPLab databased [2]. Figure 3., displays samples from the dataset and the artery area segmentation mask. The experiment was run on this dataset for 500 epochs with image size of 512x512 with batch size set to 2.

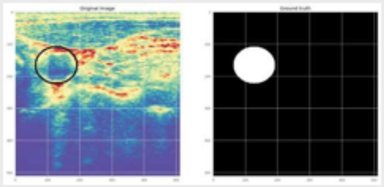


Figure 3. **Transverse view carotid artery US image with its ground truth.**

Results

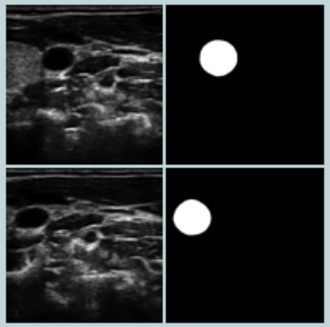


Figure 4. **Original images with generated masks after segmentation.**

Table 2. Is the evaluation result of the Unext performed for Toshiba generated images and the whole dataset consisting of ultrasonics images and Toshiba images.

Table 3. Compares the proposed method with that of traditional Unet.

Table 4. Presents the results compared with existing literature on the same data-set for media boundary segmentation.

Table 2. **Segmentation results of Unext.**

Dataset	IoU	Dice	Accuracy
Toshiba	82.72	90.54	98.81
Toshiba+ Ultrasonix	88.11	93.65	98.76

COMPARISON WITH EXISTING METHODS

Table 3. **Comparison with Unet.**

Dataset	Model	IoU	Dice	Acc.
Toshiba	Unext	82.72	90.54	98.81
Toshiba+Ultrasonix		88.11	93.65	98.76
Toshiba	Unet	68.2	83.7	98.3
Toshiba+Ultrasonix		78.17	87.12	98

Table 4. **Comparison with existing literature.**

Dataset	Model	IoU	Dice	Acc.
Toshiba+Ultrasonix	Unext	88.11	93.65	98.76
	[2]	85.34	91.78	99.29

Conclusion

Carotid artery segmentation was successfully achieved through an MLP based Unet.

High dice coefficient and IoU was achieved through this approach compared to Unet as shown in table 2, and existing literature on the same dataset as shown in table 3 demonstrating effectiveness of our approach.

Our model can help in identifying the lumen area from ultrasound images that can aid in further evaluation for early detection and diagnosis of carotid artery disease, a major risk factor for ischemic stroke.

With the growing availability of medical imaging data, deep learning models like ours have the potential to improve patient outcomes and contribute to the development of precision medicine.

Future work will involve automating the classification of the segmented area to identify the presence of plaque aiding in a complete pipeline for carotid artery risk stratification.

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Acknowledgement

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Reference

1. Valanarasu, J. M. J., & Patel, V. M. (2022, September). *Unext: Mlp-based rapid medical image segmentation network.* In Medical Image Computing and Computer Assisted Intervention–MICCAI 2022: 25th International Conference, Singapore, September 18–22, 2022, *Proceedings, Part V (pp. 23-33). Cham: Springer Nature Switzerland.*
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3. J. H. Gagan et al., *"Automated Segmentation of Common Carotid Artery in Ultrasound Images,"* in IEEE Access, vol. 10, pp. 58419-58430, 2022, doi: 10.1109/ACCESS.2022.3179402.

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