Towards Fully Automated Cardiac Statistical Shape Modeling: A Deep-Learning Based MRI View and Phase Selection Tool

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INTRODUCTION

- The manual input and time required to create models has limited the clinical translation of statistical atlases of cardiac shape and function.
- Manual cardiac view and phase identification are required, preventing end-to-end automation and processing times consistent with a clinical workflow.

OBJECTIVE

- To developed a fully-automated method for cardiac view and end-systolic (ES) phase selection.

METHODS

- A multi-institutional dataset of labeled MR images from 1,610 series of 61 patients with tetralogy of Fallot was retrospectively collected and randomly split at the patient level into training, validation, and test sets.
- The convolutional neural networks (CNN) Xception, VGG-19, and ResNet50 were trained to identify the MRI views employed in cardiac modeling from T1 MR images.
- The three CNNs above were also combined with a long short-term memory network (LSTM) and trained to identify the ES phase from 876 series of four-chamber and short-axis images, using manual phase annotations from two graduate-level students as the reference standard.

RESULTS

View Classification: The network ResNet50 achieved the best performance for MRI view classification with a weighted average ROC AUC of 0.996 and an F1-score of 0.98 on the test dataset.

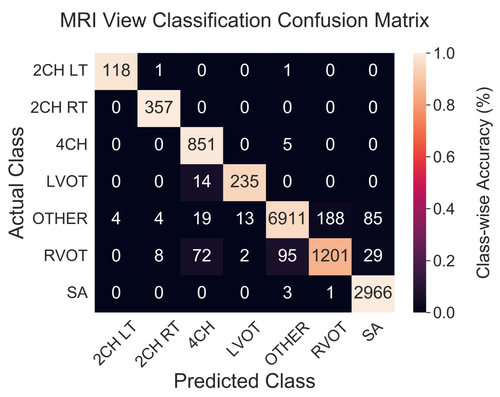


Figure 1: MRI View Classification Confusion Matrix for the best performing model, ResNet50, showing strong agreement between the predicted and actual MRI view.

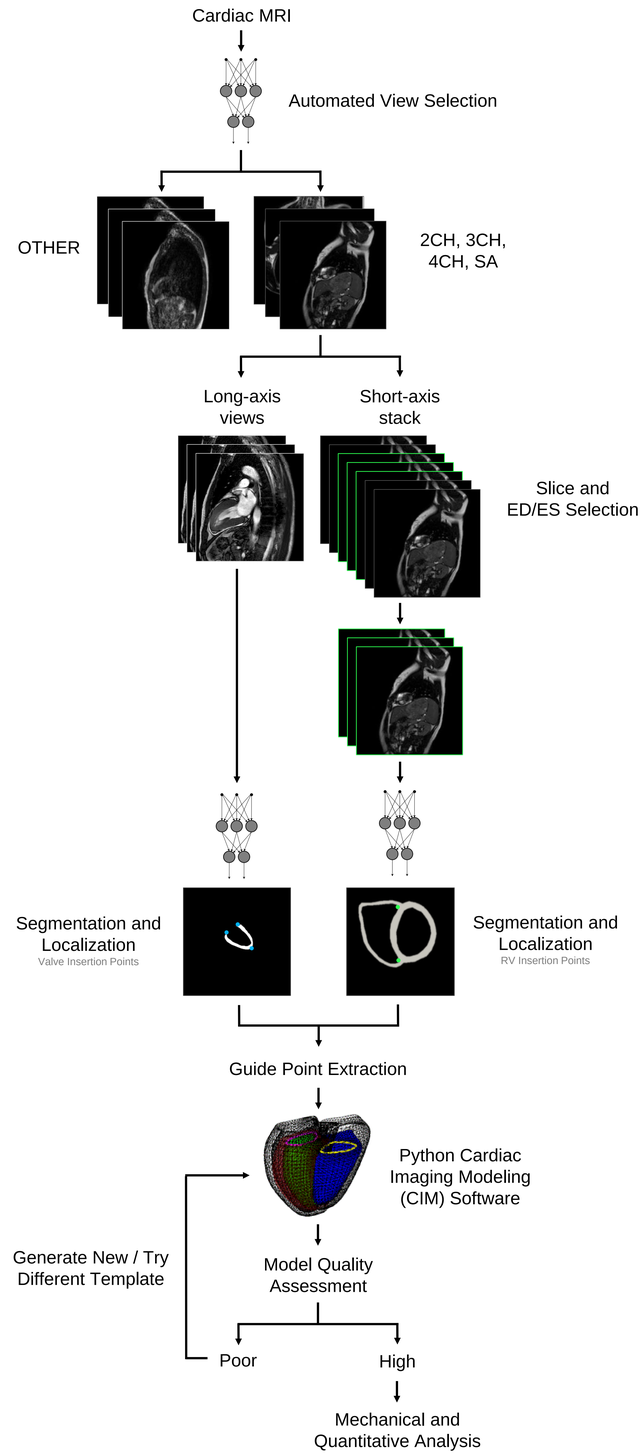
Phase Selection: For ES phase selection, the ResNet50-LSTM network had the best performance with an average absolute frame difference (aaFD) of 1.36 ± 1.12 frames. This score is comparable to the inter-observer variation between the two manual annotators in this study (aaFD 1.39 ± 1.35; p value = 0.89).

MRI view and phase selection for **cardiac statistical shape modeling** can be fully automated using **deep neural networks**.

GitHub

UC San Diego

End-to-end Automated Cardiac Shape Modeling Pipeline



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