Optimized Simulations Speed Development of Pacemaker with Two-Way Communication

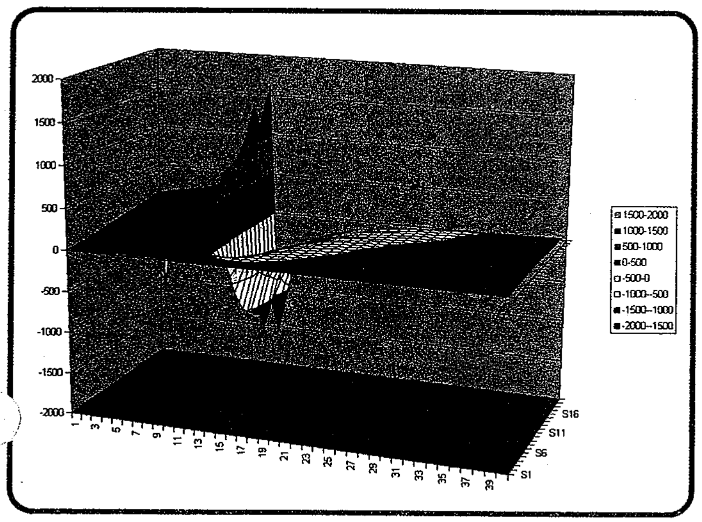
Optimized electromagnetic simulations have enabled researchers at Utah State University (Logan, Utah) to design the first cardiac pacemaker with two-way communication capabilities. The new device will be fit with a tiny antenna that makes it possible to download information about the condition of the pacemaker and the patient's heart, and upload improved instrument settings.

Pacemaker with Two-Way Communication

Problem:	Designing an antenna that enables two-way communications with a cardiac pacemaker.
Solution:	A 2-inch-square, 433-MHz patch antenna that fits on a standard pacemaker battery pack.
Solution Provider:	Utah State University (Logan, Utah)
Solution Tools:	XFDTD software, iSIGHT software, SGI Origin 2000 supercomputer
Bottom Line:	Optimum design reached in one week versus nine months with conventional design analysis.

iSIGHT™ INTELLIGENT SHELL FOR DESIGN AUTOMATION, INTEGRATION & OPTIMIZATION

Fitting pacemakers with antennas has always posed a conflict for researchers: Either the wavelength was too short to penetrate the body or the antenna was too large to be used safely. Researchers at Utah State solved the problem by developing a 2-inch-square, 433-MHz patch antenna that fits on a standard pacemaker battery pack. The final solution was arrived at in just one week by coupling electromagnetic simulation software with iSIGHT, a software package that helps customers integrate design processes to reach optimum solutions.

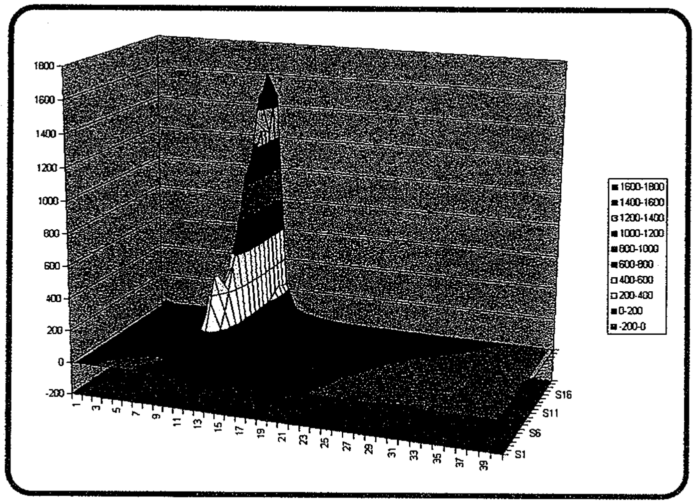


3D chart showing imaginary component of the antenna impedance; values close to 0 are good.

The Road to a Solution

Before Utah State's breakthrough, the only way to communicate with a pacemaker was to operate on the patient and remove the device from the body, which is normally done every few years. Utah State Assistant Professor Cynthia Furse set the goal of developing an antenna that would work at 433-MHz, the highest frequency capable of penetrating the body, but still be small enough to avoid risks to the patient. Antennas that operate at 433-MHz are normally five or six inches long. At that length, they protrude into the body, causing a risk of infection or lung punctures.

Furse's team used XFDTD electromagnetic finite difference time domain software from Remcom Inc. (State College, Penn.) to evaluate different designs. Computations were performed on an SGI Origin 2000 supercomputer. Hock Kwong Lai, from Utah State's Electrical Computer Engineering Department, set up a grid with a 2-mm cell size for the patch antenna, pacemaker and surrounding tissue. After nine months of analysis, Lai developed two designs that met the requirements of the project: a U-shaped patch antenna and a spiral-shaped antenna.



3D chart showing real component of the antenna impedance, with 50 as a good value.

On the Fast Track

Furse recognized that the designs would need to be reengineered at least a few and possibly many more times in order to meet additional requirements that arose as the project evolved. If done manually, the multiple design iterations would become time-consuming and expensive. Furse turned to Engineous Software's iSIGHT to automate the process.

A link was created between iSIGHT and XFDTD. Using a genetic algorithm, iSIGHT created and analyzed 100 to 300 different designs, depending on the initial design location. iSIGHT narrowed down the design possibilities to one — the optimized patch antenna — that best satisfied design constraints.

Results from iSIGHT generally mirrored those reached by Lai, but also provided additional optimizations that improved the overall design of the antenna. Whereas the manual analysis took nine months to reach an acceptable design, iSIGHT helped researchers generate an optimum design in one week. It took just two days to set up the optimization problem; the rest of the time the computer ran by itself without human intervention.

Arriving at an optimum solution faster than was thought possible could lead to faster time-to-market for a new generation of pacemakers that work better and eliminate additional operations for cardiac patients.

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