CASE STUDY

Can You Hear Me NOW?

TECHNOLOGY FOR BETTER COMMUNICATION IN THE MRI SUITE

BY SUSAN KARLIN

A COMPLICATED ABLATION. *A gingerly guided needle where a centimeter in the wrong direction can cause serious injury. The incessant metallic rattling of the MRI machine drowning all nuanced communication. Medical staff stumbles along with shouts, hand gestures, and written signs. At a critical point, the operator incorrectly hears the doctor tell him to turn off the scanner, and the image disappears. The patient remains in limbo, partially sedated. Procedure time is tripled. The doctors have to gather their thoughts before continuing.*

Thanks to a new optical fiber-based intercom system, MRI medical staff and patients at four U.S. hospitals can communicate better, increase production, and reduce risk.

MRI noise and its workflow impediment have long been critical roadblocks to advancing interventional MRI (iMRI) from cutting edge to mainstream use. Since MRI came into wide use, noise reduction solutions have eluded acoustics engineers. And the problem is threatening to worsen as more powerful – and significantly louder – MRI machines come to market. To compound this situation, hospital management expects staff to increasingly expedite MRI procedures.

Now, the Israel-based company Optoacoustics has tackled these issues with their Interventional MR Optical Communication System (IMROC™) and is transforming iMRI efficiency and safety in the process. The system's fiber optic-based microphones and headphones enable normal conversation in MRI environments by reducing gradient noise and enhancing voices for as many as eight concurrent users. Fiber optic technology is safe for the MRI suite and does not interfere with the machine's magnetic field and image clarity.

"Doctors kept telling us that one of the biggest issues was a need for a communications system for iMRI – hand signals were not going to cut it if this technology was going be ready for prime time," says Christine Lorenz, PhD, director of the Center for Applied Medical Imaging, Siemens Corporate Research, a Baltimore-based R&D group developing iMRI procedures that helped find interested hospitals but has no financial stake in Optoacoustics. "The noise of the MR scanner increases the complexity and risk, because iMRI procedures require a whole team to work in synchronization, which is hampered without good communication. The main benefit of the IMROC system is that there's no more guesswork in team communication. Procedures are done more efficiently, and the patient spends less time in the scanner."

The IMROC system has gotten high marks from four early adopters – University of Texas M. D. Anderson Cancer Center in Houston; University of Utah School of Medicine in Salt Lake City; Johns Hopkins University School of Medicine in Baltimore; and the National Institutes of Health (NIH) – and changing the way they handle interventional, intraoperative, diagnostic, and neurosurgical MRI.

"We were off and running with it from day one," says R. Jason Stafford, PhD, an imaging physicist working with a team using the IMROC for MR-guided interventions at M. D. Anderson. The center's pioneering iMRI activities focus on MR-guided biopsies and ablations for the head, neck, soft tissue, bone, liver, and kidney. "Before we got this system, we trudged through the more complex procedures, and it was just painful. The radiologist would get frustrated with his inability to communicate properly. The noise made it difficult, cumbersome, and slowed the entire procedure down.

"What IMROC did was enable everyone to do their job more rapidly and efficiently, and allow the technologist to return to where she belonged – in the driver's seat of the MRI suite – without breaking the line of communication between the radiologist and technologist," he adds. "It increases safety by improving momentum. There are no longer interruptions due to a lack of communication. It would probably be an excellent tool for teaching and facilitating communication between multiple teams working together in the MRI."

HEARING THE LIGHT

IMROC's key achievement is the integration of several breakthrough technologies into a single system. Noise reduction for MRI is vastly more complicated than simply dampening a set of noise frequencies, like the noise reduction headphones used on a jet flight. MRI noise is the product of constantly changing frequencies that reach as high as 120 dB (the equivalent of a jet engine on takeoff). Conventional technology solutions simply cannot be used, since they contain electronics or metal elements that would create safety issues and interfere in the MR imaging process.

"MRI machines present one of the most complex problems of dealing with noise," says Optoacoustics CEO Yuvi Kahana, PhD, an acoustics expert. "Not only do we deal with very high levels of noise, but also with difficult noise patterns – and these patterns change from scanner to scanner and from scan to scan. Finally, we're collecting very similar noise from many microphones simultaneously. So we had to develop a system where each headset operates independently using a digital 'brain' that can determine whether it is collecting noise or speech." To accomplish this, Kahana explains, each IMROC headset is paired with its own fully adaptive and automatic digital signal processor (DSP) chip and only subsequently are the various channels mixed in a central control unit.

The IMROC is based on Optoacoustics' core optical microphone technology, patented in the 1990s, which produces sound information by measuring changes in light waves. Light enters a microphone through one optic fiber and strikes a tiny membrane that is vibrating in response to acoustic waves. The vibration causes the light to be modulated as it is reflected off the membrane, and these very minute changes are transmitted back to a signal processor through a second optic fiber. This core technology, the basis for a complete portfolio of Optoacoustics microphones, produces extremely clear signals with low self-noise. IMROC optical microphones and headphones use advanced algorithms that can reduce noise as well as enhance much of the original speech signal.

Optoacoustics began working on IMROC prototypes in 2004 with the assistance of Robert Lederman, MD, a senior investigator with NIH's National Health Lung and Blood Institute in Bethesda, Md., and a pioneer in cardiovascular interventional MRI, who detailed specifications required by end users.

"We can hear and communicate with each other on a single open microphone as opposed to a 'push-to-talk' walkie-talkie style device, which is no good if there are a lot of people who want to talk at the same time," he says. "It's also comfortable enough to use for several hours. There's no other good solution I'm aware of that works this well. Our predecessor system, apparently no longer available, was much inferior. They required supplemental earplugs that were uncomfortable after a while or didn't suppress the noise entering through bone conduction. We're pleased and surprised at how well this works."

The effects are even more dramatic in research. At the University of Utah School of Medicine, IMROC is facilitating development of new, lifesaving technology. There, an experimental iMRI-based atrial fibrillation ablation therapy delivers radio waves via catheter into the heart to cure arrhythmias. Treatment requires pinpoint accuracy inside of a beating, shifting object.

"We can now carry out procedures we simply couldn't do before. Without an intercom system, we could only use hand signals or shouting," says Rob MacLeod, PhD, an electrophysiologist and professor of biomedical engineering overseeing several of these experiments. "Without real-time communication, there's no way for the interventionalist to change the MRI settings fast enough to track the heart. The challenge is unique to cardiology, because – unlike the brain, which is static – the heart is a moving target. Without the ability to adjust the scanner in realtime, there are only brief moments to move when the catheter, heart, and MRI slice were all lined up. In between, the physician is blind, and there is a real risk of puncturing the heart wall. IMROC has been nothing short of a complete transformation of how we did things."

IMROC is in the final stages of FDA approval. Optoacoustics will formally introduce the system at the Radiology Society of North America (RSNA) winter convention in Chicago. In the future, the company is planning to sell smaller versions of the IMROC (i.e., two channels instead of six), and is developing even more dramatic advances in adaptive noise reduction.

"Everyone I know who has tried to do interventional MR without the communication system and then gets it is thrilled," says Lorenz. "It just makes the whole environment more pleasant, easier, and the procedures more efficient. I don't think anyone would return to doing iMRI procedures without such a communication system after having used one."

For more information, go to www.optoacoustics.com.

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