Exploring the Impact of Preprocessing Techniques in Retinal Blood Vessel Segmentation using Study Group Learning Scheme

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2nd December, 2023

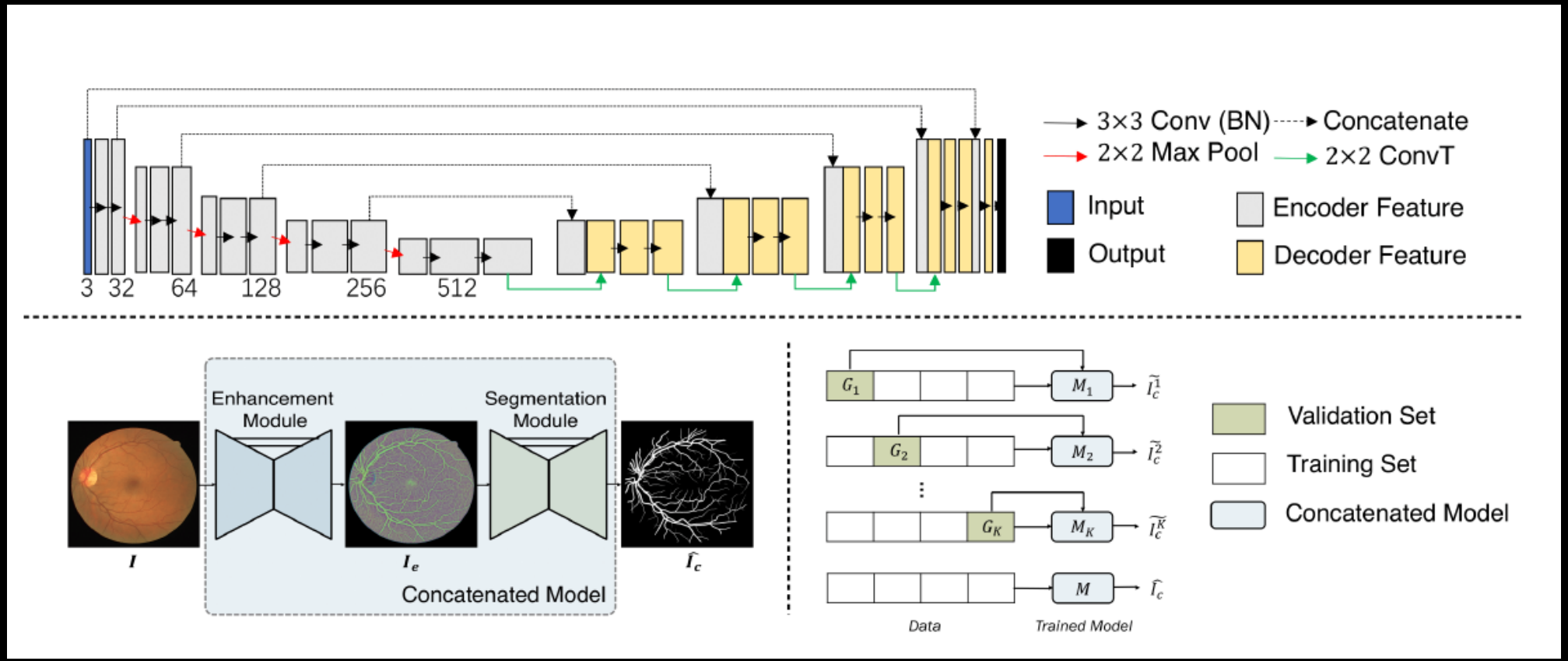
Vessel Segmentation

- Challenging Problem
- Complexity of Structures
- Variablity in Image Quality
- Noise
- Imbalanced
- Scale and Resolution

Literature Review

- U-Net
- VGN
- RV-GAN
- Multi-Level CNN
- Resnet

Study Group Learning Model



Preprocessing Methods

- Image Enhancement
- Histogram Equalization
- CLAHE
- Min-max
- Contrast Stretching

Datasets

- Drive
- CHASE
- HRF
- ISOTAR

Datasets	Train Images	Test Images
Drive	20	20
CHASE	20	8
HRF	15	30
IOSTAR	18	18

Results and Analysis

Performance Metrics	HRF	Drive	CHASE	IOSTAR
Accuracy	0.974	0.887	0.821	0.927
Sensitivity	0.916	0.66	0.907	0.852
Specificity	0.994	0.984	0.992	0.992
Vessel_iou	0.891	0.72	0.531	0.875
Dice	0.891	0.796	0.873	0.821

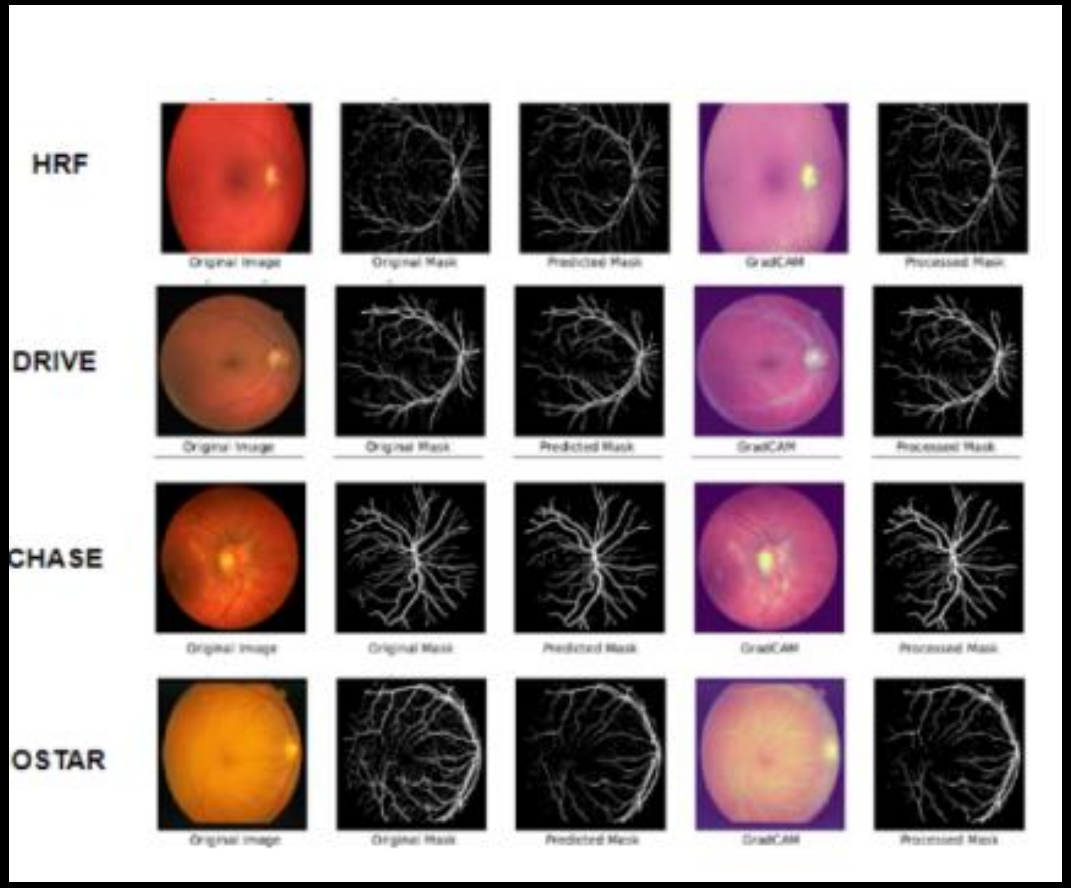
Comparison of SGL

Datasets	Metrics	SGL	CLAHE	Min-Max
HRF	Accuracy	0.9698	0.8802	0.9620
	Sensitivity	0.8566	0.7625	0.9154
	Specificity	0.9787	0.9441	0.9680
	AUC	0.9880	0.9812	0.9964
	Background_IoU	0.9677	0.8521	0.9604
	Vessel_IoU	0.6797	0.5741	0.6094
	Dice	0.8079	0.7187	0.7225
DRIVE	Accuracy	0.9659	0.9702	0.9987
	Sensitivity	0.8817	0.7927	0.6488
	Specificity	0.9738	0.9952	0.9996
	AUC	0.9883	0.9682	0.9991
	Background_IoU	0.9632	0.9685	0.9987
	Vessel_IoU	0.6862	0.7215	0.5001
	Dice	0.8134	0.8188	0.6412
CHASE	Accuracy	0.9716	0.9716	0.9908
	Sensitivity	0.9056	0.9056	0.8819
	Specificity	0.9761	0.9761	0.9979
	AUC	0.9906	0.9906	0.9986
	Background_IoU	0.9699	0.9699	0.9905
	Vessel_IoU	0.6681	0.6681	0.3352
	Dice	0.8003	0.8003	0.4572
IOSTAR	Accuracy	0.9705	0.8517	0.9621
	Sensitivity	0.8899	0.8253	0.7293
	Specificity	0.9794	0.9536	0.9871
	AUC	0.9873	0.9748	0.9986
	Background_IoU	0.9675	0.8175	0.9607
	Vessel_IoU	0.7523	0.5796	0.4937
	Dice	0.8535	0.7192	0.6347

Comparison with U-net like Models

Reference	Database	Precision	Sensitivity	Specificity	Accuracy	AUC
[20]	DRIVE	NA	0.8289	0.9838	0.9697	0.9837
	CHASE	NA	0.8365	0.9839	0.9744	0.9867
	IOSTAR	NA	0.8255	0.9830	0.9706	0.9865
	HRF	NA	0.8114	0.9823	0.9687	0.9842
[11]	DRIVE	0.8529	0.7963	0.9800	0.9566	0.9802
	CHASE	0.7630	0.8155	0.9752	0.9610	0.9804
	HRF	0.8593	0.7464	0.9874	0.9651	0.9831
[24]	DRIVE	NA	0.83	0.984	0.968	0.978
[25]	DRIVE	NA	0.7614	0.9837	0.9604	0.9846
	CHASE	NA	0.7993	0.9868	0.9783	0.9869
[21]	DRIVE	NA	0.7839	0.989	0.9709	0.9864
	CHASE	NA	0.7839	0.9894	0.9721	0.9866
[26]	DRIVE	NA	0.7941	0.9798	0.9558	0.9847
	CHASE	NA	0.8167	0.9704	0.9608	0.9865
[27]	DRIVE	NA	0.7921	0.9810	0.9568	0.9806
	CHASE	NA	0.7818	0.9819	0.9635	0.9810
	IOSTAR	NA	0.7322	0.9802	0.9544	0.9623
[28]	DRIVE	NA	0.7653	0.9818	0.9542	NA
	CHASE	NA	0.7633	0.9809	0.9610	NA
	HRF	0.6647	0.7881	0.9592	0.9437	NA
[22]	DRIVE	0.8335	0.7891	0.9848	0.9674	0.9836
	CHASE	0.8486	0.7559	0.9900	0.9738	0.9872
[29]	DRIVE	NA	0.7991	0.9813	0.9581	0.9823
	CHASE	NA	0.8239	0.9813	0.9670	0.9871
	IOSTAR	NA	0.7538	0.9893	0.9652	0.9859
	HRF	NA	0.7803	0.9843	0.9654	0.9837

Grad-CAM Visualization



Conclusion and Future Work

- Preprocessing methods improve the performance
- Larger Datasets are needed
- Domain Adaptation
- Knowledge Distillation