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Multi-resolution myocardial architecture study

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Abstract

Myocardial complexity has lead to vivid controversy in the interpretation of the cardiac form and function over the years. This complexity has not been clarified yet even with the most recent computational reconstructions of low level MRI data.We propose a data-based multi-resolution methodology and validation to tackle this problem.

1. Introduction

Diffusion Tensor MRI allows the computational measurement of the cardiac architecture. This technique obtains discrete data of the spatial arrangement of myocytes observing water difusion. The output is usually reconstructed as streamlines representing muscular connectivity. However, the most recent works on myocardial architecture disagree in their architectural interpretation of the heart [ASSQ*09]. We propose the use of multi-resolution methodologies to reduce data and obtain simplified reconstructions.

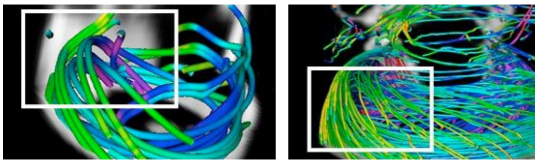

Figure 1: *Reduction and full-scale reconstruction details.*

2. Methodology

Our core streamlining methododology is based on a fifth order Runge-Kutta-Fehlbert integration method [PGAM11]. To obtain simplified representations, we pre-process DT-MRI data using two standard multi-scale generation approaches: *Gaussian pyramidal* and *Haar wavelet* decompositions. Either reduced representations summarize the original information and represent it at different levels of detail. The applicability of this methods is well known, but we need an error measurement to validate the preservation of structures from original reconstructions to those from the reduced volumes. We study curvature and torsion error measures of streamlines in small contexts. These comparisons have been done on an spline-based resampling of the streams.

3. Results

We have processed JHU database (`http://gforge.icm.jhu.edu/gf/project/dtmri_data_sets/`). We have obtained visible benefits from reduction (Fig. 1). Differences between Gaussian and Wavelet methodologies are not identifiable with naked eye. Statistic indicators show robust results (Table 1) using both methods. Mean values are always withing the lowest 10% of the distribution. Still, these measures does not help to pick a generically best suited one.

Error measure	Gaussian	Wavelet
Curvature	0.2966 ± 0.5486	0.2952 ± 0.5630
Torsion	0.9458 ± 1.3420	0.9337 ± 1.3362

Table 1: *Mean ± std summary of torsion and curvature errors.*

4. Conclusions

We have obtained promising multi-resolution reconstructions. Still, we need to identify specific strengths of our implementations.

References

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