ZONE SONOGRAPHY:™ THE NEXT MAJOR ADVANCE IN MEDICAL ULTRASOUND

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INTRODUCTION

There have been dramatic achievements in the advancement of medical ultrasound since its first application as a diagnostic tool. The advent of real-time imaging, Doppler ultrasound, miniaturization, and a host of specialized adaptations and image quality improvements have made diagnostic ultrasound a valuable and reliable tool in the medical theater – with major applications in obstetrics/gynecology, cardiology, abdominal imaging, and vascular imaging. Despite this impressive advancement, however, the data acquisition method upon which all conventional ultrasound systems are based has remained relatively static, with inherent limitations on its ability to deliver increasing image quality as well as advanced clinical benefits. This paper will explore the current state of the art in ultrasound imaging and discuss a new core technology that has the potential to far exceed the limitations imposed by conventional technology.

A BRIEF HISTORY OF MEDICAL ULTRASOUND

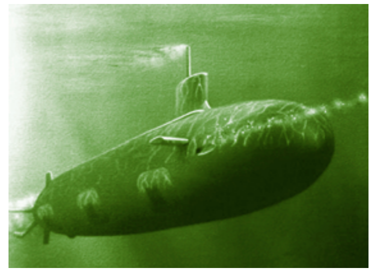
OVERVIEW

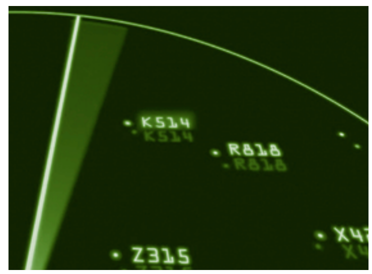
The Early Days

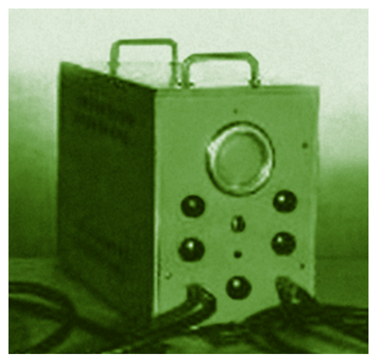
Based on sonar and related technologies, research on the use of ultrasound in medicine began shortly after World War II in a variety of centers in Europe and Japan, including pioneering work by Dr. Karl Theodore Dussik in Austria, Ian Donald and his colleagues in Glasgow, and Shigeo Satomura and colleagues in Osaka.

From the mid-1960s onward, rapid technological advances in electronics and piezoelectric materials led to substantial advancement – from bistable to grayscale images and from still images to real-time moving images. The fusing of Doppler ultrasound and ultrasound imaging and the subsequent development of color Doppler imaging provided enhanced ability to investigate hemodynamics, tumors, blood supply to organs, and other physical processes.

The adoption of the microchip in the 1970s triggered exponential increases in processing power, facilitating the development of faster and more powerful systems incorporating digital beamforming, signal processing advances, and new ways of developing and displaying data.







Underwater sonar, radar and the ultrasonic metal flaw detector were each, in their unique ways, a precursor of medical ultrasonic equipment. The modern ultrasound scanner embraces the concepts and science of all these modalities.[1]

HIGHLIGHTS OF RECENT ADVANCEMENTS

Improved Images via Computer Technology

One of the most dramatic improvements in the ongoing development of ultrasound imaging has been the application of technology originally developed for use in computers. In the beginning, ultrasound technology was developed independently of computer technology. Existing scanners returned satisfactory images through electrical channels, but the images could not be refined because computers for ultrasound imaging did not exist.[2]

That all ended in the early 1980s with the development of the computerized beamformer platform, which ushered in a whole new era in diagnostic ultrasound imaging. With the wedding of computer technology and diagnostic ultrasound, a computerized image formation process provided black-and-white images with superior resolution and clarity.

Doppler Imaging

Continuous wave Doppler instruments were available in the mid-1960s. However, it wasn't until the introduction of pulsed-Doppler systems in the early 1970s that the technology had a major impact on ultrasound imaging, for the first time providing noninvasive localized measurements of blood velocity.[1] The introduction of duplex pulsed-Doppler in the mid-1970s, an important milestone, enabled 2D gray scale imaging to be used in the placement of the ultrasound beam for Doppler signal acquisition.[1]

Doppler color flow imaging technology was introduced and incorporated into a highly successful phased array cardiac system in the mid-1980s. This major advance vastly improved the utility of ultrasound imaging and provided the cardiovascular community with important new options for the study of blood flow in the heart and vascular system. This new technology has important applications in virtually all aspects of ultrasound imaging, including obstetrics.[3,4] For example, Doppler ultrasound examination of the umbilical artery is an important noninvasive tool in the assessment of fetal development.[5]

Digital Beamformation

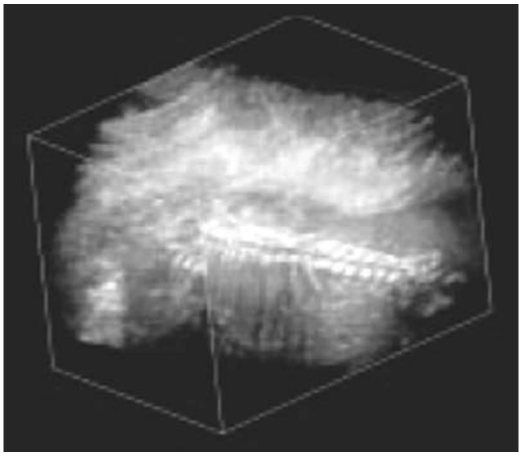
The development of a digital beamformer in the mid-1980s and the subsequent migration to a digital platform by ultrasound manufacturers substantially raised the level of performance industry-wide. This new technology allowed for more sensitive, consistent, and accurate acquisition of sonographic data, providing for higher-resolution images.

Harmonic Imaging

Harmonic imaging was first developed to increase blood flow detection sensitivity in color and power Doppler applications using echo enhancing contrast agents.[6] Based on research results using Contrast Harmonic Imaging (CHI), researchers investigated the possibility that harmonic imaging would also improve B-mode imaging without contrast agents, particularly in difficult-to-image patients. The subsequent introduction of Tissue Harmonic Imaging (THI) has demonstrated that this technology can increase spatial and contrast resolution and more effectively suppress artifacts compared with conventional B-mode imaging not only in obese patients, but also in many other applications.[7]

3D Imaging

The first 3D scanner was produced in 1974, but it was not computerized and proved a disappointment. However, computerized modeling of ultrasound images began in the 1980s and the result of that research, combined with 3D scanning technology, ultimately led to the development of improved 3D imaging.[8] This provided clinicians with a level of imaging detail substantially better than what had been previously available. And as data acquisition and display continue to improve, 3D imaging will be increasingly more clinically useful.



The 3D MIP volume is rotated and processed to display the length of the spine and ribs in an early 2nd trimester pregnancy.[10]

Compact Systems

A variety of portable ultrasound devices have been developed over the years, culminating in the late 1990s with the introduction of compact ultrasound diagnostic systems weighing less than six pounds. Although early portable systems did not produce images at a level of quality comparable to full-size machines, recent advances in miniaturization represent a technological milestone that will undoubtedly lead to increasingly capable compact ultrasound systems.

Innovation Typically Comes From Small Companies

It is interesting to note that most significant innovation in ultrasound technology, both historically and continuing to the present, has been achieved by small companies or individual researchers working with a small group of colleagues. Larger manufacturers, despite superior resources and extensive research groups, have typically focused on incremental refinement of existing technologies.

DESPITE DRAMATIC PROGRESS, SIGNIFICANT PROBLEMS STILL REMAIN

ACQUISITION TIME IS PHYSICALLY CONSTRAINED

In all conventional ultrasound systems, the time required to acquire ultrasound data is physically constrained by sound propagation in the body. In soft tissue, this averages 1.54 mm/μs.[9] Conventional ultrasound systems have to wait for this sound propagation, during both transmit and receive, due to the serial nature of line-by-line data acquisition. No matter how sophisticated or advanced processing modes may be, this limitation poses very real and significant problems, some of which are discussed below.

Using Multiple Modes Simultaneously

Although great strides have been made in digitizing and processing data in the "back end" of conventional ultrasound systems (e.g., image processing and scan conversion), image acquisition and "front end" processing (e.g., beamforming and data acquisition) is still a slow and inefficient process. As a result, multiple-task processing with conventional systems requires the sacrifice of frame rate and overall speed, often forcing the clinician to choose between frame rate and image quality or making some desirable modes or potential combinations unacceptable in terms of image quality. For example, temporal resolution may be sacrificed for an improvement in detail resolution.[9]

The acquisition speed limitation of conventional systems also causes a degradation of either frame rate or B-mode imaging when color Doppler is employed. This is because color Doppler techniques can require 10 or more pulses per scan line, and therefore frame rates are lower than those for comparable depth gray scale anatomic imaging.[9] The problem, as noted earlier, is that conventional beamforming is physically constrained by the line-by-line data acquisition method.

Real-Time 3D Imaging

The development of a practical real-time 3D system has been delayed by similar technical problems, including processing speed, reliance on and size of position sensing devices, and poor resolution of images.[10] Technological and scientific advances recently solved some of these problems and in the late 1990s, devices that began to approach the ideal of real-time 3D ultrasound were finally introduced. The limitations of conventional ultrasound image acquisition technology, however, continue to prevent 3D images from being both real-time and high quality. 3D images are still formed through the acquisition of many parallel two-dimensional sections of echo information.[9]

CUSTOM BEAMFORMING ARCHITECTURE IS INEFFICIENT

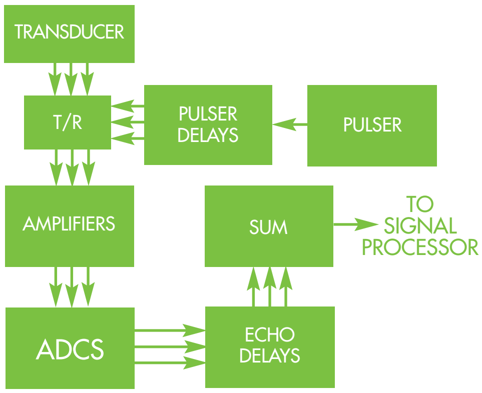
As noted earlier, despite significant advancements in other aspects of ultrasound technology, conventional systems still rely on custom-designed beamforming architectures that are implemented through proprietary hardware. Following is a brief discussion of some of the primary limitations imposed by this approach.

Cost/Performance Trade-Off

Because conventional ultrasound systems consist primarily of proprietary hardware and electronic components, the high cost of development and manufacturing must be passed on to the ultimate purchaser. Equipment capable of producing high quality images is expensive to produce and therefore expensive to purchase. And development time is extensive. Economies of scale characteristic of commodity-based technologies such as computers have not yet been realized to a significant extent in ultrasound image formation.

Portability/Performance Trade-Off

While it has been possible to miniaturize the general process of ultrasound imaging, the limitations of conventional technology force conventional compact systems to sacrifice image quality for size, thus compromising diagnostic confidence. Systems that deliver high quality images, on the other hand, are large and heavy, require enormous amounts of electrical power, and present substantial logistical problems in the clinical environment.



The conventional beamformer consists of a pulser, delays, transmit/receive (T/R) switch, amplifiers, analog-to-digital converters, and a summer. It sends digitized echo data to the signal processor.[11]

Cost of Upgrading

Conventional ultrasound systems are based on a rigid architecture that is inflexible because it is implemented primarily through custom hardware. It is therefore difficult to change the data acquisition method, difficult and costly to alter the architecture, and costly to upgrade existing systems.

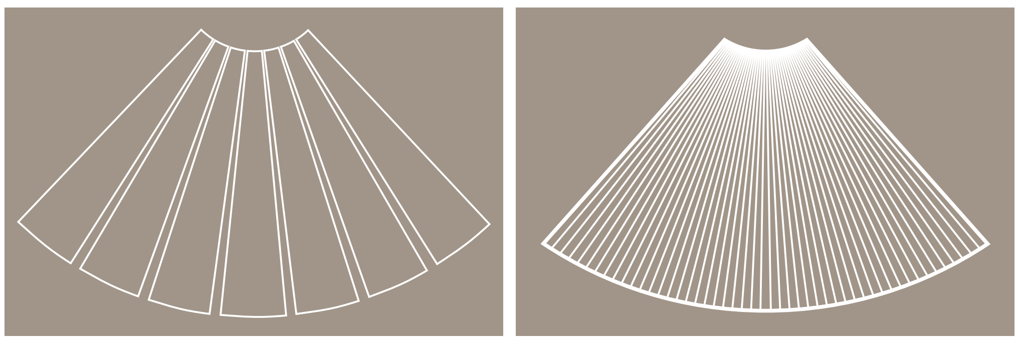
ZONE SONOGRAPHY: THE NEXT MAJOR MILESTONE

WHAT IT IS AND HOW IT'S DIFFERENT

Zone Sonography is an entirely new approach to ultrasound image acquisition and processing. While conventional systems typically have digital beamformers, they are still implemented through custom-designed hardware. Only back-end processing is implemented in software. Zone Sonography is extensively implemented in software on both the front and back ends, with the promise of substantial clinical benefits.

ZONE CAPTURE VS. LINE-BY-LINE ACQUISITION

The acquisition of echo data in large zones vs. conventional acquisition in narrow "lines" provides dramatic advantages. Imagine, for example, the difference in transporting water with a large bucket rather than a teaspoon.



The illustration on the left shows the vertical zones of an image acquisition using Zone Sonography. The illustration on the right shows the conventional method of line-by-line image acquisition. Hundreds of lines may be required to acquire a typical image using conventional technology, compared with far fewer zones using Zone Sonography.

Faster Data Acquisition

Regardless of the specific equipment, all conventional ultrasound systems acquire and process echo data line-by-line and therefore are limited by the time required for sound propagation in the patient's body. Zone Sonography, however, captures a great deal of data very quickly in a relatively small number of large zones, each of which contains a volume of data equivalent to many "lines" in a conventional system.

5.2 msec vs. 52 msec

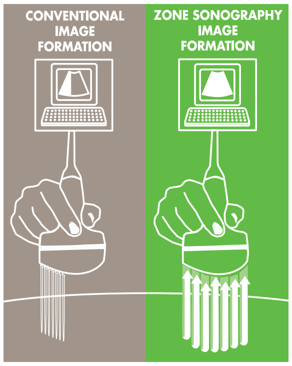
Time to acquire a representative frame in Zone Sonography vs. conventional ultrasound.

Acquisition time = number of transmit firings x 2 x depth/c
where c = 154 cm/ms (the speed of sound in normal human tissue)
Conventional systems may use 200 firings to scan the field of view, so that for an image depth of 20 cm, the acquisition time would be 52 ms. In Zone Sonography, the number of firings is an order of magnitude smaller, so that for the same field of view, the acquisition time can be as short as 5 ms.

In addition, conventional ultrasound imaging systems form only one or a few receive beams from each transmit excitation and each of these transmissions is also limited by the speed of sound traveling through tissue. Zone Sonography acquires echo data from a substantially larger region from each firing by insonifying it with a broad transit beam. This data is captured and processed in far greater quantities by a software system installed on a powerful processing unit, and therefore image formation is not directly tied to the speed of sound.

Constraint on Performance is Processing, Not Physical Properties

Because so much data is acquired quickly and processed in software, the speed of data acquisition and image formation is not significantly limited by the speed of sound propagation in the body. Therefore the performance of a Zone Sonography system is not tied to the speed of sound propagation, as in conventional systems, but to the speed of the processor. And as processor technology continues to evolve, this performance will improve accordingly.



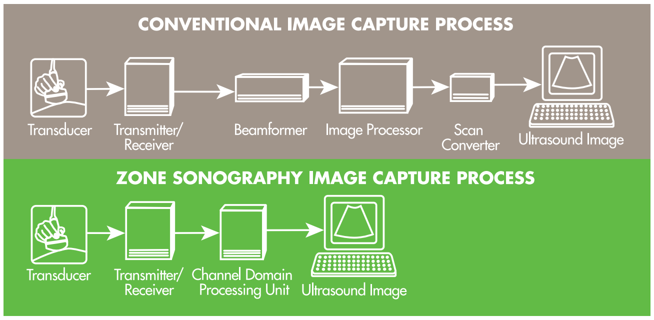
Zone Sonography insonifies large areas, then receives and processes signals in channel domain (averaging, filtering, etc.), reconstructing many receive beams within each transmit zone.

CHANNEL DOMAIN PROCESSING™

Channel Domain Processing implements the full reality of data acquisition and management in software rather than hardware. This approach delivers substantial benefits immediately and sets the stage for rapid and dramatic improvement as processing power continues to increase. It's very much like converting from a mechanical typewriter to a computer-based word processing system. Flexibility, speed, quality, and options increase immediately – and expand exponentially with the power of the computer.

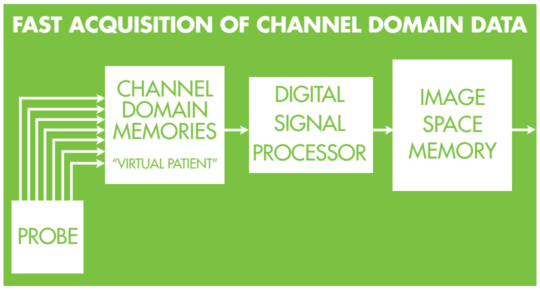
Conventional ultrasound systems often have digital beamformers, but only Zone Sonography implements the beamformer entirely through software. The difference is dramatic. The sheer size of a physical beamforming unit in a system capable of producing a high quality image makes the overall size and weight of the system unwieldy. As noted earlier, custom hardware-based beamforming units are inherently expensive to produce, purchase, and upgrade. The hardware architecture is inflexible and difficult to change.

Zone Sonography combines the beamformer, image processor, and scan converter – typically hardware components in conventional ultrasound systems – into a software based Channel Domain Processing (CDP) unit.



Development cycles tend to be lengthy. And image formation in hardware-based systems do not benefit directly from continuing advances in processing speed.

In contrast, the Zone Sonography beamformer is implemented entirely through software. Therefore, it can be housed in an extremely small processing unit, making it possible to create a small, light system capable of producing high quality images. Software development is faster and less expensive than the combination of technological and manufacturing development required for hardware systems. Software-based systems are also easier to change and more flexible in operation than rigid hardware architectures. And they will become more powerful and more capable as processing power increases.



Zone Sonography translates data acquired in each large zone into the equivalent of multiple "lines" of data that would be acquired by conventional technology. Data for each zone is then stored, processed, and displayed at the speed of light.

Channel Domain Data™

In conventional ultrasound systems, each line is formed by summing together the contributions of all the channels in the transducer. As soon as each line is formed, the original channel data is discarded. Zone Sonography, on the other hand, aggregates the original channel data in large zones and stores this information in Channel Domain Memory. All of the original raw echo information from each transducer channel is then utilized in Channel Domain Processing to form the image. In addition, reconstructed line data is stored permanently in a separate cine memory, substantially increasing post-processing options.

This approach provides more flexibility and capability and employs a more complete data set in processing the echo data. For example, because all of the data is available and also because data acquisition itself is so fast, the system could process the Channel Domain Data multiple times using different algorithms to develop an optimum solution. Each time, the system would be able to process the complete set of original data. The result would be an optimum image from the available data.

Off-the-Shelf Hardware

Whereas existing systems are comprised predominantly of proprietary hardware components, Zone Sonography utilizes primarily off-the-shelf hardware that is mass produced and has already been perfected and proven in commercial use. There are several advantages to this approach. Since it is not necessary to invest heavily in custom hardware development, Zone Sonography development is focused almost entirely on refinement of the software that operates the system. This reduces the overall development cost while making it possible to upgrade the software on a continuing basis. It also reduces the purchase price of the system, since there is significantly less hardware in the system and the open-source hardware that is involved is substantially less expensive than proprietary equipment.

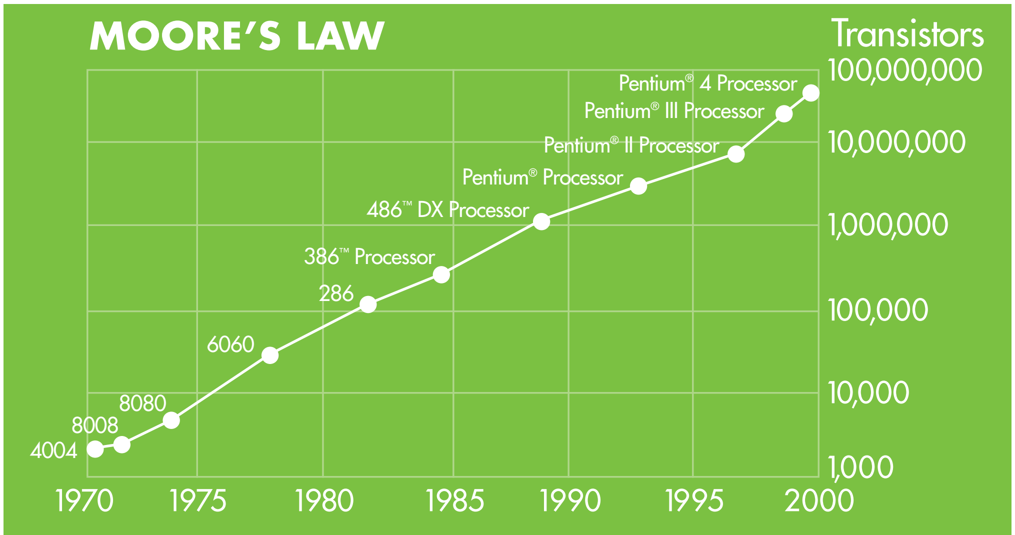


Chart shows Intel's actual increase in processing power over time.[11]

Moore's Law

Moore's Law states that the data density, and hence processing capability, of integrated circuits will double approximately every 18 months.[12] This pace of advancement is expected to continue for at least another two decades.[13] This means that the speed and capability of software-based systems dependent upon processor power will increase as processors become more powerful. Therefore, because it is not significantly limited by the speed of sound propagation, Zone Sonography will be able to leverage Moore's Law and become faster and more capable as processor capability increases. Hardware-based systems such as conventional ultrasound systems do not benefit from the rapidly increasing power of computer processors in their image formation. Only back-end processing, a small part of overall system performance in conventional systems, is affected by improvement in processor speed.

THE PROMISE OF THE TECHNOLOGY

As we have seen, each advancement of ultrasound technology has ushered in important new clinical capabilities. That is also true of Zone Sonography. In addition, it also offers economic and operational benefits.

THE CLINICAL PROMISE

High Image Quality in a Compact Package

Because Zone Sonography is software-based and implemented on a standard digital signal processor (DSP), it is inherently compact. Therefore a full-featured, high quality system can be implemented in an efficient, portable configuration. For example, a system by ZONARE, the first ultrasound system to implement Zone Sonography technology, is a full-featured, cart-based system with a large monitor and a wide array of dedicated controls, offering the same comprehensive ultrasound workstation as the best premium cart-based systems. The "brains" of the system are contained in a self-enclosed compact unit that can be removed from the cart and transported to the patient quickly and easily.

Convertible Ultrasound™

The ZONARE configuration provides efficient convertibility, giving the clinician flexibility to employ high quality ultrasound in a variety of ways, depending upon the specific workflow requirement. The clinician can take the compact unit to patients who cannot be transported to Radiology, or to the ER, where access to the patient may be limited and time at a premium, and to situations such as the ICU, where an abundance of other equipment may preclude the use of a larger system. The cart format is smaller and lighter than conventional systems of equivalent image quality, and therefore it is possible to use the full cart system in situations where the typical 400-pound system simply would not fit. And it's easy to use the system in both modes, transporting the compact component to the patient's bedside and then performing all of the data analysis and postprocessing on the cart. Therefore, it is no longer necessary to settle for poor image quality when the situation requires a compact unit or to transport a sick patient to Radiology for a high quality examination.

Zone Sonography and related technology has therefore made it possible to develop the only high quality ultrasound unit that is both a light, transportable compact system and a full-featured premium cart system – with a full-sized monitor, familiar user interface, and comprehensive, full-sized controls – on demand.

In the future, the compact unit, operating on its own power, will also be able to transmit information wirelessly to the Radiology lab or other locations within the facility, providing yet another level of flexibility, efficiency, and convenience.

Potential Advantages of Channel Domain Processing™

As processing power advances, applications can become increasingly sophisticated. For example, all conventional ultrasound systems have to make an assumption regarding the speed of sound in the tissue being imaged. However, different types of tissue have different sound properties and even the same type of tissue may not have similar properties from patient to patient. Therefore, these built-in assumptions are often inaccurate. This refraction and propagation speed error can cause inaccuracy and also may cause a structure to be displayed with an incorrect shape.[9] Using the full set of Channel Domain Data, fast processing, and the flexibility of a software-based beamformer, a Zone Sonography system could analyze the actual echo data in a variety of ways to optimize the accuracy of tissue representation for that specific patient – rather than relying on rigid prior assumptions.

Because Zone Sonography has comprehensive Channel Domain Data and the flexibility of a software beamformer, the system can potentially process the Channel Domain Data multiple times using different receive focus calculations that will optimize the focus at different points in the image. The results can then be combined in a single image with dramatically improved overall quality. With sufficient processing power, it is conceivable that this optimized focus approach could be applied to every pixel in an image.

Unique Imaging Capabilities

The speed with which Zone Sonography acquires data makes it possible to employ a variety of simultaneous modes without sacrificing frame rate or to increase frame rate where appropriate (e.g., cardiac imaging). This can be particularly useful in situations such as imaging obese patients, where a variety of viewing modalities may be combined to enhance penetration and image quality. With widespread obesity becoming a national epidemic, yesterday's difficult patient is today's average patient, posing a real challenge for the clinician that Zone Sonography can help to address.

Faster Access to new Clinical Applications

New clinical applications and enhanced system capability can be made available to the clinician quickly and inexpensively through software upgrades. Long development cycles and the high cost of system upgrades may no longer be an impediment to the improvement of clinical capability.

Improved Temporal Accuracy

The inherent time delay in the data acquisition process of conventional ultrasound systems poses a significant problem when imaging moving objects such as a heart or a fetus. The process unavoidably introduces artifacts of motion into the image with the associated degradation of integrity. The speed of data acquisition in a Zone Sonography system, and the acquisition of data in larger volumes, provides images that are substantially more temporally coherent and artifact-free.

For example, in imaging blood flow in the carotid artery, conventional systems may present an image depicting flow on each side of the image with different velocities. However, in reality the flow velocity does not change from one end of the artery to the other. The slowness with which the Doppler data was acquired results in samplings from different points in the cardiac cycle.

Zone Sonography substantially reduces the effect of temporal artifacts because the images presented are much closer to being a snapshot in time rather than a combination of sequential events.

Fast, Volumetric Exams

Due to the speed of image acquisition and the powerful image processing capability of Zone Sonography, the promise of true real-time 3D imaging may finally be realized. This would have broad clinical utility, particularly in cardiology and obstetrics/gynecology. For example, the application of true real-time 3D imaging in obstetrics would make it possible to examine a fetus both faster and more thoroughly. That's an important issue because the detection of anatomic congenital anomalies is one of the goals of prenatal care.[14] And the accuracy of ultrasound in detecting congenital anomalies has been the subject of considerable debate in the literature.[15] In studies evaluating accuracy in detecting congenital anomalies by routine ultrasound screening before 24 weeks, sensitivity (the ability to detect an anomaly when it is present) ranged from 16% to 92%, depending upon the center conducting the screening.[15] It is hoped that better 3D imaging would improve this clinical performance.

Zone Sonography acquires data much more quickly than conventional systems, thereby improving both the accuracy and clinical utility of the data. The acquisition of a 3D data volume set via Zone Sonography would, for example, enable the clinician to capture a "virtual patient" that can be viewed in a variety of ways even after the patient is gone. It would be possible to view the data from a variety of angles, including angles from which the data could not have been acquired directly.[16] The clinical benefits of this capability include the potential of a more complete diagnosis, a faster exam process, and simplified data acquisition.

The Power of the Platform

Another way Zone Sonography can improve image quality is through the potential to accommodate many channels of data without sacrificing compact size or frame rate. Because of the way data is acquired and the software implementation of the beamformer, it is substantially less expensive to expand the channel density on a Zone Sonography system than it would be to develop a hardware-based system with the same image quality. Zone Sonography could incorporate twice the number of data channels of a conventional system and still be substantially smaller and lighter.

More Research Options

Since Channel Domain Data contains all of the original raw data, maintaining the full contribution of each original channel, it is a more complete representation of the ultrasound data than the data set processed by conventional systems. Researchers will therefore have greater freedom in the application and analysis of this data set. Also, the open architecture of the software-based system allows algorithms developed by researchers to be added to a Zone Sonography system for use in a research or other clinical setting. This enables the researcher to explore a virtually unlimited range of possibilities with an inherently richer data set than is available on conventional systems.

THE ECONOMIC PROMISE

The largely software architecture and reduction of development costs substantially improves the performance/cost ratio of a Zone Sonography system. It offers a lower purchase price and lower maintenance cost than conventional systems with comparable image quality due to the elimination of costly proprietary hardware and the inherent simplicity of the physical aspects of the system. As a result, it provides a substantially lower lifetime cost of ownership.

Quick and Easy Upgrades

Since Zone Sonography is almost entirely implemented through software, it is possible to upgrade the system through a variety of fast and inexpensive distribution modalities. For example, an upgrade could be made available for download through the Internet, distributed on inexpensive CD disks, or mailed out on flash memory cards. It is likely that upgrades would be frequent, since the cost of distributing them would not be an impediment.

Long-Term Viability of Technology

Because the system can be upgraded quickly and inexpensively through software updates, the technology can be refreshed on a continuing basis. It is therefore likely that a typical Zone Sonography system will remain viable longer than a comparable system that is primarily hardware-based, since it is far more difficult and expensive to replace hardware than software.

Improved Reliability

Less hardware typically translates into more reliability simply because there are fewer things to break down. Therefore, it is likely that Zone Sonography systems will be more reliable and require less repair than conventional ultrasound systems. This is even more likely because of the extensive use of proven, off-the-shelf components.

Better Service

Service is also likely to be faster and easier. The primary components and software are contained in a compact unit that can be replaced quickly, potentially on a same-day basis. Therefore the inconvenience and revenue impact of downtime can be virtually eliminated.

OPERATIONAL PRODUCTIVITY

Whereas conventional systems are either large and heavy or small and limited in image quality, Zone Sonography provides both high image quality and compact size, with significant operational advantages.

Workflow Flexibility

The quick and easy convertibility from a cart-based system to a compact unit provides the convenience of portability plus the superior functionality of a highly efficient, full-size workstation, giving the clinician a high degree of workflow flexibility.

Increased Number of Exams per day

It may be possible to perform more examinations per day due to the combination of portability and image quality, enabling the clinician to transport the scanner quickly and easily and reducing the necessity for repeat scanning due to questionable image quality. With Channel Domain Data and software beamforming, it is possible for the system to automatically optimize the image for the user based on the nature of the data set without requiring time-consuming image manipulation or experimentation. The user also does not have to be concerned with focal zones because the comprehensive processing of channel domain data makes them unnecessary.

Portability Between Facilities and Within Facilities

Because it is not necessary to sacrifice image quality for portability, the technology can be transported quickly and easily within a facility or between facilities for full operational capability virtually anywhere. Thus it is simple and convenient to take the compact unit to remote facilities or imaging centers whenever necessary and without delay.

The Human Benefit

It's a sad fact that 81% of ultrasound technologists experience some sort of physical problem associated with repetitive stress injury.[17] And for many, this is a career-ending event. The reasons are rather straightforward. They often have to push systems weighing up to 500 pounds and they have their hands in unusual positions, applying pressure, for hours on end.

A Zone Sonography system addresses these problems in two ways. First, since the cart is substantially smaller and lighter than a conventional system at the same level of image quality, the operator is relieved of the sheer physical burden of pushing unwieldy equipment. Using the system in its compact form is even less of a physical burden. And second, whether used as a compact or cart-based system, the Zone Sonography unit is significantly easier to maneuver into an ergonomically correct position than a conventional system with the same image quality, reducing the potential for repetitive stress injury.

A compact system with premium performance such as the Zone Sonography unit also offers important benefits for the patient. It ensures that the patient will not receive a lower-quality examination in situations where a compact unit must be used due to restricted access, and it makes it unnecessary to transport a sick patient to Radiology for a high quality examination. Of benefit to both the patient and the operator, since the quality of the examination is often dependent upon the performance of the operator,[15] a lighter, more maneuverable high quality system offers fewer impediments to optimum performance.

SUMMARY

Until now, advancement in ultrasound imaging has been incremental, improving the implementation or performance of a base technology that has remained relatively static. Image acquisition has continued to rely on proprietary hardware that perpetuates the inherent limitation of a conventional line-by-line image acquisition methodology. Zone Sonography may offer the opportunity to replace that base technology with a more efficient methodology. If that proves to be the case, Zone Sonography may represent the next major turning point in the history of ultrasound development.

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