A 3-D Heart Model for Arrhythmia Simulation and Visualization

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August 4, 2011
Motivation: Cardiac Arrhythmias

Normal Sinus Rhythm

Arrhythmic Rhythm

Remedies
- Medication
- Medical Devices
- Ablation

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Motivation: Arrhythmia Therapy

Problem

• Anti-arrhythmic drugs used by 1.5 million Americans do not offer health benefits

• Ablation procedures only yield success rates of 40-85%, thus requiring repeated procedures in half the cases

Goal

• Develop a 3-D Heart Model for Arrhythmia Simulation and Visualization
Heart Conduction System

• The electrical conduction system of the heart is important natural real-time system

• The coordinated contraction of the heart is governed by the electrical conduction system

• We model the heart by extracting their timing related properties
Common Cause of Cardiac Arrhythmia Circuit

Circular pathways in heart’s conduction system is a common cause of arrhythmias.
Ablation: Restoring Heart Rhythm

Ablation burns cells to eliminate rhythm abnormalities in patients.
Catheter Ablation Procedure

- Spatial
  - Xray
  - Ultra-sound
- Temporal
  - Electrogram

Electrogram  Xray  Echocardiography
Electrogram

Xray

Echocardiography

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3D Heart Geometry

Accurate Anatomical Spatial Information

- MRI of the heart from the 3 different axes were processed
- Number of vertices on 3D surface reduced from 7,807 to 437 nodes (93% reduction)
Conclusion

• Current 3D model is first step towards building automated guidance tool for surgeons conducting EP studies

• Such a tool will make surgeon’s work faster, more precise, and reduce the intellectual demand on the surgeon
Future Work

• Atrial Flutter Case Study

• Develop patient-specific model, connect to real patient data

• 3D model to operate in real-time and guidance tool for physician
Acknowledgements

- Dr. Rahul Mangharam
- Zhihao Jiang
- Dr. Sanjay Dixit
- Dr. Jan Van der Spiegel
- SUNFEST staff
- National Science Foundation