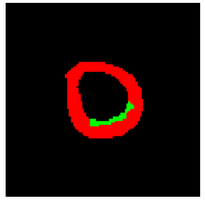
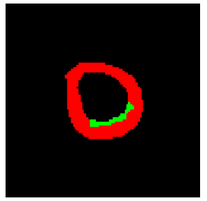


A deep learning approach for the segmentation of myocardial diseases



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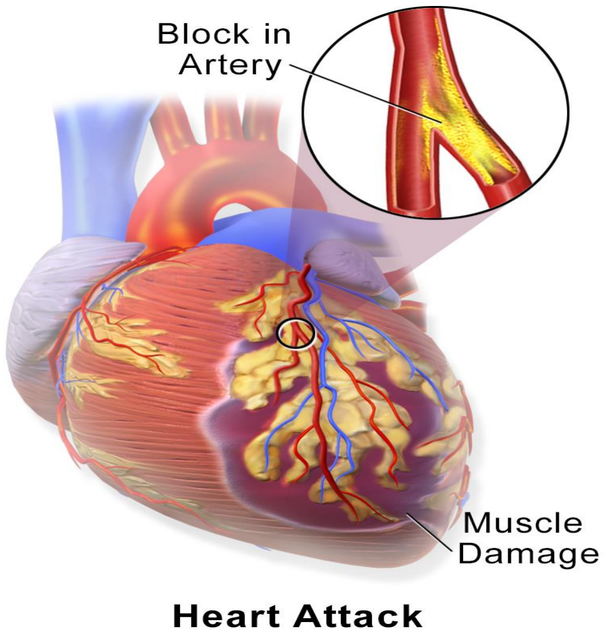
ICPR: International Conference on Pattern Recognition, Milan, Italy (10| 15 January 2021)

Table of Content

1 Introduction



Heart Attack

Introduction

- Myocardial infarction (MI) is an important cause of death worldwide.
- Late gadolinium enhancement (LGE) MRI is highest resolution technique to assess the myocardium and myocardial infarction

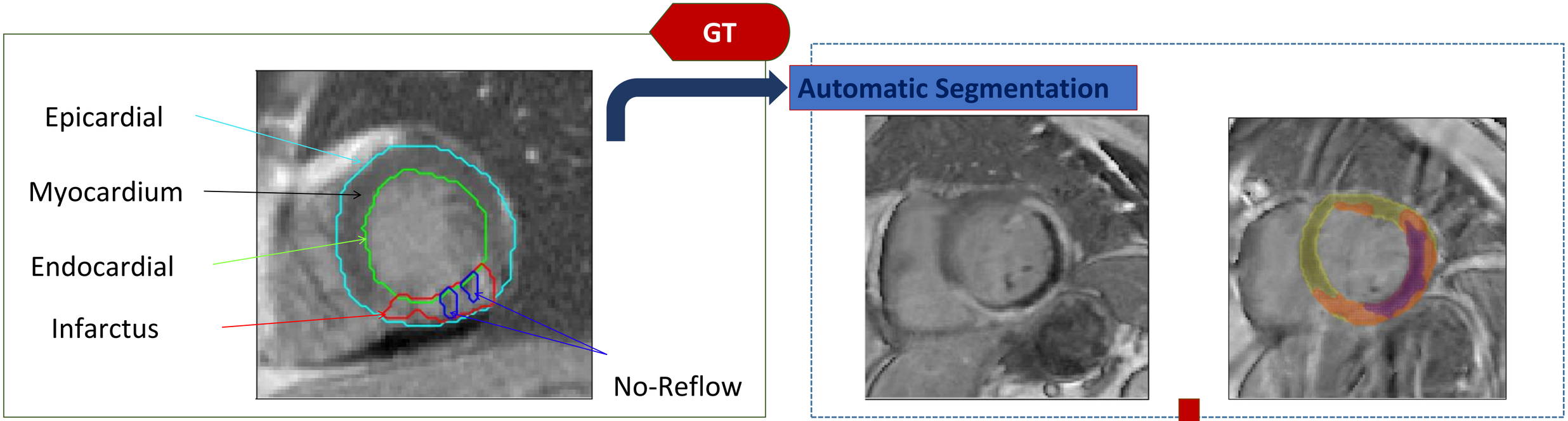
Challenges

- Brightness heterogeneities due to the non-homogeneous
- Partial volume effects
- Inherent noise due to motion artefacts and heart dynamics
- The presence of banding artefact

Solution

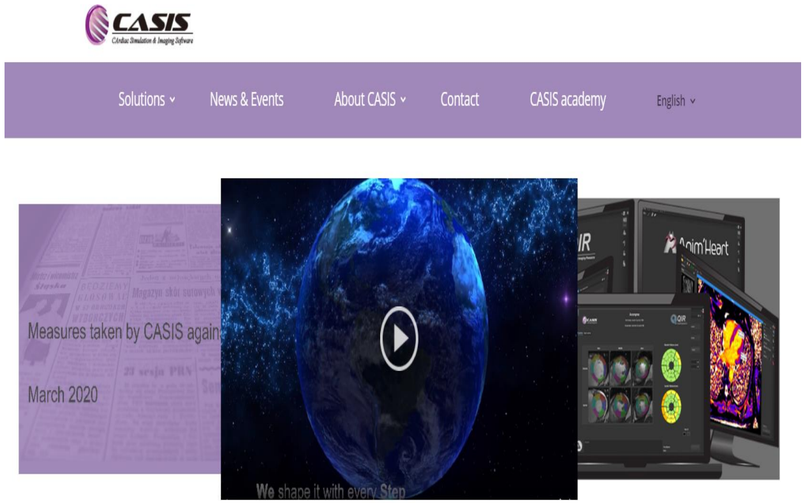
- This work aims to develop an accurate automatic segmentation method based on deep learning models for the myocardial diseases borders on LGE-MRI

1 Introduction



- **Motivation**
  1. Analysis of Myocardial Viability
  2. LGE-MRI is a valuable tool for MI assessment
  3. Myocardium Segmentation

2 Data Acquisition & Pre-processing



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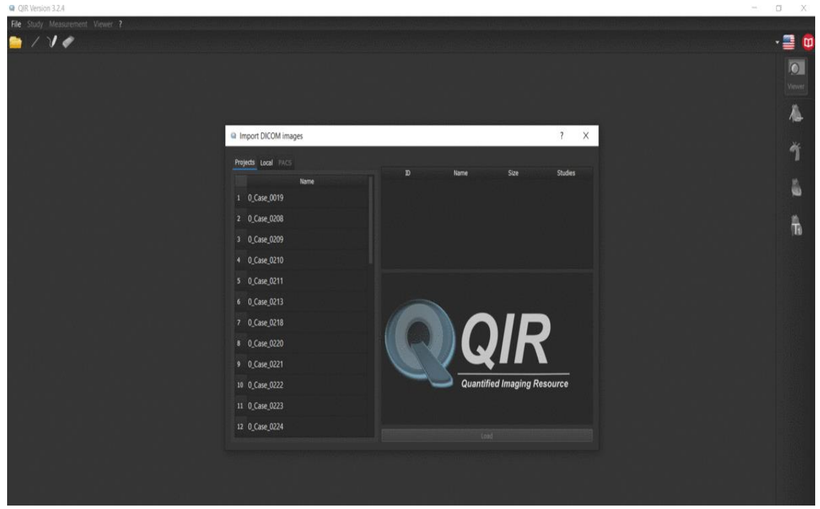


Fig. 1. LGE-MRI raw image processed and manual contouring

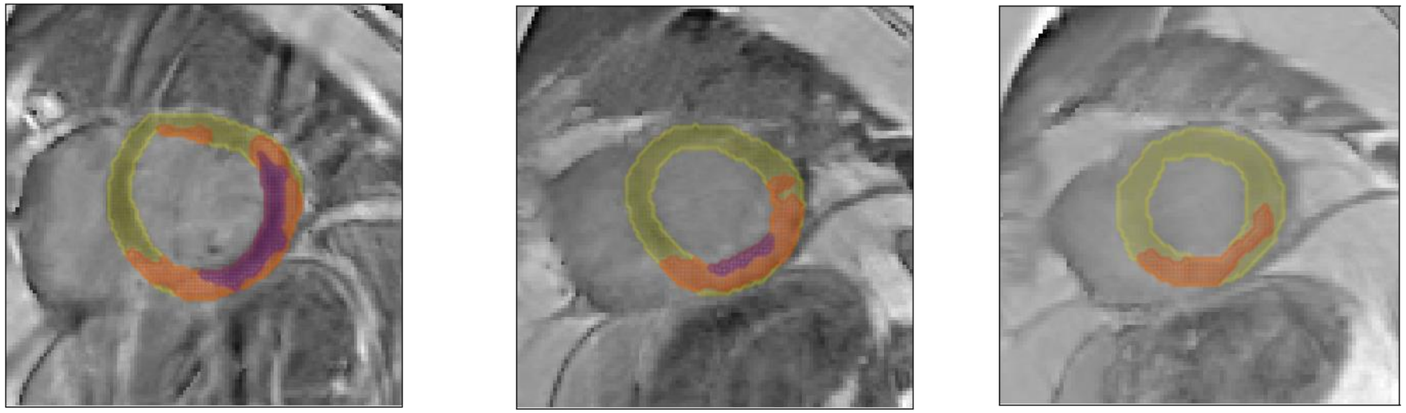
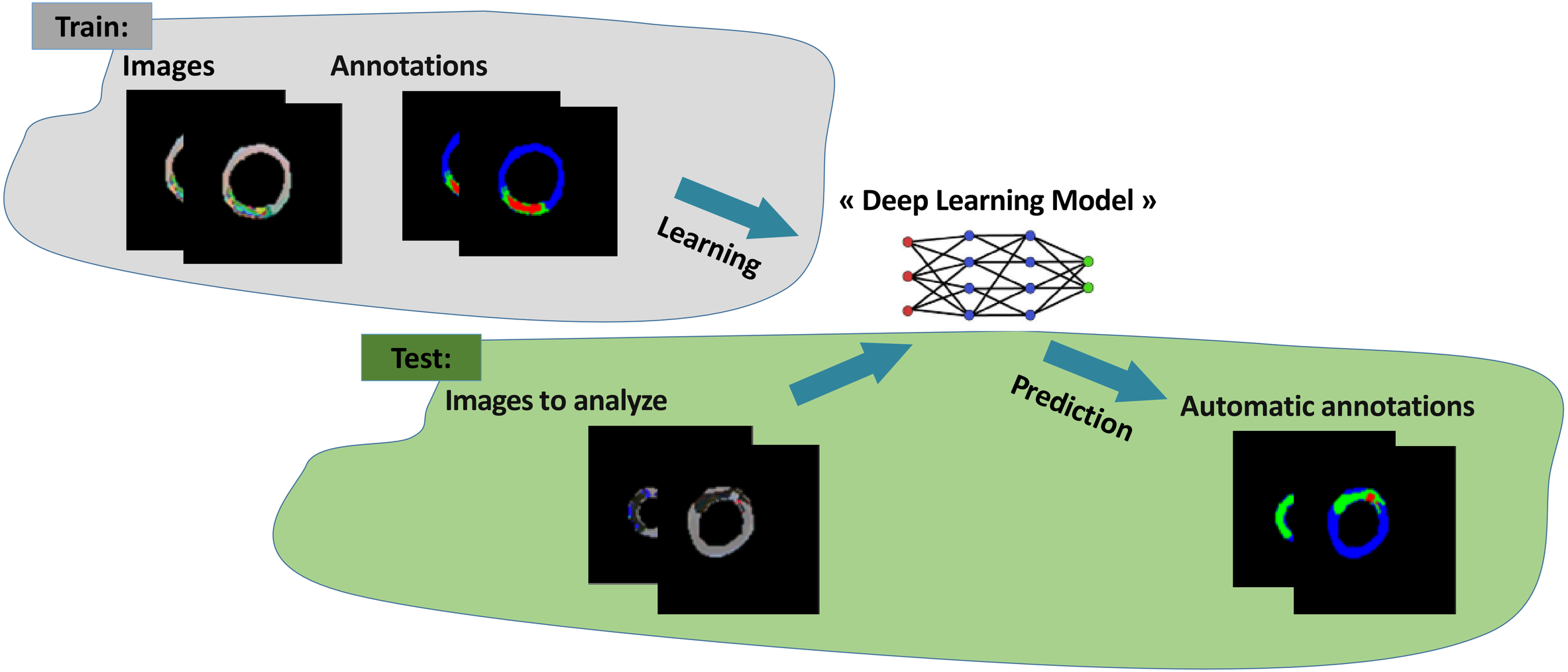


Fig. 2. Myocardium Segmentation (Myocardium area (yellow), MI area (red), No-reflow area (blue))

3 Methodology



2.5D SegU-Net Architecture:

- Built on a typical **Convolutional Neural Network (CNN).**

- Fine and coarse features preservation through concatenation of layers.

- Skip connection **[[1]Ronneberger et al]** and Max Pooling Indices **[[2]Badrinarayanan et al]** are integrated for restoring spatial pixel information of the image.

[1]Ronneberger et al [Ronneberger, O., Fischer, P., Brox, T. : U-net: Convolutional networks for biomedical image segmentation. In International Conference on Medical image computing and computer-assisted intervention, Springer, pp. 234–241. (2015).]

[2]Badrinarayanan et al [Badrinarayanan, V., Kendall, A., Cipolla, R. : Segnet: A deep convolutional encoder-decoder architecture for image segmentation. In IEEE transactions on pattern analysis and machine intelligence, 39(12), pp.2481–2495. (2017).]

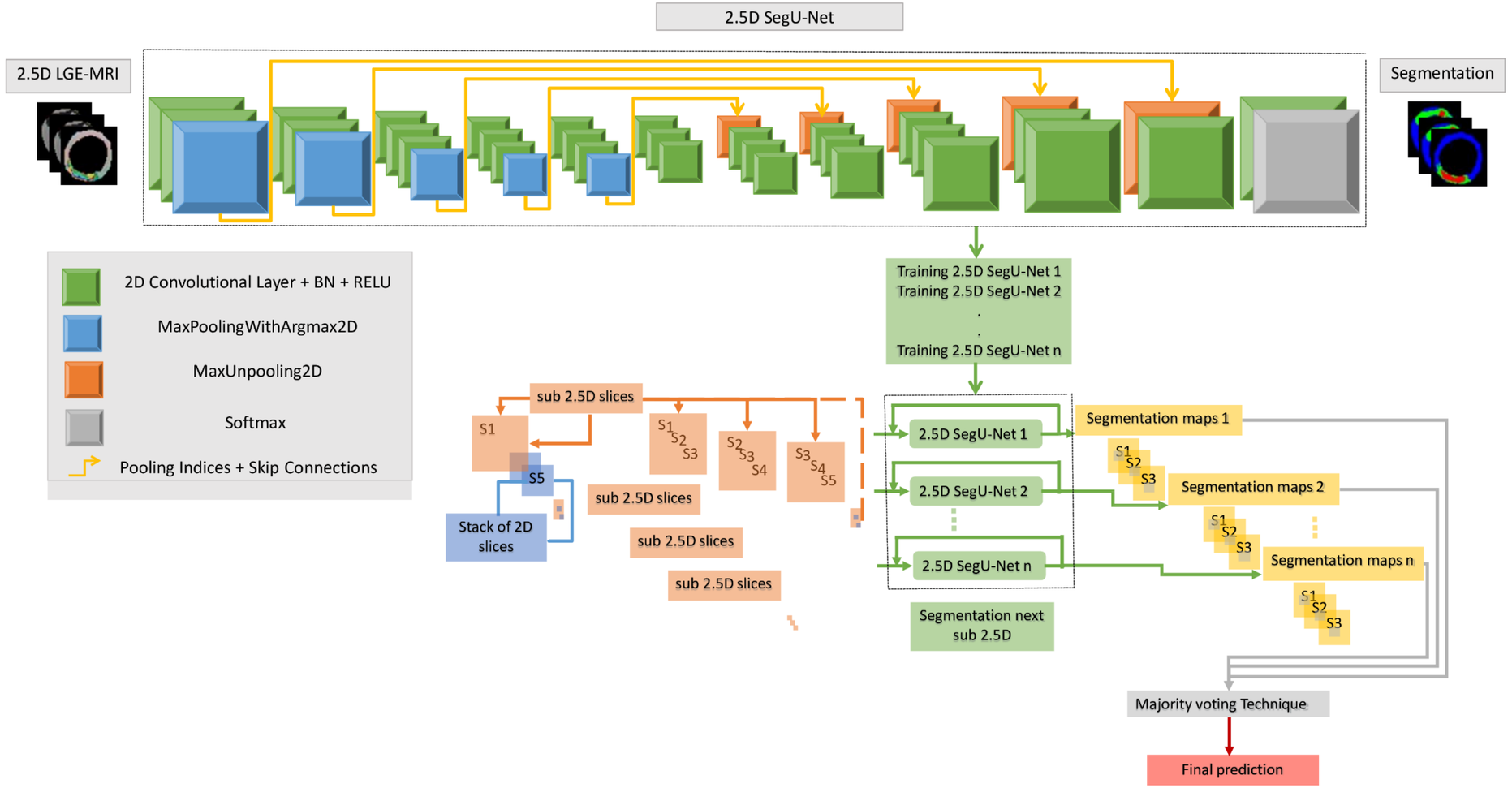


Fig. 3. Architecture of the proposed 2.5D SegU-Net model based on late-combination technique for myocardial scar segmentation.

4 Qualitative Results

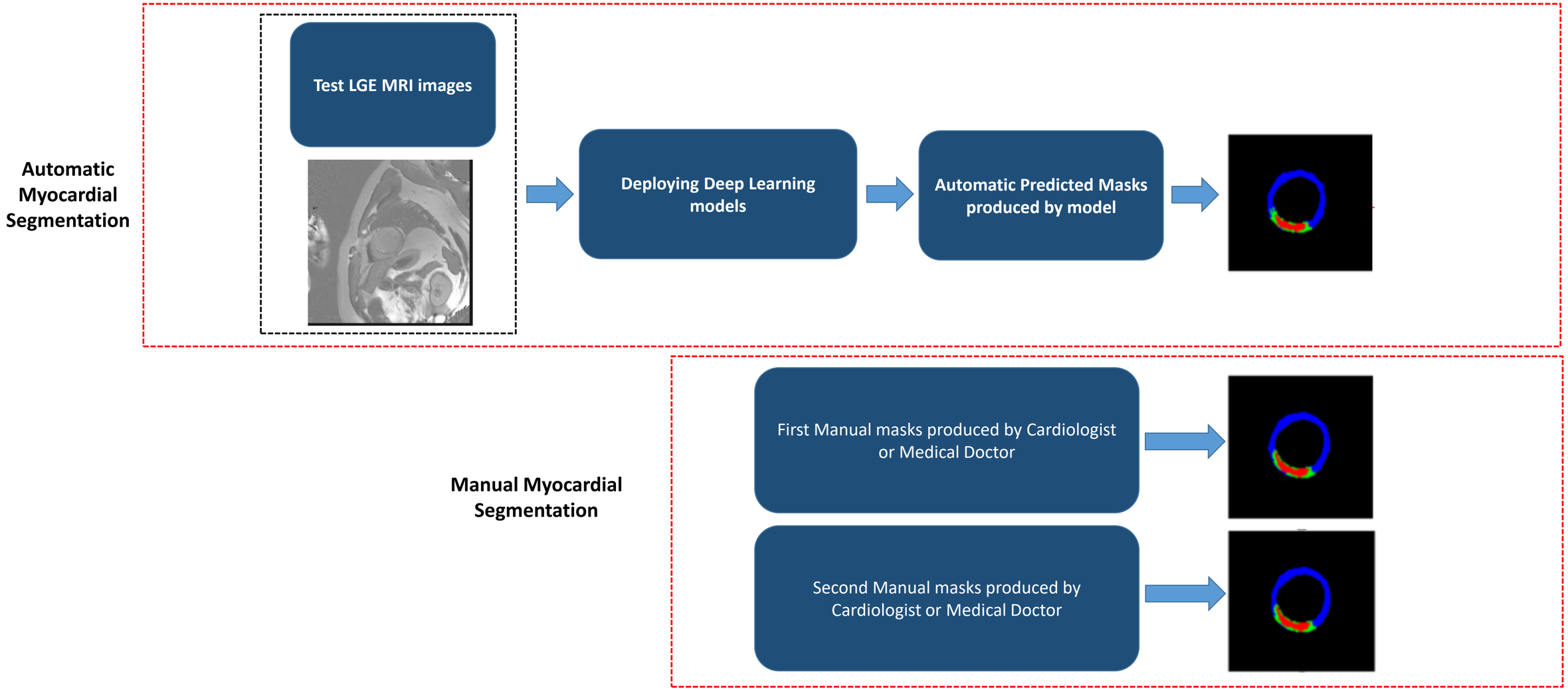


Fig. 4. Deployment of Proposed Model

4 Qualitative Results

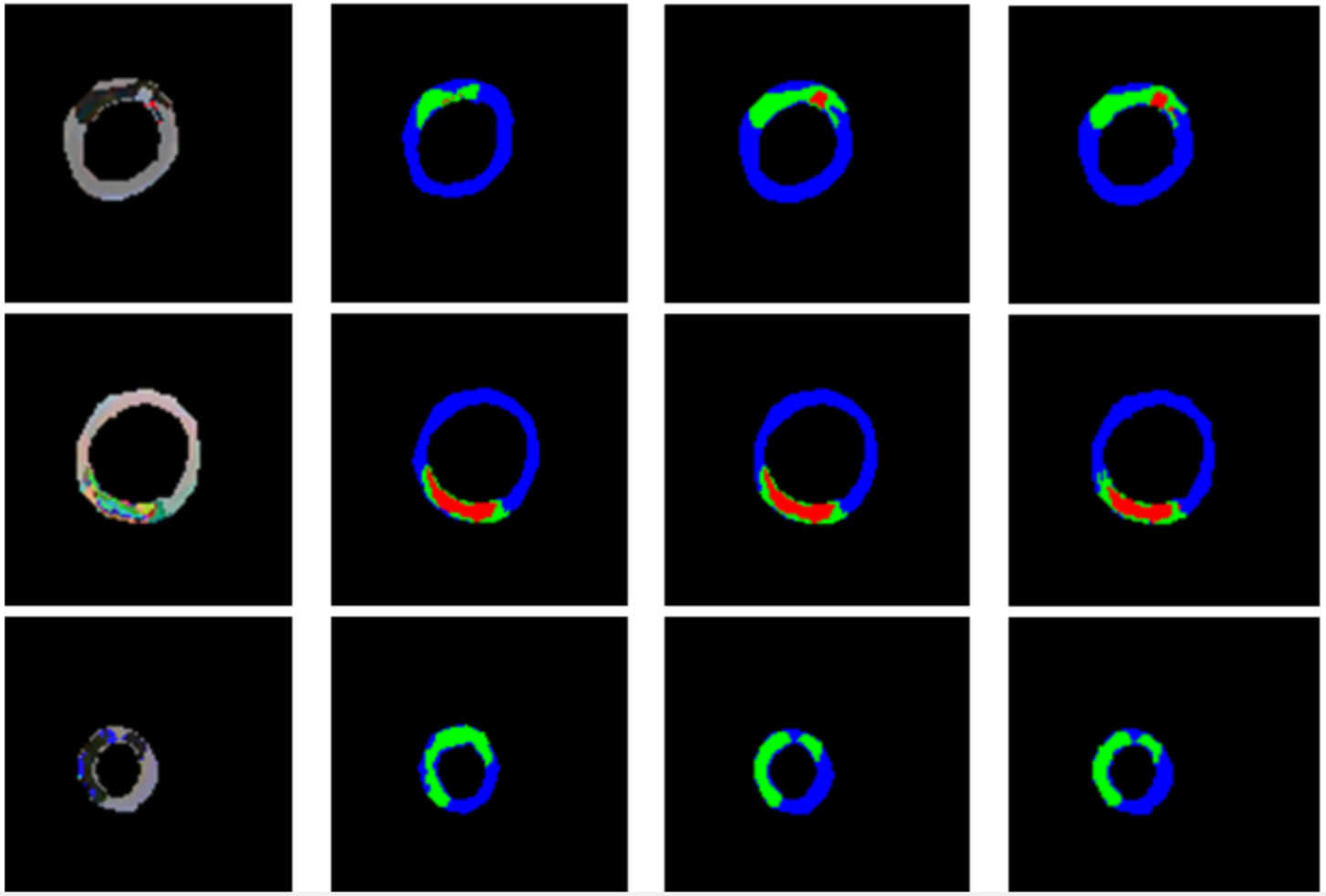
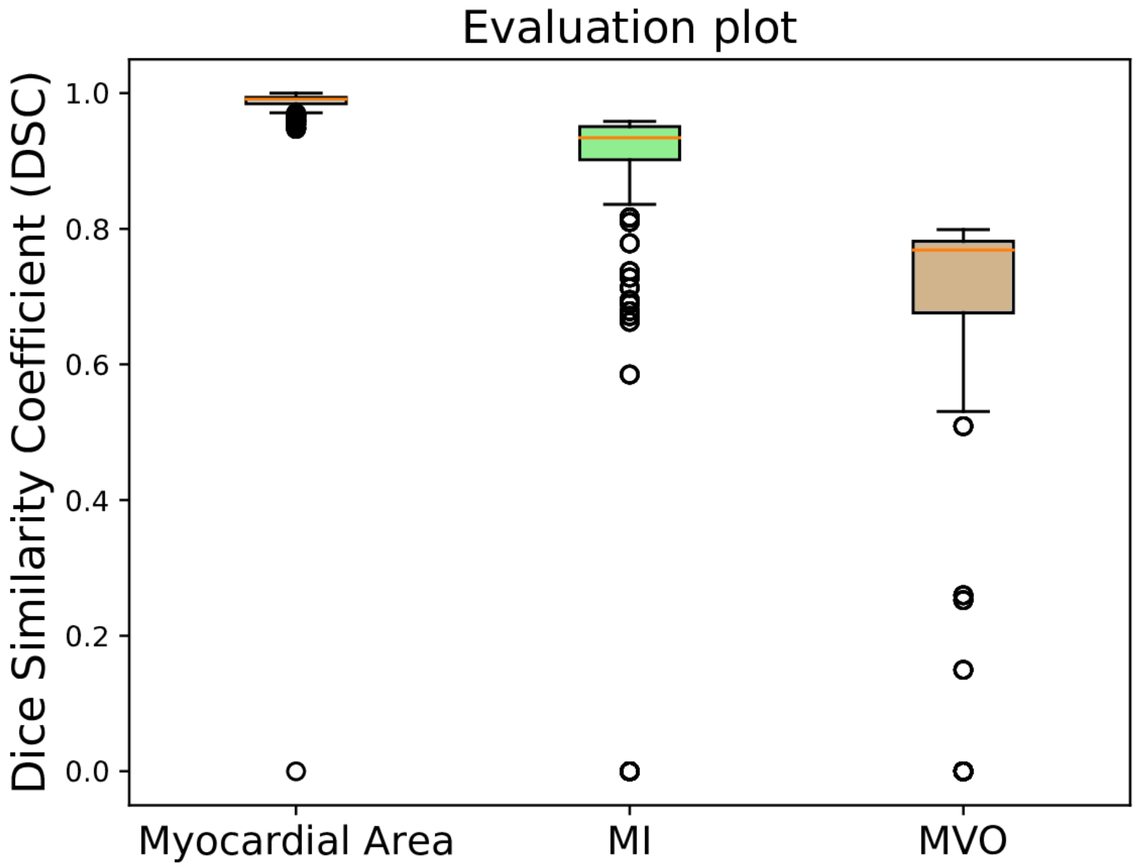


Fig. 5. Three slices from three different input patients. From left to right: 2.5D Input images, First intra ground-truth , Second intra ground-truth, and 2.5D SegU-Net generated-result (Myocardium area (blue), MI area (green), no-reflow area (red))



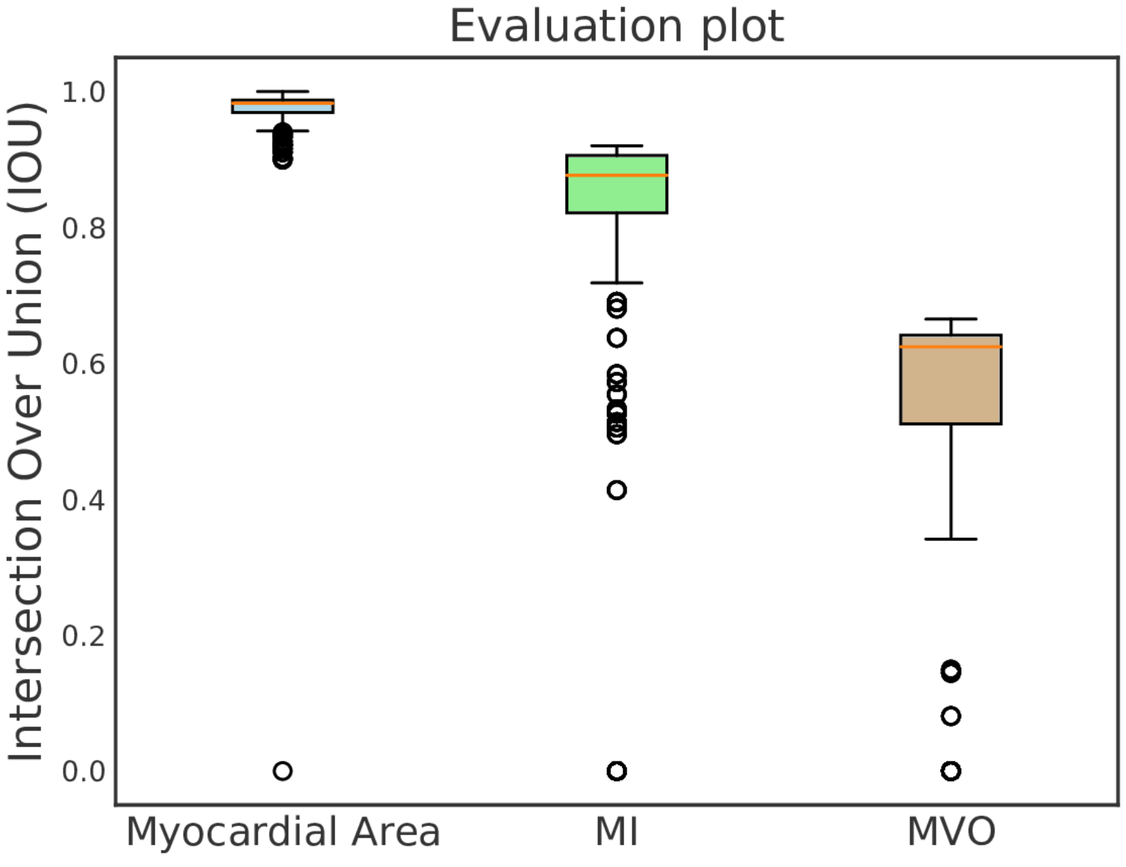


Fig. 6. Boxplots of the evaluation of the performance for the final SegU-Net model. From left to right: Dice similarity coefficient, and Intersection Over Union

4 Qualitative Results

Method	Metrics	Structures			
		Background	Myocardium	Infarctus	No-reflow
Our proposed model	IOU	**0.99998**	**0.98874**	**0.91547**	**0.64371**
	Accuracy	**0.99999**	**0.99873**	**0.96273**	**0.91972**
	DSC	**0.99999**	**0.99434**	**0.95587**	**0.78324**
2D DenseNet-121	IOU	0.99984	0.95443	0.73963	0.31258
	Accuracy	0.99989	0.99467	0.85563	0.82690
	DSC	0.99992	0.97668	0.85033	0.47628
2D UNet	IOU	0.99737	0.74302	0.19792	0.00459
	Accuracy	0.99861	0.90564	0.41232	0.74867
	DSC	0.99868	0.85257	0.33044	0.00913
2D Xception-residual	IOU	0.99257	0.80819	0.20069	0.0000
	Accuracy	0.99262	0.92750	0.91291	0.74762
	DSC	0.99627	0.89392	0.33429	0.0000
2D BCDU-Net-D3	IOU	0.99761	0.82020	0.11265	0.0000
	Accuracy	0.99963	0.91314	0.33900	0.74762
	DSC	0.99881	0.90122	0.20249	0.0000
2D ResNet	IOU	0.99980	0.80202	0.0000	0.0000
	Accuracy	0.99996	0.99254	0.21429	0.74762
	DSC	0.99990	0.89014	0.0000	0.0000
2D ENet	IOU	0.99956	0.77503	0.0000	0.0000
	Accuracy	0.99993	0.96345	0.21429	0.74762
	DSC	0.99978	0.87326	0.0000	0.0000
2D ICNet	IOU	0.99030	0.27225	0.0000	0.0000
	Accuracy	0.99824	0.31130	0.21905	0.77619
	DSC	0.99513	0.42799	0.0000	0.0000

(a). Quantitative evaluation for myocardial segmentation in LGE-MRI

Local measures	Myocardium	Left Ventricle	Right Ventricle
IOU	0.75360	0.78380	0.94241
Accuracy	0.80848	0.95228	0.93370
DSC	0.85949	0.87880	0.97035

(b). Results. SegU-Net values on MS-CMRSeg 2019 Dataset

Table. 1. Performance evaluation for proposed deep learning model

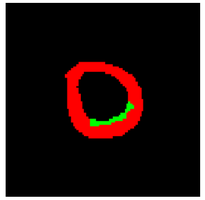
- Conclusion -

- We have proposed a novel fully automated model with 2.5D strategy for myocardium and myocardial diseases segmentations from LGE-MRI.
- The proposed model perfectly segments damaged myocardial areas of different subjects.
- Majority voting technique and morphological mathematics post-processing are applied to increase sensitivity for quantifying scarred areas.

- Perspectives -

- Three-dimensional convolutional neural network will be proposed to further LGE-MRI detection of viable myocardial segments

Thanks for your attention



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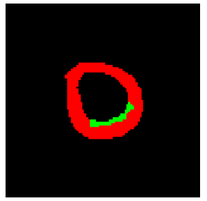

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