Microsoft Research

Ultrasound Imaging More Portable, Affordable with USB-Based Probes

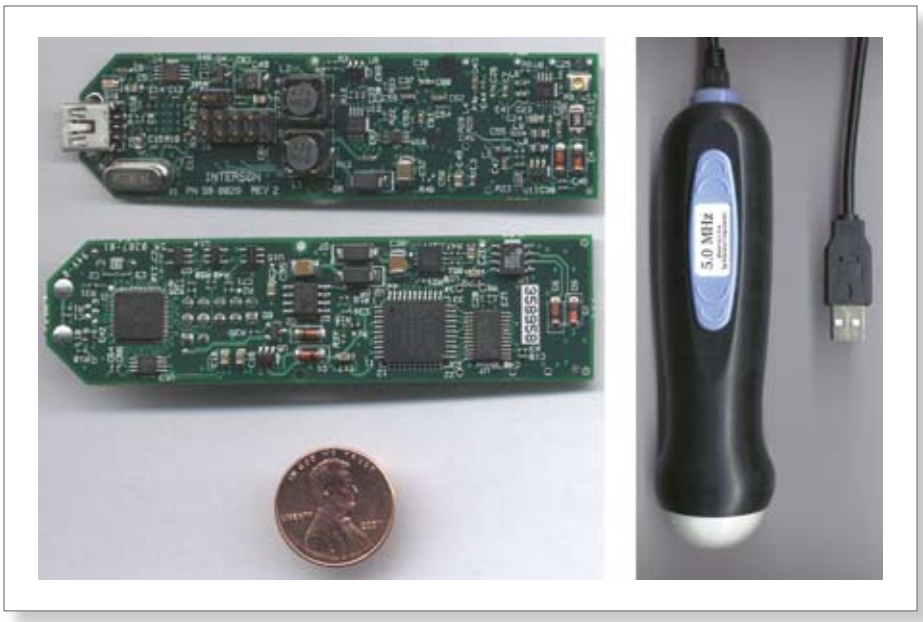
Ultrasound is one of the most basic and important medical imaging technologies, yet it remains out of reach for people in many remote or poor regions of the world. That could change, thanks to researchers at Washington University in St. Louis who have developed a line of low-cost ultrasound probes that run on laptops and small PCs and who are now working on a new generation of smartphone-based probes.

Ultrasound technology, a valuable tool for diagnosing numerous diseases and medical conditions, has simply been too expensive and often too cumbersome for use in remote or impoverished locations. This is true in developing countries as well as in many rural and urban communities in the United States and other developed countries.

But what if physicians or other caregivers had ultrasound devices that could be attached to a laptop computer or even a cell phone?

That's precisely the goal for William D. Richard, Ph.D., an associate professor of computer science and engineering at Washington University in St. Louis. Richard and his research partner, David Zar, have already developed a line of low-cost ultrasound probes that connect to laptops and small-form-factor PCs via a USB connection.

With a combination of cash, software, hardware and research support from Microsoft Research, Richard and Zar are working on a new generation of USB probes that will be compatible with Microsoft® Windows Mobile®–based smartphones.



Left: The two sides of the circuit board developed by William Richard.
Right: One of the USB-based ultrasound probes manufactured with Richard's technology.

Fast Facts

Project Principals:

William D. Richard, Ph.D., associate professor of computer science and engineering, Washington University in St. Louis

David Zar, research associate in computer science and engineering, Washington University in St. Louis

Web Sites:

www.cs.wustl.edu/~wdr/
www.cse.wustl.edu/~dzar/

Profile:

Researchers at Washington University in St. Louis are developing a low-cost ultrasound probe that will run on a Windows Mobile smartphone. This technology could give people in many remote or poor regions access to ultrasound, a valuable tool in diagnosing numerous diseases and medical conditions. It could even make in-home ultrasound use possible.

Microsoft External Research

The Microsoft External Research Division within Microsoft Research partners with academia, government and industry to advance computer science, education and scientific research aimed at helping address some of the world's most urgent and significant social and technological challenges. Along with investing cash, software, hardware and research expertise to enable ground-breaking projects worldwide, Microsoft External Research is committed to providing the advanced technologies and services needed to support every stage of the research process. Efforts are focused in four research areas—including Health and Wellbeing, which explores technologies that advance healthcare and help people make better choices about their health.

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While some existing ultrasound devices are cabinet-sized and can cost up to US$100,000, the USB probes developed by Richard sell for a few thousand dollars. Richard aims to cut the cost even further.

"My goal for this project with Microsoft Research is to eventually produce probes for cell phones and laptops that can sell for a few hundred dollars," he says.

Richard started working on ultrasound system designs 25 years ago as a graduate student. About 10 years ago, he developed his first PC-based system by putting the ultrasound imaging electronics onto a single PCI bus plug-in card. That system used a standard ultrasound probe.

As his work progressed, Richard began moving all of the imaging electronics into the probe itself and switched to a USB interface. He eventually got it all down to a circuit board that measures just 1 inch by 3 inches. "Over 25 years, I've shrunk a cabinet full of electronics down to this tiny card," he says.

Richard's current generation of USB probes for PCs are being sold commercially by several distributors. The underlying technology has been adapted to a variety of probes, including a 5 MHz general-purpose probe used for kidney, liver, bladder and other types of imaging; a 12 MHz ophthalmic probe used for eye examinations; and an endocavity probe used for prenatal exams, uterus and ovary scans in women and prostate exams in men.

The probes use a USB driver that is compatible with Windows® XP and Windows Vista®. Ultrasound data is sent via the USB cable to the host computer, with the PC supplying necessary power for the probe through the same cable.

Now, in their one-year project with Microsoft Research, Richard and Zar are working to make commercial USB-based probes compatible with Windows Mobile smartphones. Richard handles all of the hardware development, and Zar has been writing the software for the USB probes.

Cell-phone service is one of the few technologies that is abundant in the developing world, so a smartphone-based ultrasound probe would be especially useful. For example, a doctor or caregiver doing a prenatal exam in a remote village could perform an ultrasound scan and then e-mail the results—in essence, a short video—to a specialist anywhere in the world.

Another option Richard is exploring with support from Microsoft is pairing a smartphone with Fone+, a device developed by Eric Chang—currently director of technology strategy for Microsoft Research Asia—that enables a user to display the image from a smartphone onto a television screen. In addition to an RGB output, the Fone+ cradle device includes USB ports for a mouse, keyboard and the ultrasound probe. This enables the smartphone to basically become the server for the ultrasound device. The technology would allow healthcare professionals in places such as rural health clinics to examine ultrasound results without being limited by the small smartphone screen.

Richard says the biggest challenge has been in developing new imaging software and USB drivers for the smartphones, which are not as powerful as general-purpose PCs. The only significant change that had to be made to the actual probes was reprogramming the circuit board to run on a slower USB connection. (Most smartphones use USB version 1.1, whereas current laptops use USB 2.0.)

"Over 25 years, I've shrunk a cabinet full of electronics down to this tiny card."

—William D. Richard, Ph.D., Washington University in St. Louis

Richard field tests the newly adapted smartphone-based probes by holding them up to his own neck to take images of his carotid artery. Within a few months, he and Zar were able to get a probe to run on a smartphone at about three frames per second—compared to the PC versions that run at up to 30 frames per second. Richard is confident that they will be able to get the smartphone-based probes to run at up to 10 frames per second—a speed that he says is more than adequate for many ultrasound uses.

Richard says that once they have optimized the probe electronics and developed a functional USB driver, he will make a software development kit available for free on his university Web page. "There are so many people out there writing applications for smartphones," Richard says. "We just want to enable them."

Besides the obvious benefits to people in underserved areas, low-cost USB-based probes could be put to many uses in modern hospitals, such as when a nurse is having difficulty locating a vein for an intravenous drip. Richard believes such a device also would be useful in a wide range of other settings, such as on the battlefield or even for wildlife biologists doing remote field work.

Richard envisions numerous possible in-home uses as well. Caregivers could use the probes to make sure an elderly or ailing patient's catheter is working. And he has talked to doctors who are developing implant-based drug delivery systems, who say the USB-based probes might be ideal for monitoring the implants.

Says Richard, "I want to see one of these probes on a pharmacy shelf in a few years."