Craig S Henriquez, Professor

Dr. Henriquez is also a Professor of Computer Science and Co-Director of the Center for Neuroengineering. Henriquez's research interests include large scale computing, heart modeling, and brain modeling.

A breakdown of the normal electrical activation sequence of the heart can sometimes lead to a state of ventricular fibrillation in which the heart ceases to function as an effective pump. Abnormal rhythms or arrhythmias often result after an episode of ischemia (a localized reduction of blood flow to the heart itself) which affects both the ionic processes necessary to elicit an impulse and the passive electrical properties of the tissue. Identifying the complex mechanisms of arrhythmogenesis will require experimentation as well as mathematical and computer models.

Current projects include the application of the bidomain model to diseased tissue to investigate how changes in tissue structure (both natural and diseased induced) and changes in ionic current flow influences the nature of conduction and the onset of arrhythmia.

Dr. Henriquez's group is also interested in developing realistic models that will enable investigators to better interpret electrophysiological measurements made in the clinic. For example, activation maps at the surface of the heart are typically constructed based on the detection of specific features of the surface extracellular recordings. However, for complex activation, such as might arise during an arrhythmia, the features are difficult to distinguish.

The use of models that simulate both activation and the resulting extracellular potential and the application of signal processing techniques can lead to a tool for constructing more meaningful maps from experimental recordings during abnormal conduction. This works involves direct interaction with experimental research performed in the Experimental Electrophysiology Laboratory under the direction of Dr. Patrick Wolf and the use of MRI based techniques for tissue structure characterization, in collaboration with Dr. Edward Hsu. Dr. Henriquez is also collaborating with Dr. Doris Taylor in Cardiology who is using the injection of skeletal myoblasts as a biological therapy to replace damaged cardiac tissue.

Because realistic models of cardiac conduction involve lengthy calculations and large computer resources, some of our projects have involved developing advanced numerical techniques (in collaboration with Don Rose in Computer Science, Henry Greenside in Physics and John Trangenstein in Math) that employ Finite Volume Methods and Adaptive Grid Refinement and optimized algorithms for supercomputers. These models will also require the use and development of computer visualization tools to animate the conduction process in both two and three dimensional tissue representations.

Dr. Henriquez is presently applying the concepts needed in large scale cardiac models to the development of biological neural networks to understand the cortical-cortical interactions in the brain that underly a particular motor task. This work is being done in collaboration with Miguel Nicolelis in Neurobiology.

The Computational Electrophysiology (CEL) lab consists of a local network of SUN, SGI and PC workstations. A high speed link provides direct access to outside computing resources including a CRAY T90 and an IBM SP supercomputers at the North Carolina Super Computing Center in Research Triangle Park.

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Heart, Electrophysiology
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Neuroengineering
Neural Prosthesis

Research Interests:

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Recent Publications (More Publications)

1. V. Jacquemet and C. S. Henriquez, *Genesis of complex fractionated atrial electrograms in zones of slow conduction: A computer model of microfibrosis*, Heart Rhythm, vol. 6 no. 6 (June, 2009), pp. 803 -- 810 [abs].
2. T. A. Kayagil and O. Bai and C. S. Henriquez and P. Lin and S. J. Furlani and S. Vorbach and M. Hallett, *A binary method for simple and accurate two-dimensional cursor control from EEG with minimal subject training*, Journal Of Neuroengineering And Rehabilitation, vol. 6 (May, 2009) [abs].
3. V. Jacquemet and C. S. Henriquez, *Modulation of Conduction Velocity by Nonmyocytes in the Low Coupling Regime*, Ieee Transactions On Biomedical Engineering, vol. 56 no. 3 (March, 2009), pp. 893 -- 896 [abs].
4. W. J. Ying and D. J. Rose and C. S. Henriquez, *Efficient Fully Implicit Time Integration Methods for Modeling Cardiac Dynamics*, Ieee Transactions On Biomedical Engineering, vol. 55 no. 12 (December, 2008), pp. 2701 -- 2711 [abs].
5. S. F. Roberts and J. G. Stinstra and C. S. Henriquez, *Effect of nonuniform interstitial space properties on impulse propagation: A discrete multidomain model*, Biophysical Journal, vol. 95 no. 8 (October, 2008), pp. 3724 -- 3737 [abs].

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