IMAGE SEGMENTATION FOR HEART USING DEEP LEARNING

The University Of Sheffield.

By: Valentin Craciun

Supervised by: Dr. Haiping Lu

Introduction

Cardiovascular diseases (CVD) represent the problems related with heart or blood vessels. Based on the reports published by World Health Organization about 17.9 million people died from CVDs in 2019 representing 32% of all global deaths. Furthermore, United Kingdom the mortality rate was 255 deaths in 100,000 people **[1][2].**

Background

Artificial neural networks are used for predictive modeling, the self-learning process resulting from allowing the network to train itself over a number of epochs. Neural networks contain an input layer, a set of deep hidden layers and an output layer.

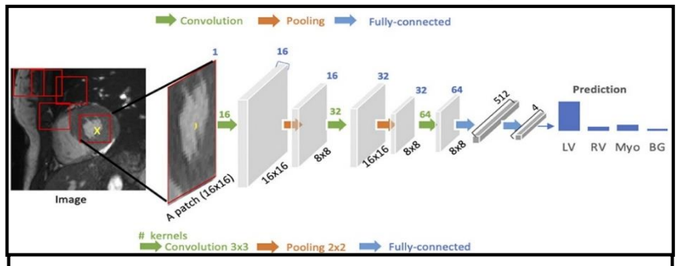

Fig 1. Convolutional Neural Network ***[3]***

Segmentation is the process of dividing a digital image into multiple sub-areas in order to be easier to analyze while keeping relevant information from the input image.

There are multiple ways to achieve image segmentation: thresholding, grouping similar regions by values, bounding all the pixels delimited by a contour in a class and neural networks.

Method

Program flow:

- split the dataset (training 85% and testing 15)
- apply normalization
- train convolutional neural network (U-Net architecture)
- post processing output enacement
- left atrium volume, 3D cloud points, overlays

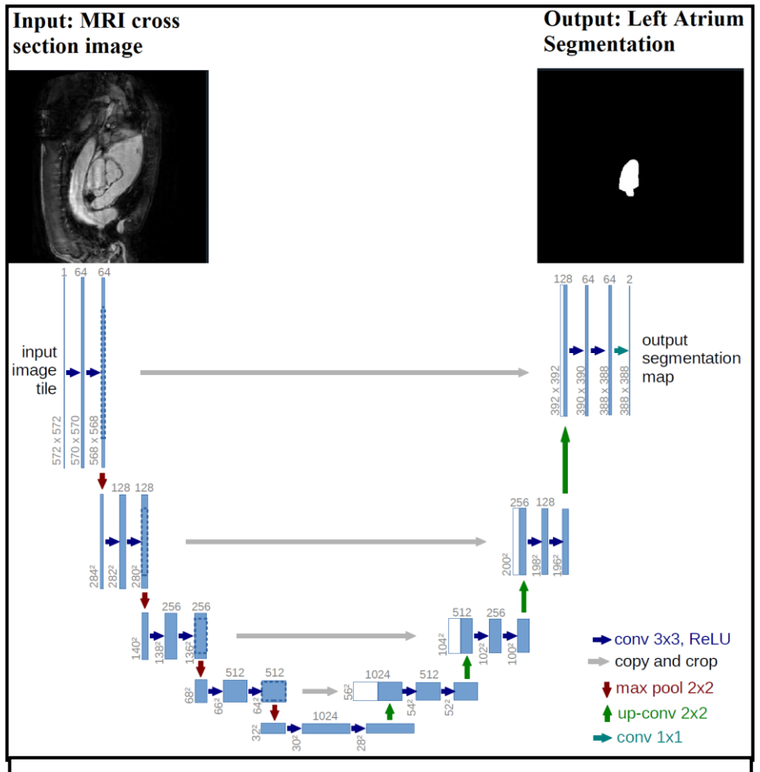

Fig 2. U-Net – the process to from MRI segmentation ***[3]***

Results

Accuracy obtained: **87.97%**

Training time: **9 minutes and 20 seconds**

```
Patient(0) Output volume: 10902.0 mm^3 ||  True volume: 10219.0 mm^3
Patient(1) Output volume: 12323.0 mm^3 ||  True volume: 11348.0 mm^3
Patient(2) Output volume: 17742.0 mm^3 ||  True volume: 18865.0 mm^3
==========
Patient(0)  Output volume: 10.902 ml ||  True volume: 10.219 ml
Patient(1)  Output volume: 12.323 ml ||  True volume: 11.348 ml
Patient(2)  Output volume: 17.742 ml ||  True volume: 18.865 ml
```

Fig 3. Volume comparison using the segmentation images

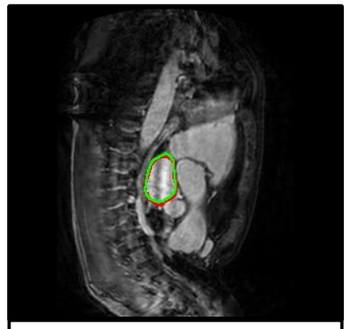

Fig 4. Overlay output compared to ground truth

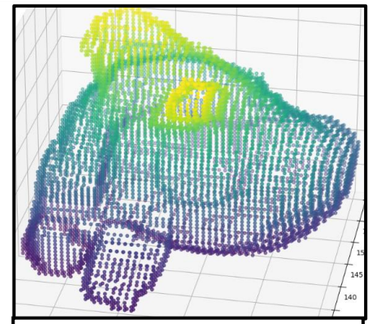

Fig 5. Intractable 3D point cloud volume

Novel Contributions

- **Training speed increased** from 8h to 9 minutes while maintaining high accuracy for outputted segmentation 87.97%
- A combination of **output visualization** (volume, 3D point cloud representation, video overlays comparison)

BIBLIOGRAPHY

- **[1]**https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds)
- **[2]**https://www.statista.com/statistics/940678/cardiovascular-disease-mortality-rate-in-the-united-kingdom-uk/
- **[3]**https://www.frontiersin.org/articles/10.3389/fcvm.2020.00025/full