Ultrasound at Siemens Healthineers

- Ultrasound is a rapidly growing, non-invasive imaging modality that delivers detailed images for almost every medical specialty
- Technology advancements enable ultrasound to provide diagnostic information to aid in surgical planning and minimally invasive procedures
- Siemens has been pioneering ultrasound technology since the 1930s and offers an expansive product portfolio across cardiology, general imaging, and point of care

Ultrasound is the most commonly used medical imaging method. The technology was first used more than 100 years ago, mainly for civilian and military navigation. Today it is used as a non-invasive diagnostic tool in clinical practice. Ultrasound was first applied in medical imaging in 1942 by neurologist Karl Dussik (1908–1968), who used it to image a lateral ventricle of the cerebrum. From that point on, the use of ultrasound in diagnostics has been constantly growing. Today, thanks to more and more detailed clinical images, ultrasound is also used for advanced diagnostics, for example in helping physicians in assessing liver tumors.

Foundations of ultrasound imaging (sonography)

Ultrasound imaging, also known as sonography or echography, uses high-frequency sound waves to generate real-time images of tissues and organs inside the body. An ultrasound transducer emits frequencies above the threshold of human hearing (between 1 and 40 MHz); these enter the body and are dispersed, reflected or absorbed by different types of tissue. The transducer then detects reflected waves and converts them into electric pulses. From the timing of the reflected waves – also known as an echo – a computer can calculate the distance from the transducer to the tissue. These data are then used to generate real-time images of the examined area in two, three or four dimensions, enabling a doctor to assess the size, shape and density of organs and other tissue. Additionally, color-coded Doppler sonography, which works at specially
defined frequencies, can be used to dynamically image the flow of liquids, such as the blood.

One prerequisite for an ultrasound examination is that the tissue to be studied must contain fluid. For cavities that contain air, like the lungs or intestines, ultrasound is of limited use in examination and assessment. For example, ultrasound can be used to image the lungs’ surface and permit conclusions about bleeding or inflammation; however it can’t be used to diagnose the interior of the lungs. Since air represents a physical barrier for ultrasound, a contact gel with high water content is used for examinations, so as to eliminate interference from air between the probe head and the surface of the skin.

**Advantages over other imaging methods**

Sonography can provide rapid initial assessment – it is non-invasive and painless. Using non-ionizing radiation, ultrasound can be used on a broad range of patients including those with weak kidneys, allergies to contrast media, or pregnant women. Ultrasound also has advantages for less mobile patients because the systems are portable and can be moved as needed to a patient location. Sonographic examinations can also be combined with methods like tapping or biopsy. Here the technique’s capacity for real-time observation is an advantage over computed tomography (CT)-guided tapping. Ultrasound has a lower cost of acquisition and operation than other imaging techniques like CT or magnetic resonance tomography (MRT). Additionally, since there is no ionizing radiation involved, there’s no need for extensive protective measures, building alterations (including shielding) and staff safety training as there are for techniques which involve radiation exposure.

**Medical applications for ultrasound imaging**

Sonography has the broadest use for imaging clinical applications. Ultrasound is used in almost every medical specialty, including obstetrics, gynecology, radiology, urology, emergency medicine, pediatrics, neurology and internal medicine. It can be used to examine the thyroid, abdomen (e.g., liver, kidneys), smaller organs, the breast, testicles and musculoskeletal organs. Ultrasound is also used in cardiovascular and intracardiac applications – meaning diagnostics of the heart and blood vessels.
Today, imaging devices with specialized software and transducers are increasingly needed for specific applications. Ambulances are equipped with high-performance ultrasound units, portable units are used in retirement homes, and cardiovascular scanning systems provide detailed images of the heart in real time during surgery. Modern gynecology and pregnancy are almost unimaginable without ultrasound, especially as part of preventive care. Ultrasound imaging reveals multiple pregnancies and helps physicians diagnose developmental problems and malformations in the fetus long before birth. Sonography is also an integral part of today’s preventive pediatric examinations – for example, it’s used routinely to diagnose signs of hip disease in babies at three months of age.

**Trends in ultrasound diagnostics**

With numerous technological advances in imaging, ultrasound continues to conquer new fields of advanced application. Experts have especially noted trends in elastography, contrast-medium ultrasound, image fusion, and minimally invasive surgery (for example, in cardiology).

**Trend 1: Elastography**

Diseased tissue is often harder and more rigid than healthy tissue. Measurements of tissue stiffness permit early diagnosis about illnesses or even tumors, for example in the breast, prostate, liver or thyroid. In addition to classic biopsy, this kind of tissue information can often also be gathered with ultrasound. One option is manual compression, in which the examiner applies mild pressure from outside the body to an organ with the ultrasound probe. A software program then evaluates small shifts between individual images to calculate tissue rigidity. On its premium ultrasound systems, Siemens offers conventional shear-wave elastography under the Virtual Touch (VT) brand, as well as up to three automated elastography applications – Virtual Touch™ imaging (VTI), Virtual Touch™ quantification (VTQ), and Virtual Touch™ IQ (VTIQ) – all based on Acoustic Radiation Force Impulse (ARFI), and provide both qualitative and quantitative elastography data. ARFI technologies are used successfully in patients with serious liver disease, potentially reducing the need for liver biopsies.
Trend 2: Contrast-medium ultrasound

According to DEGUM, the German medical ultrasound society, contrast-medium ultrasound represents the most significant diagnostic advancement in recent years.\(^1\) While conventional ultrasound scans can show organs and tissues with a high spatial resolution, the addition of contrast medium makes it possible to show the blood supply to tissue – which could be helpful for the physician in diagnosing tumors and heart attacks.

In such an examination, gas-filled microbubbles are administered intravenously to a patient. Over time they accumulate in tissue in a particular pattern. By viewing the migration of the contrast medium in the circulatory system, a doctor can assess the blood supply to various organs like the brain, kidney and liver. On its ultrasound systems, Siemens offers a variety of applications for many types of contrast-medium sonography, including Cadence Contrast Pulse Sequencing\(^*\) (CPS) and Contrast Harmonic Imaging\(^*\) (CHI). In both these techniques, certain sequences of sound waves are emitted, causing the contrast-medium bubbles to vibrate yielding ultrasound images by way of the echoes. CPS permits observation of deeper layers of organs on a screen, while CHI reveals smaller vessels and volumes, closer to the surface, in great detail.

Trend 3: Image fusion with ultrasound

With image fusion, medical images taken in various modes are superimposed to combine their respective advantages. This capability supplies additional relevant clinical information, speeds up workflow, and is easier on patients. While therapeutic monitoring previously used CT scans, it is now possible to monitor the progress of cancer therapy by superimposing existing CT images with real-time ultrasound images. An approach like this reduces x-ray exposure from CT scans for both patients and hospital personnel. The Siemens Acuson S3000\(^{™}\) ultrasound system, HELX Evolution\(^{™}\) with Touch Control incorporates eSie Fusion\(^{™}\) imaging technology, which permits real-time ultrasound images to be automatically superimposed with previously generated three-dimensional CT or MR images. At a touch of a button, doctors are presented with more information for diagnosing complex issues for surgery or biopsies.

Trend 4: Real-time transesophageal echocardiography (TEE)

Some parts of the heart, such as the cardiac valves, cannot be displayed adequately by scanning with ultrasound from outside the patient’s body. Interfering factors like lung tissue or ribs prevent a clear view. To get as close as possible to the region of the heart under examination, a flexible ultrasound probe can be introduced via the esophagus. This makes it possible to show some parts of the heart better than trans-thoracically, from outside over the ribcage. While imaging in 3D/4D current methods combine images from multiple heartbeats to generate a representative sample of the heart through a full cycle (a method known as “stitching”), Siemens’ True Volume TEE probe supplies real-time 3D/4D images of the heart as it beats. That also makes it possible to examine patients with disruptions of the cardiac rhythm, or to assess heart valve function during surgery. Siemens’ eSie Valves™ software analysis package makes it possible to measure aortic and mitral valves at the touch of a button. These measurements give a doctor detailed anatomical information, saving several minutes per patient.

A history of ultrasound at Siemens

Siemens has been working with medical applications of ultrasound since the end of the 1930s. The company continues to innovate new applications and solutions ever since:

1938: Reimar Pohlmann began his experiments on medical use of ultrasound on patients. From 1939 on he worked on ultrasound technology for Siemens.

1947: Based on Pohlmann’s ideas, an ultrasound material testing device and the first therapeutic ultrasound machines, such as the Sonostat, were created.

1953: The Siemens ultrasound device for material testing was used to examine the heart in motion using sound waves. This new technique was pioneered by the cardiologist Inge Edler and the physicist Carl Hellmuth Hertz in Sweden. From 1960 on, the method was called “echocardiography”.

1967: The Siemens Vidoson 635 ultrasound system comes to the market. It makes processes observable in real-time for the first time. The real-time technique reduces the number of x-ray examinations of pregnant women – once a common procedure – by about 90 percent.

1979: The Siemens Echopan KS ultrasound system is being expanded by a mechanical sector scanner to enable the first B-mode images of the moving heart.
1981: Siemens introduces its first portable ultrasound system, the Sonoline 1000.

1981: Siemens’ first fully digital ultrasound device, the Sonoline 8000, offers significantly faster data analysis. Siemens offers the Sonoline product line in a variety of series for nearly 25 years.

1990: Siemens puts its first ultrasound system with color Doppler capability on the market: the Q2000. This is the first unit that can display blood flow in vessels, without invasive peripheral angiography.

1996: Siemens introduces the ultrasound imaging Sonoline Elegra, the first high-end system with SieScape panoramic imaging.

2003: Siemens presents the first portable ultrasound unit for echocardiography, the Acuson Cypress™ ultrasound system. The system is used on the 2003 Mount Everest Expedition to measure the influence of extreme altitude on cardiac and pulmonary function.

2007: Siemens brings out the Acuson P10™ ultrasound system, the world’s smallest ultrasound unit at the time. Weighing only 0.725 kilograms and the size of a Blackberry smartphone, it is small enough for doctors to carry around in their medical bags.

2013: The Acuson Freestyle™ ultrasound system is the world’s first ultrasound unit with wireless transducers to expand ultrasound applications into sterile environments like surgery.

2014: Siemens’ 3D TEE (transesophageal echocardiography) supplies real-time 3D/4D images of the heart as it beats, while current methods for imaging in 3D/4D combine images from multiple heartbeats to generate a representative sample of the heart through a full cycle (a method known as “stitching”).
The Siemens ultrasound portfolio

Siemens Healthineers sells ultrasound systems with an emphasis on general imaging, cardiology, women’s health, and point of care*. It also sells software solutions from the Siemens syngo™ series.

Acuson S Family

The Acuson S Family™ of ultrasound systems is a premium series that offers advanced applications in addition to routine uses. The HELX™ Evolution with Touch Control makes these systems even easier and more intuitive to use.

**Acuson S1000™ ultrasound system**
This entry-level system for high-end sonography has a wide range of applications and a complete set of probes for almost any patient.

**Acuson S2000™ ultrasound system**
Excellent image quality in 2, 3 and 4 dimensions, with all Doppler modes, for general imaging. It also includes all ARFI (Acoustic Radiation Force Impulse) technologies for elastography.

**Acuson S2000™ with Automated Breast Volume Scanner (ABVS)**
The ACUSON S2000™ Automated Breast Volume Scanner is a comprehensive breast ultrasound solution which combines 2D/3D ultrasound and advanced technologies with automation. Automated acquisition improves the workflow of breast ultrasound examinations and delivers user-independent, standardized 3D images, enabling data consistency and efficiency.

**Acuson S3000™ ultrasound system**
A diverse range of premium applications like automated fusion imaging make the Acuson S3000 ideal for interventional radiology.
Acuson SC2000™ ultrasound system
The ACUSON SC2000 system delivers extraordinary performance across a wide variety of cardiologic environments including cardiac anesthesiology, interventional cardiology, surgery, and general cardiology.

Acuson X Family (Mid-range)
The Acuson X Family™ ultrasound systems comprises all-around systems that meet the needs of a variety of exam types in general imaging, cardiology, and women’s health. With a good price-performance ratio, this family of systems is suitable for both doctors who have their own offices and hospitals.

Acuson X150™ ultrasound system
The fully digital Acuson X150 contains all imaging technologies for basic ultrasound diagnostics – all with intuitive, easy operation.

Acuson X300™ ultrasound system, Premium Edition (PE)
Thanks to an extensive set of probes, the Acuson X300PE entry-level system has a wide variety of applications, including in urology, cardiology and intensive care.

Acuson X600™ ultrasound system
The cost-effective Acuson X600 has a robust architecture, with workflow solutions from the premium segment. It’s suitable for applications in neurology, gynecology and internal medicine.

Acuson X700™ ultrasound system
The Acuson X700 offers a good price-performance ratio for general and basic cardiology applications. The latest version includes innovative imaging technologies like eSie Touch™ elasticity imaging.

Acuson NX3™ ultrasound system
The Acuson NX3 and NX3 Elite are designed with a simple, intuitive user interface and offer advanced imaging and exclusive transducer technologies. They are ideal for
shared-service environments where users must quickly switch between exam types, like general imaging, cardiology and OB/GYN.

**Acuson P Family**

The portable ultrasound systems in the Acuson P Family™ ultrasound systems have a compact design and optional battery operation that make them easy and flexible to use.

**Acuson P300™ ultrasound system**

The portable Acuson P300 can be easily set up and taken down, making it ideal for fast-paced environments, multiple users, or where space is limited.

**Acuson P500™ ultrasound system, FROS K Edition**

The robust, notebook-sized Acuson P500 FROS K, with its intuitive infrared touchscreen display, uses two imaging technologies to reduce movement artifacts. It’s well-suited for uses in emergency medicine.

**Acuson Freestyle™ ultrasound system**

The first ultrasound system with wireless transducers, the Acuson Freestyle is particularly suitable for uses in sterile environments. At present it is used primarily in anesthesiology, surgery, interventional radiology, and musculoskeletal imaging.

**Acuson AcuNav™ Ultrasound Catheters**

Intracardiac ultrasound catheters enable real-time 3D visualization from inside the heart. It is ideally suited for electrophysiology and minimally invasive structural heart procedures. These catheters may enable surgical treatment for those patients who cannot undergo general anesthesia.

**Acuson AcuNav V:** The ACUSON AcuNav V ultrasound catheter provides real-time volume intra-cardiac imaging with a 10F catheter with 90 cm insertable length and offers 24 degree x 90 degree real-time volume.

*The products/features mentioned herein may not be commercially available in all countries. Due to regulatory reasons their future availability cannot be guaranteed. Please contact the local Siemens organization for further details.*