Iowa Initiative for Artificial Intelligence

Final Report

Project title:	Accelerated free breathing LGE for early detection of Pulmonary Hypertension
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Other investigators:	
Date:	

Were specific aims fulfilled:	N
Readiness for extramural proposal?	N
If yes … Planned submission date	
Funding agency	
Grant mechanism	
If no … Why not? What went wrong?	Free breathing Image mismatch with Dicom Image and small number of data.

Brief summary of accomplished results:

Due to image mismatch between Sense reconstruction of free breathing MRI and ground truth Phase Sensitive Inversion Recovery (PSIR) Image and small number of data, the machine learning model results for testing data were not good.

Research report:

Aims (provided by PI):

1. Deep learning-based reconstruction of Phase Sensitive Inversion Recovery(PSIR) Motion Corrected (MOCO) LGE to reduce the acquisition of free breathing Late gadolinium enhancement (LGE) data.

2. Preliminary evaluation of the proposed reconstruction algorithms by comparing to ground truth PSIR LGE.

Data:

67 patients free breathing MRI were acquired in the study. 7 patients data can't be exported using twixtool and 17 patients' orientation were not matched with others. 43 patients were left after preprocessing step.

AI/ML Approach:

In this study, U-net model was implemented for generating reconstruction image using Python. Training/validation split was 75/25% (32/11 patients). Each slice of each case was treated separately due to small data set. Total of 321 and 143 slices were used for training and

validation. The Structural Similarity Index (SSIM) [1] was used to quantify the agreement between prediction and ground truth. Ground truth was reconstruction image of free breathing from Siemens.

Experimental methods, validation approach:

Data preparation

Data preparation or pre-processing is an essential step in any machine learning study. In this project, we readed in datasets using python library twixtool and computed 6 phases Sense reconstruction image using Python library Sense. Second phase and ROI were selected based on largest ssim compared with ground truth. The input was downsampled to (128,128) to save computation time.

Unet

The Unet is convolutional network architecture for fast and precise segmentation of images. In this project, Unet was implemented with Keras functional API, which makes it extremely easy to experiment with different interesting architectures. (https://github.com/zhixuhao/unet).
Input was the prepressed sense reconstruction images. Output from the network is a 128x128 ground truth PSIR LGE. Loss function was changed to SSIM to quantify similarity between prediction and ground truth.

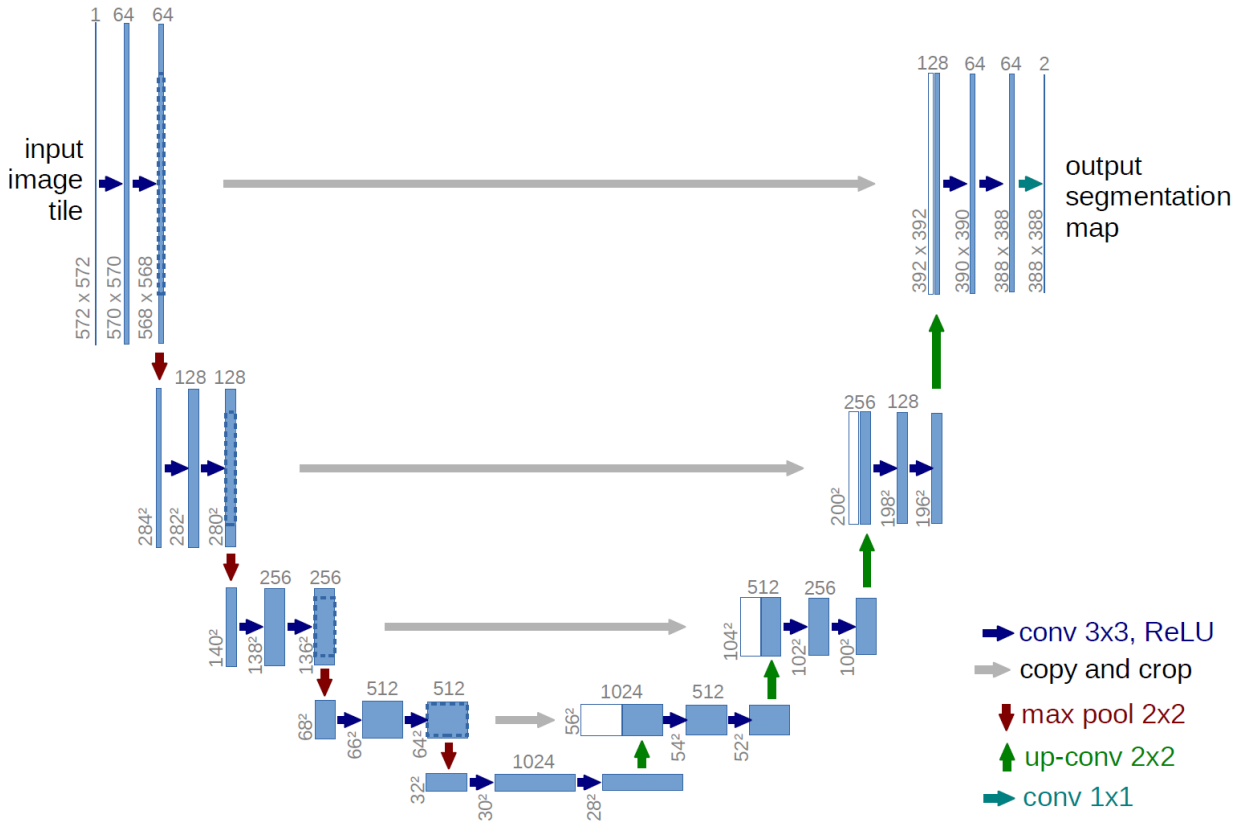

Figure 1. U-net architecture [2]

Results:

SSIM achieved in the training datasets was 0.97 and in the testing datasets was 0.01. The main issue is mismatch of size and orientation of different patients. Registration didn't solve this issue because it requires same size of input and output image and it can't rotate the image sufficiently in order to change its orientation completely. The other issue is very small number of patients datasets.

Ideas/aims for future extramural project:

None – PI's leaving UI.

Publications resulting from project:

None

References

1. Wang, Zhou; Bovik, A.C.; Sheikh, H.R.; Simoncelli, E.P. (2004-04-01). "Image quality assessment: from error visibility to structural similarity". IEEE Transactions on Image Processing. **13** (4): 600–612
2. O. Ronneberger, P. Fischer, and T. Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation," Med. Image Comput. Comput. Interv. -- MICCAI 2015, pp. 234–241, 2015.