

DeepSnake: A Deep Convolutional-Snake Model Combination for Breast Ultrasound Image Segmentation



Existing Methods

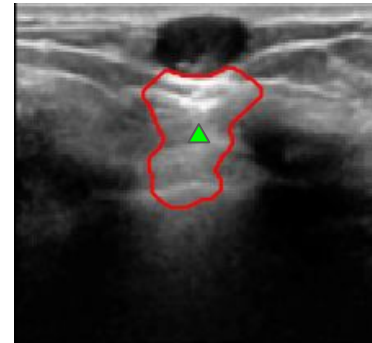
❖ Conventional Method - Active Contour Model

➤ Geodesic contour model, Snake Model, Active contour without edge(ACWE)

- Cons
 - Limitations related to initialization
 - Poor convergences



Ground Truth



AC model contour evolution

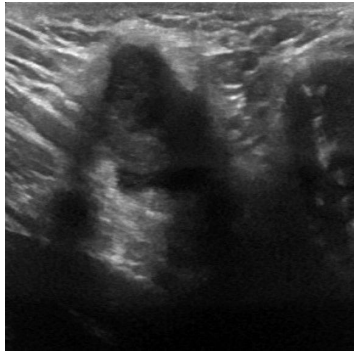
Existing Methods

❖ CNN-based Model

➤ FCN, UNet, SegNet, GSCNN, DeepLab V1-3

- Cons

- Shaky at preserving shape information, spatial resolution
- Rigid shaped mask generated



BUS image

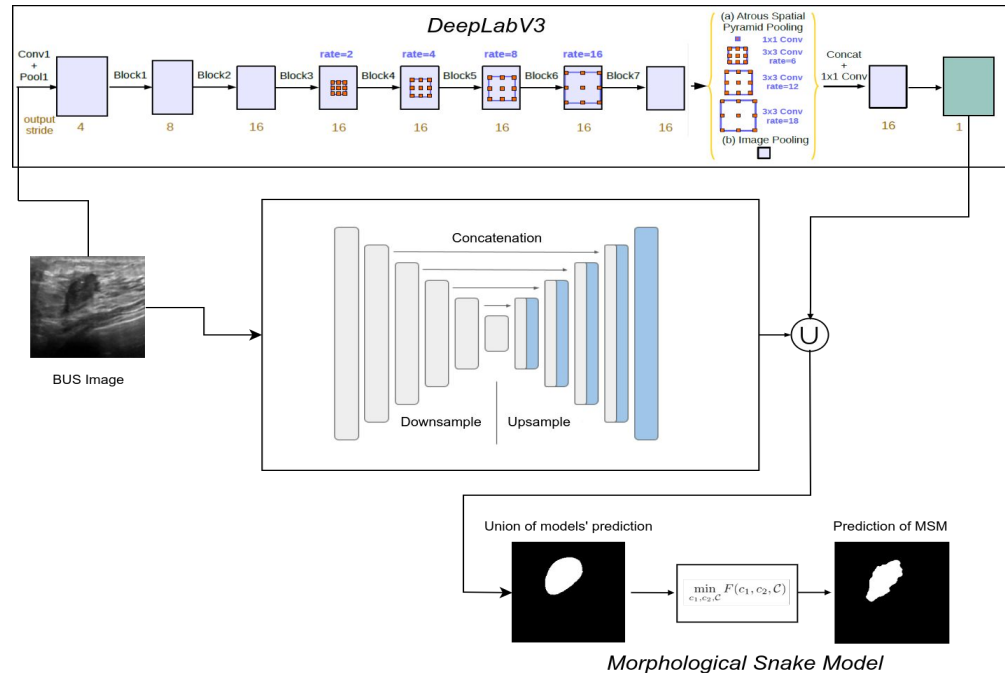


Ground Truth



Predicted output

DeepSnake : A Deep Convolutional-Snake Model Combination



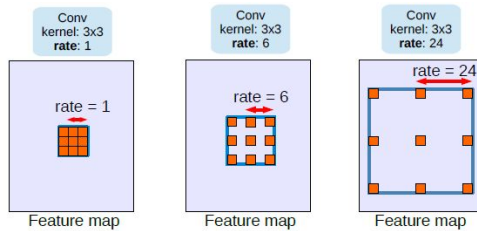
- Combination of CNN-based model and Morphological Snake model
- Pretrained UNet and DeepLabV3 are ensembled for localization of segmentation
- Morphological Snake model is added for better spatial resolution

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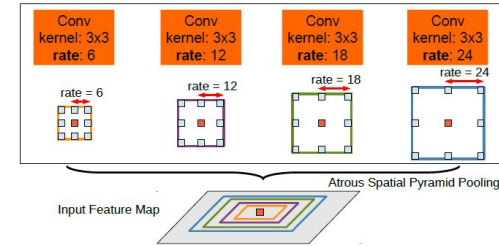
❖ DeepLabV3

- Tag Point

1. Atrous Convolution



2. Atrous Spatial Pyramid Pooling



❖ UNet

- Tag Point

1. Encoder

- 3x3 Convolution Layer
- 2x2 Maxpool Layer

2. Decoder

- Deconvolution layer with stride 2
- Concatenation with the corresponding cropped feature map from the contracting path

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❖ Morphological Snake Model¹

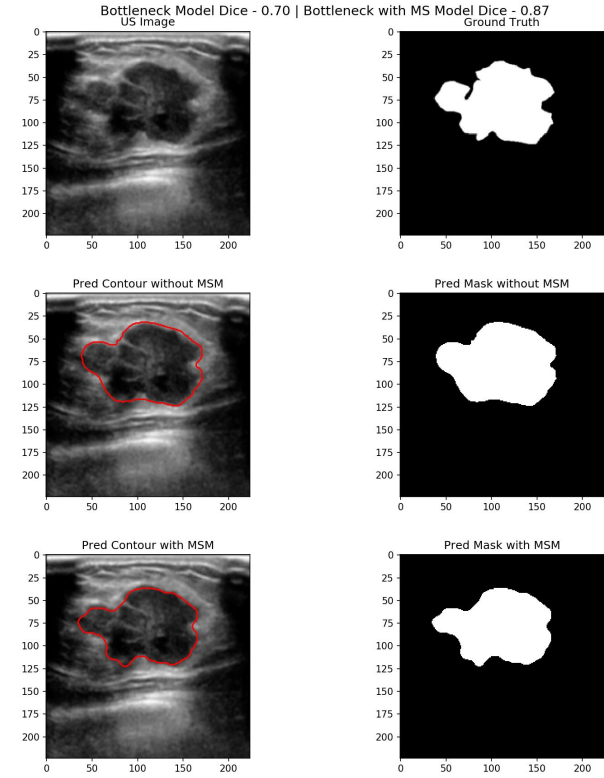
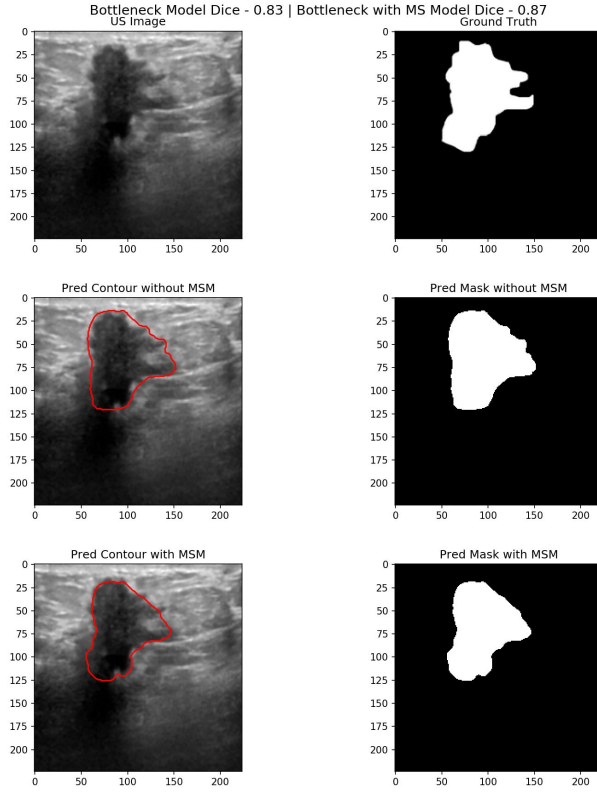
- Tag Point
1. Morphological Operator - erosion and dilation
 2. Uses Binary Image Operation

❖ Solved Problems

- Better spatial resolution then CNN-based model
- Initialization of active contour model
- Convergence of active contour model

1. Marquez-Neila *et al.* 2013

DeepSnake : Visualization



DeepSnake : Model Evaluation

❖ Dataset Used - BUSIS (Thailand) and BUSI (Egypt)

- Trained on BUSI train set(600 images)
- Tested on both BUSI and BUSIS test set
- Mean IoU(%) and mean Dice coefficient(%) are the evaluation metrics

Comparison of CNN-based models on BUSI test set

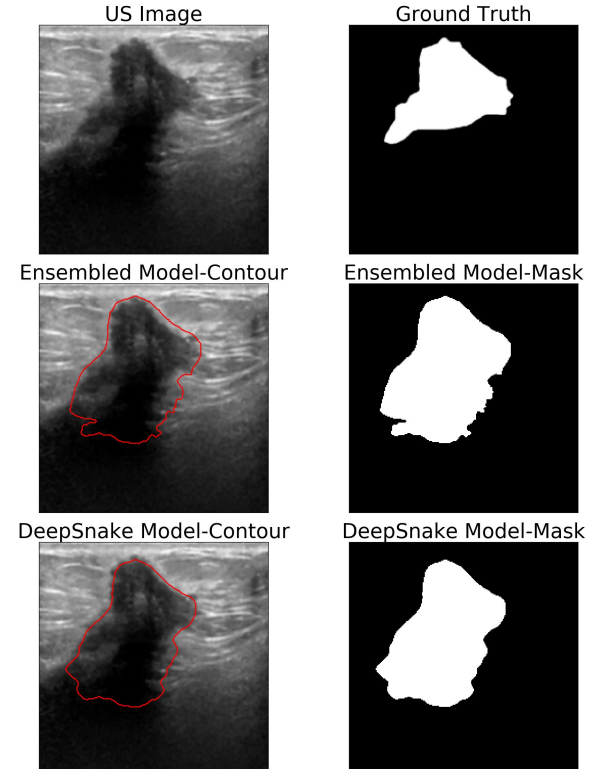
<i>Model Name</i>	<i>mDice</i>
SegNet	56.6
DeepLabV3	60.1
FCN	46.2
UNet	62.7
GSCNN	59.1

Comparison of performance on both BUSI and BUSIS test set

Model Name	BUSI test set				BUSIS test set			
	mDice	mIoU	pixel	bf	mDice	mIoU	pixel	bf
SegNet[Badrinarayanan et al.]	56.6	10.2	68.3	22.1	66.9	13.1	66.7	8.7
UNet[Ronneberger et al.]	62.7	11.1	67.1	30.2	66.8	12.1	65.1	9.1
DeepLabV3[Chen et al.]	60.1	9.8	72.4	26.9	64.3	12.4	68.3	5.4
Ensembled model	61.7	46.6	67.1	28.6	68.0	51.8	70.3	7.5
Ensembled model with MSM	63.5	53.1	68.1	22.3	72.7	63.3	75.3	9.2

DeepSnake : Limitations

- BUS image with high shadow got our proposed method confused sometimes. GAN can be used to automatic detect shadow from US image
- Morphological Snake Model's hyper-parameter can be made learnable.



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Questions?