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Bioimaging Breakthroughs

An expanded market for medical imaging is helping to make MRIs and x-rays more accessible.

By Donna Mitchell-Magaldi

Significant innovations emerging in the medical imaging industry are expanding the global market for medical imaging equipment and holding promise for making x-rays, ultrasounds, and MRIs accessible to billions of people across the globe.

Many of the innovative technologies are moving medical imaging devices away from large, complex, expensive, stationary devices anchored in hospitals toward simpler, mobile, and less expensive designs. These newer technological advances allow for imaging capabilities to expand to smaller, more remote areas, rural physician's offices, on the road with emergency responders, and other, traditionally inaccessible medical settings.

A trend toward hybrid imaging, which combines data from multiple images and systems, is also improving the accuracy of diagnoses.

With an estimated 75% of the world's population with no access to medical imaging equipment, new imaging techniques for health monitoring, disease detection and treatment, and surgical procedures could improve the quality of life for billions.

A BCC Research report from 2007 indicates the medical imaging device market will be worth $11.6 billion by 2012, with an average annual growth rate of 8.2%. With the market expanding at such a pace, medical imaging companies must continue to innovate in order to survive.

Newer imaging designs entering the market also focus on combining ease-of-use with higher levels of accuracy. This allows information to be accessed efficiently while providing higher patient throughput (the process of moving patients efficiently through the health system). New solutions for a variety of clinical applications will significantly lower the cost of medical imaging because the apparatus is at the patient site and the technology greatly simplified. Many do not require specialized training for image acquisition or processing.

For example, GE Healthcare's CardIQ Function Xpress contains a fully integrated post-processing and analysis tool tailored specifically for cardiac use. Boston Scientific received 510(k) approval for its iLAB Ultrasound Imaging System, which has an easy-to-upgrade platform that will promote even greater advancement of innovative technologies.

Physicians and technicians can perform SPECT and CT scans simultaneously with Philips' Precedence SPECT/CT system, which fuses images from the two scans.

GE Healthcare's digital mobile imaging systems include the OEC 9900 Elite, which has a motorized, mobile C-arm and precision imaging technology. The device allows the user to perform digital subtraction angiography imaging while moving the C-arm or the patient, and the flat panel monitors mount on an articulating arm for viewing at any angle.

Mobile technology

Portable devices, which are becoming the standard, could vastly improve health care in the developing world as well as greatly improve survival rates in industrialized countries. This is particularly true in circumstances such as a stroke, when there is a small window in which to diagnose and successfully treat a patient.

Medical imaging systems made with lighter materials that allow for transport to multiple sites, including hand-held imaging devices, will continue to get smaller and more mobile. In fact, the medical imaging industry is already manufacturing smaller, portable units that are user friendly and provide highly accurate diagnosis with little patient discomfort.

The majority of new FDA 510(k) approvals for imaging systems feature designs that allow for portability. For example, Digirad Corp.'s XPO System can be configured or fixed for mobile operation and services many different sites. Mobile imaging services currently comprise 70% of Digirad's annual revenue. Other companies investing in the development of mobile imaging technologies include Toshiba, GE Healthcare, Siemens, and Teratech.

The Digital Age

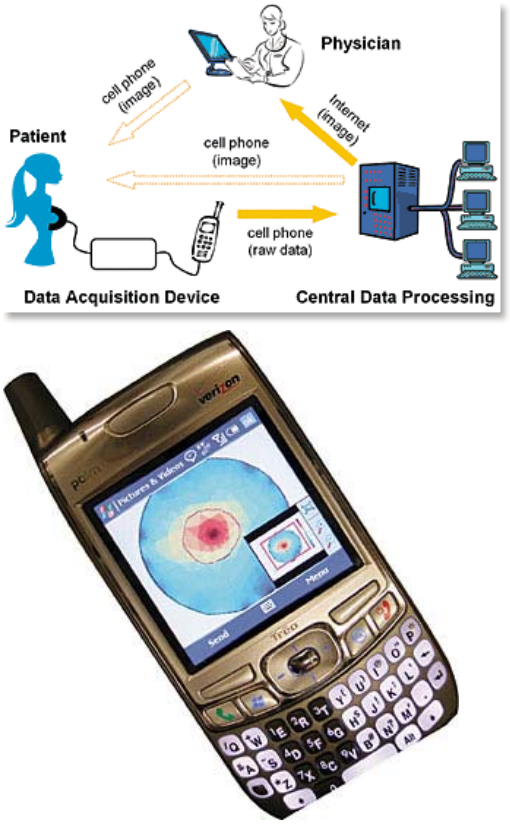
Digital imaging has made it possible to share information with multiple team members via wireless communication. The iMRIsneuro, owned by the University of Virginia Health System, is a multifunctional, moveable, high-field MRI that allows a medical team to scan, review, and share information during a surgical procedure.

Digital imaging also allows for the integration of intraoperative procedures with imaging guided surgery to provide real-time data. This reduces surgical time, increases efficiency, and helps medical facilities recover the investments more quickly because they can schedule more patient scans per day.

Systems Design

Unique designs are moving away from conventional, self-contained systems that combine data acquisition hardware with software processing hardware and an image display to a method in which all these components are utilized separately.

For example, researchers at University of California, Berkeley, are currently working on a new medical imaging system made of two independent components connected through cellular phone technology.



Berkeley researchers are using a cell phone and other technologies to acquire, send, and view medical data.

The mobile phone is connected to a data acquisition device (DAD) at the patient site, and the cell phone serves as a conduit between the DAD and the central facility where the data is processed or translated.

The cell phone transmits to this central facility the raw data so it can be reconstructed into an image with advanced hardware and software. The data is then returned from the facility to the cell phone as an image and displayed on the screen.

This device was tested by Berkeley researchers using a silicone simulation for breast cancer. The results indicated that the use of a DAD can be separate and independent from the reconstruction process and that the use of a cell phone can be effective acting as a conduit both in transmitting and receiving data.

Such technology will significantly lower the cost of medical imaging because the apparatus is at the patient site and the technology greatly simplified. There is no need for personnel highly trained in imaging processing.

"This could open up whole new avenues of health care for the developing world," said Boris Rubinsky, professor of bioengineering and mechanical engineering and head of the team that developed the new application for cell phones. "Health professionals in rural clinics could affordably get the tools they need to properly diagnose and treat their patients."

"Medical imaging is something we take for granted in industrialized countries," Rubinsky added. "Imaging is considered one of the most important achievements in modern medicine. Diagnosis and treatment of an estimated 20 percent of diseases would benefit from medical imaging, yet this advancement has been out of reach for millions of people in the world because the equipment is too costly to maintain. Our system would make imaging technology inexpensive and accessible for these underserved populations."

In another study reported in the Journal of Digital Imaging, researchers at the University of Yonsei in South Korea developed an imaging method that uses a picture archiving and communication system (PACS) to interpret and transmit radiological images to remote areas with mobile phone/PDA technology. The digital camera in the cell phone or PDA takes the picture and sends the data through a CDMA cellular network to the physician's cell phone or PDA. This

data, captured directly using Bluetooth technology, is sent to the PACS terminal where the information is processed. The data is analyzed and, through the use of a progressive compression program, is sent back to the physician's phone or PDA and back to the specialist's PDA or cell phone.

Hybrid Imaging

The use of hybrid imaging methods over single-method scans is another innovation in the field that will increase steadily over time, especially in the field of oncology. Image fusion in particular is increasingly useful in merging two or more different images to create one fused image.

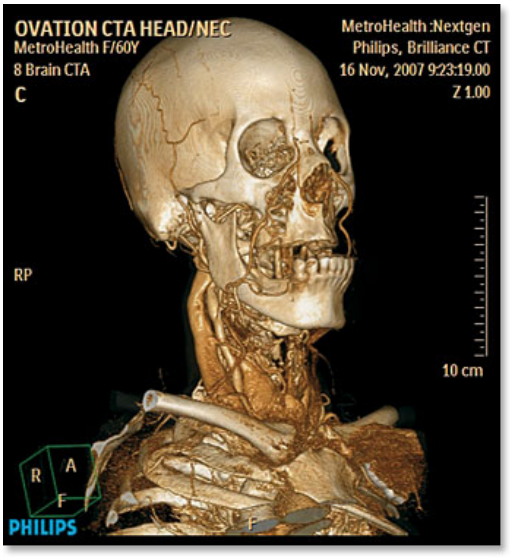
Studies have found that hybrid systems could detect cancer better than single systems, allowing for early treatment. Philips currently markets the Precedence SPECT/CT system, a hybrid system that allows physicians to perform SPECT and CT scans simultaneously. It then fuses images from the two scans, providing physicians with crucial information about metabolism and structure.

Philips BV makes devices for mobile fluoroscopy imaging applications. The BV Pulsera with 3D-RX (left) provides high-quality intraoperative 3D imaging without compromising full conventional 2D imaging functionality during routine procedures.

Philips also developed Syntegra, multi-modality software that automatically superimposes physiologic data (such as PET) with anatomic data (CT or MR). The real-time data aids in the identification of tumors, shortens the radiation therapy planning cycles, and results in more confident diagnoses.

The use of hybrid technology will continue to emerge as the combination of imaging methods proves to be more effective in diagnosing problems over the singular imaging methods. Fusion of multiple image data from multiple systems will be used to recreate accurate anatomical structures.

A trend also is emerging in Europe in which systems are using higher slice configurations. Both Toshiba and Philips market systems that use 256-slice configurations in cardiology imaging that result in a 256 mm coverage area. A 256-slice CT, for example, can perform a full bank of five key diagnostic tests on the heart or in the brain, thereby exposing the patient to far less radiation. This equates to as little as one-eighth to one-third of the dose required in testing with the 64-slice scanner.



Philips' 256 ICT system can conduct five key diagnostic tests on the brain.

Pill Camera

Researchers have developed the first-ever steering and control system for a tiny camera that a patient swallows for an examination of the gastro-intestinal system. A doctor holding a magnetic device the size of a candy bar can steer and stop the ingested camera as it makes its way down a patient's esophagus, stomach, and intestines.

The system includes a camera contained in a capsule, a transmitter that sends images to a receiver, a battery, and cold-light diodes that flash when a picture is taken. Researchers at the Fraunhofer Institute for Biomedical Engineering (Germany), in collaboration with Given Imaging (Israel), the Israelite Hospital in Hamburg (Germany), and the Royal Imperial College (London) announced their innovation in June 2008.

Given Imaging pioneered PillCam capsule endoscopy.

Imaging Events at Photonics West

SPIE Photonics West will have numerous conferences and events on the latest clinical and technical innovations in medical imaging. This year's mega event is in San Jose, CA (USA). For more information, go to spie.org/pw. A sampling of relevant events:

- Hot Topics sessions at BiOS, 7 p.m., Saturday, 24 January.
- NIH Brain Imaging Workshop, 6:30 p.m., Sunday, 25 January.
- BiOS exhibition, 24-25 January.
- Six conferences at BiOS on biomedical spectroscopy, microscopy, and imaging.
- Professional development courses on biomedical imaging, spectroscopy, endoscopy, and microscopy, 24-28 January.

Find references and further reading online at spie.org/spieprofessional.

Biomedical News

Hand-held medical imaging devices, tiny magnetic cameras that a patient can ingest, surgical robots, image fusion techniques, and similar innovations are playing an increasingly important role in world health – and in the medical imaging marketplace.

By addressing this critical human need, optical scientists and companies can also take credit for expanding the global market for medical imaging equipment.

Read the latest news and technical articles about medical imaging in the SPIE Newsroom: spie.org/news-biomedical

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Kalender to Speak at Symposium In February

Willi Kalender, known as the father of Spiral CT, will give a symposium wide plenary talk at the SPIE Medical Imaging Symposium in Florida (USA) on Monday, 9 February.

Kalender, director of the Institute of Medical Physics at Friedrich-Alexander-University Erlangen-Nürnberg (Germany), will speak on "Advances and New Directions in x-ray Computed Tomography." The symposium is being held at the Disney Coronado Springs Resort near Orlando.

X-ray CT, the first of the modern slice-imaging modalities, was introduced into clinical practice in 1972. Reconstructing images mathematically from measured data and displaying and archiving them in digital form was a novelty then. Significant advances in its implementation have since been made, including the development of volumetric, or spiral, CT scans by Kalender in the 1980s and the advent of multi-slice scanners.

For more information about the SPIE Medical Imaging Symposium, which is being dedicated to the late Bob Wagner, see spie.org/mi. SPIE members receive discounts on all meeting registrations.

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Nerac Analyst Donna Mitchell-Magaldi partners with medical device manufacturers, dental companies, and environmental companies, helping them identify "prior art" for patents they are pursuing on inventions as well as assisting companies invalidate patents. She also assesses medical device research to validate or invalidate claims from companies promoting competing products. Nerac Inc. (www.nerac.com) is a global research and advisory firm for companies developing innovative products and technologies. This article was adapted from one published last year in Nerac Insights (tinyurl.com/nerac-devices). Information from Sarah Yang at UC Berkeley was also used in this report.

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