Teaching
Signal Processing, Image Processing, Wavelets

Research
* Multidimensional, multiresolution signal processing
* Current Project Summary*
  - Atrial Fibrillation is a common arrhythmia caused by irregular electrical activity in the heart.
  
  **Goal:** To map conduction of electrical activity in the heart to aid in procedures for destroying diseased tissue.
  
  - We use Spectral Analysis to automate the determination of local activation time.
  - We use Morphology Analysis to characterize the mechanism of AF.

* with Dr. Peter Spector, Cardiology, College of Medicine, UVM and Ms. Shruti Sharma, School of Engineering, UVM.
Spectral Analysis of Atrial Fibrillation Electrograms

Conduction in a Normal Heart

Simultaneous Mapping of the Atrium using a Basket Catheter at 38 points.

Conduction with Atrial Fibrillation

Intra-Cardiac Electrogram from the Right Atrium using a Basket Catheter

Electrograms from Consecutive Points show the Direction of Conduction
Results - Activation times

Synthetic non-stationary electrocardiogram signal

<table>
<thead>
<tr>
<th>Actual event frequency</th>
<th>5 6 7 7 4 7 6 4 10 7 8 10 7 3 9 8 4 9</th>
<th>10 5 3 7 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculated event frequency (New method)</td>
<td>4 8 7 7 4 7 6 3 7 8 10 7 3 9 8 3 9 10</td>
<td>4 3 9 9 9</td>
</tr>
</tbody>
</table>

Comparing Average Frequencies:
Ground Truth - 6.73Hz
Using State of the Art - 7.75Hz (Cannot do event frequency)
New Method - 6.69Hz
Results - Morphology Analysis

Electrocardiogram signal

Characterizing morphologies through singularities with a wavelet transform

Measuring singularities through wavelet transform modulus maxima and Lipschitz exponents