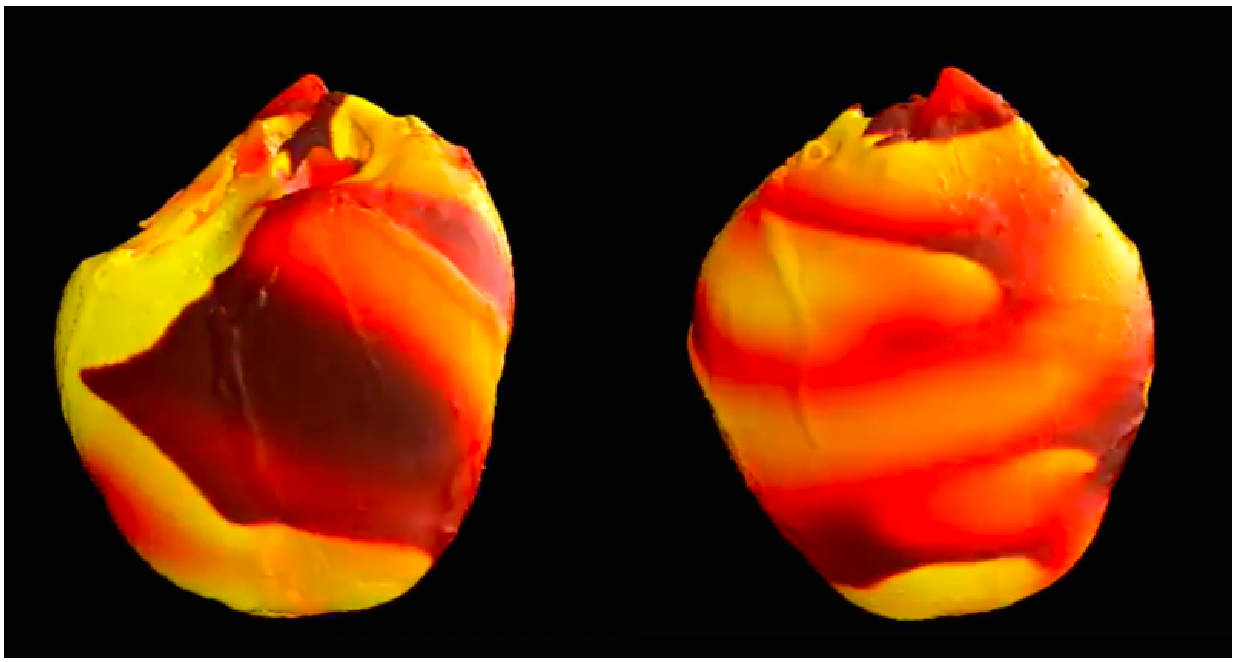
UMD scientist to develop virtual 'CyberHeart' to test, improve implantable cardiac devices

May 18 2015



Simulation of electrical impulse propagation through the heart during ventricular fibrillation. Color represents the transmembrane potential (i.e., the voltage across the cell membrane) on the surface of the heart. Yellow indicates largest potential values while dark red represents resting level. This simulation was performed by Pras Pathmanathan and Richard A. Gray at the US Food and Drug Administration. Credit: Pras Pathmanathan and Richard A. Gray, US Food and Drug Administration (FDA)

A University of Maryland expert in the model-based testing of embedded software is working to accelerate the development of improved implantable medical devices used in the treatment of heart disease.

W. Rance Cleaveland, a professor of computer science, is part of a multi-institutional team developing a "CyberHeart"—a sophisticated digital platform used for patient-specific testing of current devices like pacemakers, as well as prototyping the next generation of implantable cardiac devices now under development.

"We believe these virtual platforms can be used to design, test and validate implantable medical devices faster and at a far lower cost than existing methods," says Cleaveland, who has appointments in the University of Maryland Institute for Advanced Computer Studies and the Institute for Systems Research.

The project, which involves researchers from seven U.S. universities and centers, is funded by a five-year, $4.2 million grant from the National Science Foundation (NSF).

The research group's approach combines patient-specific computational models of heart dynamics with advanced mathematical techniques for analyzing how these models will interact with cardiac medical devices. The results can be used in a clinical setting to optimize device settings on a patient-by-patient basis.

"We're able to take a specific patient's history and then run a detailed analysis of how a device might work, interchanging different settings on the device and seeing the reactions, before the device is implanted in the patient," Cleaveland says.

For new devices under development, these same CyberHeart analytics can be used to detect potential flaws early on during the device's design phase, before animal and human trials begin.

"We believe that our coordinated, multidisciplinary approach—which balances theoretical, experimental and practical concerns—will yield transformational results in medical-device design and foundations of cyber-physical system verification," says Scott Smolka, a professor of computer Science at Stony Brook University who is principal investigator of the project.

In addition to Smolka and Cleaveland—who co-directs the project—other researchers include Edmund Clarke (Carnegie Mellon University), Elizabeth Cherry (Rochester Institute of Technology), Flavio Fenton (Georgia Tech), Rahul Mangharam (University of Pennsylvania), Arnab Ray (Fraunhofer Center for Experimental Software Engineering) and James Glimm and Radu Grosu (Stony Brook University). Richard A. Gray of the U.S. Food and Drug Administration is another key contributor.

The NSF funding falls under its "cyber-physical systems" effort, which looks to develop state-of-the-art engineered systems that are built from and depend on the seamless integration of computational and physical components.

"NSF has been a leader in supporting research in cyber-physical systems, which has provided a foundation for putting the 'smart' in health, transportation, energy and infrastructure systems," said Jim Kurose, head of Computer & Information Science & Engineering at NSF.

Provided by University of Maryland

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