Machine Learning Tools for Automated MRI Segmentation

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Introduction

- Abdominal MRI scans are necessary to diagnose several diseases, including those relating to the liver and spleen. For example:
  - Hepatomegaly (abnormally large liver)
  - Splenomegaly (abnormally large spleen)
  - Hepatic Steatosis (fatty liver disease)
- These diseases can lead to severe conditions without timely diagnosis and treatment, such as:
  - Cirrhosis (scarring of the liver)
  - Hepatocellular carcinoma (liver cancer)
- Organ segmentations are helpful for assessing these diseases, but producing them is a time-constraining process.
- Machine learning algorithms have been able to perform segmentation tasks more quickly and as accurately as a professional radiologist, but require large training image datasets.

Research Objective

The objective of this study was to construct a neural network to automatically segment the liver and the spleen on abdominal MRI and test its performance given limited training data.

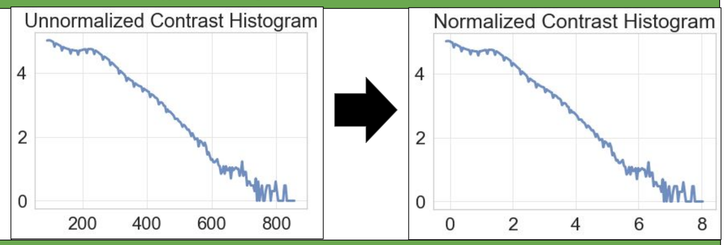
Materials and Methods

Step One: Image Preprocessing

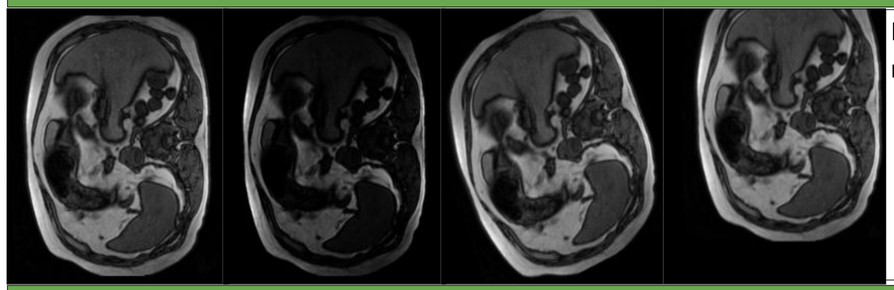
a. Intensity Normalization

b. Split 3D images into slices

c. Resize images



Step Two: Data Augmentation



From left to right:

a. Original
b. Contrast Adjusted
c. Rotated
d. Translated

Step Three: Algorithm Training

Data was obtained from two main sources:

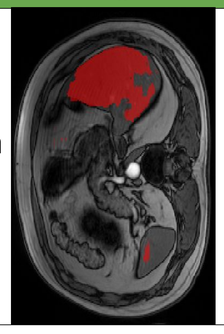
1. Penn Medicine Biobank
2. Combined Healthy Abdominal Organ Segmentation (CHAOS) Grand Challenge Dataset

Training Data consisted of 86 in and out of phase abdominal MRI images, and the test set consisted of 4 out phase images.

Step Four: Testing and Validation

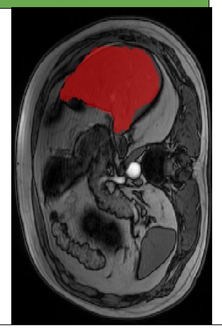
Un-segmented Test Image

Run Algorithm



Automatically Segmented Test Image

Compare (dice score)



Ground Truth Segmentation

Results

- The algorithm achieved:
  - **0.611** average dice score for liver segmentation
  - **0.596** average dice score for spleen segmentation

Discussion and Future Steps

- Even given a limited quantity of data, the algorithm exhibited reasonably strong performance on the test set.
- Transfer learning may improve classification accuracy.
- Increasing dataset size and incorporating cross-modality in training may make this algorithm applicable to other scan types, such as CT (computed tomography).

Selected References

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