Automatic segmentation of epicardial fat and quantification of radiomic parameters in cardiac computed tomography

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Motivation

The objective of this work is to develop a computational tool that automatically segments epicardial adipose tissue (EAT) and quantifies radiomic parameters, while also offering functionality for manual correction of pericardium tracking.

Cardiovascular Diseases

Cardiovascular diseases (CVDs) remain a global challenge. New methods based on deep learning, segmentation, and radiomics offer new perspectives for more accurate diagnosis and treatment.

Proposed Solution

Develop an architecture for automatic segmentation of epicardial adipose tissue (EAT) on cardiac CT images. Create a computational tool with automatic segmentation and manual pericardium correction.

1: Radiomics

Radiomics is one of the fastest growing areas of research in nuclear medicine, related to the extraction of quantitative metrics from medical images.

The radiomics workflow involves acquiring and enhancing medical images (CT, MRI) to ensure uniformity and quality, followed by the systematic extraction and analysis of quantitative features using statistical and machine learning methods for disease diagnosis.

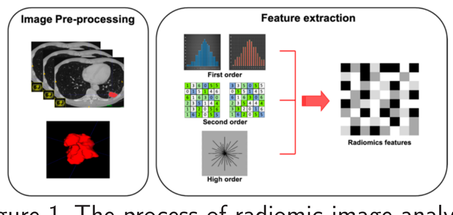

Figure 1. The process of radiomic image analysis

2: Architecture Segmentation Algorithm

The reported approach performs fully automatically without prior specialist input. After automatic segmentation, specialists can make necessary adjustments and re-run the algorithm.

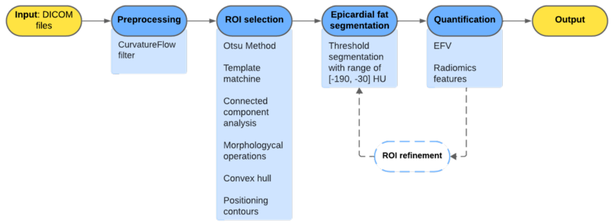

Figure 2. Architecture of the proposed algorithm

3: App

The graphical interface of this tool is developed as a desktop application for the Windows operating system. The implementation is done in the Python programming language using the PyQt5 library.

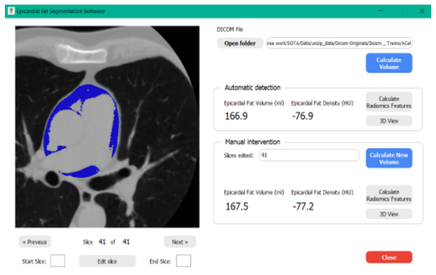

Figure 3. User interface of the application

The tool allows you to perform the following operations

- Manual editing of the pericardium.
- Calculation of radiomic indicators of the studied ROI.

4: Results

To perform statistical analysis, images automatically segmented using the described method were compared with manually segmented images (considered reference), slice by slice.

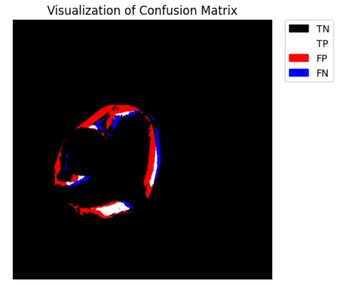

Figure 4. Evaluation image obtained by comparing manual and automatic segmentation

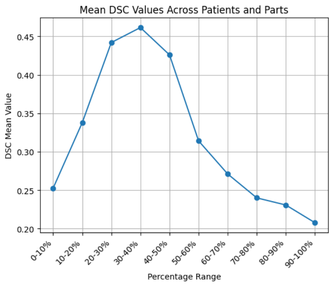

Figure 5. Local DSC from lower to upper heart

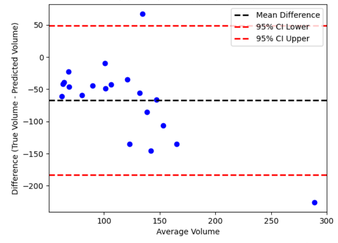

Figure 6. Bland-Altman plot of EFV measurements, with 95% confidence interval for optimized $\mathrm{EFV_a}$ and manually derived $\mathrm{EFV_m}$

By comparing manual and automatic segmentation on a pixel-by-pixel basis on 878 images, an average accuracy of **0.95** was obtained.

Conclusion

(a) An architecture for automatic segmentation of epicardial fat in cardiac CT images has been developed.

(b) The processing speed of cardiac CT images is $\mathbf{22.3 \pm 1.7}$ seconds.

(c) A tool has been created for automatic segmentation of cardiac EAT from CT images, calculation of radiomic parameters of ROI, and manual pericardium correction.

References

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[2] Visual Lab. (2014). *A computed tomography cardiac dataset*. Retrieved February 15, 2024, from `http://visual.ic.uff.br/en/cardio/ctfat/`