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Phased Array Transducer for Ultrasound Hyperthermia Design and Performance of an Ultrasonic Phased Array Transducer Transducers and Arrays for Underwater Sound Transducers and Arrays for Underwater Sound An Electrical Load for Simulating a Transducer in an Array Pass Ultrasound Physics Exam - Volume 1 Computer Controlled Transmit Receive System for an Ultrasonic Phased Array Transducer Pass Ultrasound Physics Exam Study Guide Review Volume I PDF Edition Real-time, Software-based Ultrasound Image Formation for Array Transducer Systems Fundamentals of Ultrasonic Phased Arrays The Performance of Large Element Ultrasonic Array Transducer Transducers and Arrays for Underwater Sound High Frequency Piezo-Composite Micromachined Ultrasound Transducer Array Technology for Biomedical Imaging Design and Development of a Phased Array Transducer System for Measuring Defects in Materials Endoscopic Ultrasonography Closed-loop Finite Element Design of Array Ultrasonic Transducers for High Frequency Applications Ultrasound Angular Scatter Imaging and Sound Speed Determinations with Array Transducers Crossed-Array Transducer for Real-Time Three-Dimensional Ultrasound Imaging Ontwerp van een versterker voor EMFi transducers in een Phased Array A Correlation Technique for Determining the Self- and Mutual-radiation Impedance of Transducers in an Array Ultrasound in Medicine Pass Ultrasound Physics Exam Study Guide Match the Answers - PDF Edition Diagnostic Ultrasound, Third Edition Ultrasound Tapered Phased Array Imaging Transducer Focusing the Field of a HIFU Array Transducer Through Human Ribs Breast Ultrasound Investigation of a Piezo-polymer Array Transducer for Pulse-echo Ultrasonic Material Examinations A Curved Array Ultrasound Transducer for Autonomous Vehicle Navigation Impedance of Interstitial Gaps in Transducer Arrays The Design, Fabrication and Characterization of Capacitive Micromachined Ultrasonic Transducers for Imaging Applications A Dual-mode Ultrasound System for Imaging and High Intensity Focused Ultrasound (HIFU) with a Single 2-D Capacitive Micromachined Ultrasonic Transducer (CMUT) Array Transducer Arrays and Array Processing Ultrasound of the Musculoskeletal System Focusing the Field of a HIFU Array Transducer Through Human Ribs High Frequency Piezo-Composite Micromachined Ultrasound Transducer Array Technology for Biomedical Imaging An Inertial-optical Tracking System for Quantitative, Freehand, 3D Ultrasound Development of 20-MHZ PMN-PT Single Crystal Phased-array Ultrasound Transducers for Biomedical Imaging Applications Color Doppler Sonography in Gynecology and Obstetrics Theoretical and Experimental Evaluation of Radiation Patterns Generated by Phased Array Ultrasound Transducers with Mechanical and Electronic Focussing The Essential Physics of Medical Imaging

This improved and updated second edition covers the theory, development, and design of electro-acoustic transducers for underwater applications. This highly regarded text discusses the basics of piezoelectric and magnetostrictive transducers that are currently being used as well as promising new designs. It presents the basic acoustics as well as the specific acoustics data needed in transducer design and evaluation. A broad range of designs of projectors and hydrophones are described in detail along with methods of modeling, evaluation, and measurement. Analysis of projector and hydrophone transducer arrays, including the effects of mutual radiation impedance and numerical models for elements and arrays, are also covered. The book includes new advances in transducer design and transducer materials and has been completely reorganized to be suitable for use as a textbook, as well as a reference or handbook. The new edition contains corrections to the first edition, end-of-chapter exercises, and solutions to selected exercises. Each chapter includes a short introduction, end-of-chapter summary, and an extensive reference list offering the reader more detailed information and historical context. A glossary of key terms is also included at the end. Volumetric ultrasound imaging can present numerous advantages to medical diagnostics, such as increased spatial context, better long-term patient tracking, and reduced imaging times. Creating three-dimensional ultrasound systems is complicated by the attendant increase in system complexity that is required to capture the additional data, and by pulse discrimination imposing repetition frequency limits from the fixed speed of sound in tissue. If the same principles utilized in two-dimensional cross-sectional imaging are applied directly to capture a volumetric data set, the electrical interface, system complexity, and acquisition times grow exponentially. An alternative volumetric imaging method that enables real-time three-dimensional ultrasound imaging using a crossed-array structure is presented in this thesis. The crossed-array transducer developed in this thesis makes use of careful material design and optimization to increase sensitivity and eliminate artifacts. A fine-pitch 1-3 piezocomposite has been optimized for performance in this application. This is combined with a novel method for creating intrinsic apodization within the piezoceramic material. Direct manipulation of the material sensitivity was found to be necessary to eliminate an artifact unique to the large defocused aperture being used: range secondary lobes. An acoustic stack has been designed for the transducer that optimizes sensitivity and reduces manufacturing complexity. Traces on a flexible circuit are used to define the array elements and the polyimide substrate is acoustically integrated as a matching layer. A defocusing rubber lens is used to keep the unfocused axis from experiencing near-field effects. Custom electronics are developed that incorporate a pulser and transmit beamforming system. The pulser uses a new circuit topology to create Ohmic grounding of the array elements when inactive. This is necessary in order to use the same substrate for both send and receive. A transmit beamformer and an advanced control interface have been developed that permit flexible testing using computer control, as well as stand-alone operation using focal data loaded through interchangeable cards. The system is characterized by its C-scan radiation patterns, showing confinement along the beamformed axis of 0.42mm at 75mm imaging depth. The defocused axis exhibits a smooth defocused profile with a 6dB angular spread of 45 degrees. The most comprehensive book on electroacoustic transducers and arrays for underwater sound Includes transducer modeling techniques and transducer designs that are currently in use Includes discussion and analysis of array interaction and nonlinear effects in transducers Contains extensive data in figures and tables needed in transducer and array design Written at a level that will be useful to students as well as to practicing engineers and scientists Capacitive micromachined ultrasonic transducers (CMUTs) have proven themselves to be excellent candidates for medical ultrasonic imaging applications. The use of semiconductor fabrication techniques facilitates the fabrication of high quality arrays of uniform cells and elements, broad acoustic bandwidth, the potential to integrate the transducers with the necessary electronics, and the opportunity to exploit the benefits of batch fabrication. In this thesis, the design, fabrication and testing of one- and two-dimensional CMUT arrays using a novel wafer bonding process whereby the membrane and the insulation layer are both silicon nitride is reported. A user-grown insulating membrane layer avoids the need for expensive SOI wafers, permits optimization of the electrode size, and allows more freedom in selecting the membrane thickness, while also enjoying the benefits of wafer bonding fabrication. Using a row-column addressing scheme for an NxN two-dimensional array permits three-dimensional imaging with a large reduction in the complexity of the array when compared to a conventional 2D array with connections to all N2 elements. Only 2N connections are required and the image acquisition rate has the potential to be greatly increased. A simplification of the device at the imaging end will facilitate the integration of a three-dimensional imaging CMUT array into either an endoscope or catheter which is the ultimate purpose of this research project. To date, many sizes of transducers which operate at different frequencies have been successfully fabricated. Initial characterization in terms of resonant frequency and, transmission and reception in immersion has been performed on most of the device types. Extensive characterization has been performed with a linear 32 element array transducer and a 32x32 element row-column transducer. Two- and three-dimensional phased array imaging has been demonstrated. LINEAR-SYSTEM ANALYSIS IS APPLIED TO A TRANSDUCER ARRAY AND AN INPUT-OUTPUT RELATION IS ESTABLISHED FROM WHICH THE SELF- AND MUTUAL-RADIATION IMPEDANCE OF THE ARRAY TRANSDUCERS MAY BE DETERMINED. THE RADIATION IMPEDANCES ARE DETERMINED BY APPLYING CURRENTS AT THE ELECTRICAL TERMINALS OF THE ARRAY TRANSDUCERS THAT ARE DERIVED FROM MULTICOLORED TIME SERIES AND BY MEASURING THE CROSSCORRELATION BETWEEN THESE CURRENTS AND THE VOLTAGES APPEARING AT THE ELECTRICAL TERMINALS. SINCE ONLY ELECTRICAL QUANTITIES ARE INVOLVED, IT IS POSSIBLE TO OBTAIN THE RADIATION IMPEDANCES OF A TRANSDUCER ARRAY OF VERY GENERAL CHARACTER BECAUSE NO KNOWLEDGE OF THE NATURE OF THE ACOUSTIC FIELD OF THE ARRAY OR OF THE MECHANICAL MOTION OF ITS RADIATION SURFACES IS NEEDED. SO LONG AS THE TRANSDUCER-ARRAY SYSTEM IS LINEAR AND OF FINITE SIZE, IT MAY CONSIST OF TRANSDUCERS OF DISSIMILAR TYPES, HAVING ARBITRARY SHAPES AND SIZES, WITH NORMAL VELOCITIES THAT ARE NOT NECESSARILY UNIFORM ACROSS THE TRANSDUCER FACES. MOREOVER, THE TRANSDUCERS MAY BE LOCATED IN ONE OR MORE BAFFLES OF ARBITRARY SHAPE AND ACOUSTIC CHARACTERISTICS AND ONE OR MORE REFLECTORS--THESE, TOO, BEING OF ARBITRARY SHAPE, SIZE, AND ACOUSTIC CHARACTERISTICS--MAY BE LOCATED IN THE VICINITY OF THE RADIATING ARRAY. Ultrasound imaging technology has many applications for the medical field and for the public. Thanks to ultrasound imaging, parents can meet their precious child even before the baby is born. In clinical applications, ultrasound is inexpensive, portable and reveals the structure and movement of organs in real time, allowing physicians to monitor the growth and physical development of a fetus. Because there is no ionizing radiation exposure to the patient, it is a very safe technology. In addition to diagnostic applications, ultrasound has been used for therapeutic treatment. High intensity focused ultrasound (HIFU) has been widely used to treat different types of tumors, including those of prostate, liver, breast, kidney, bone and pancreas because of its non-invasive and precise approach for tissue ablation. The basic concept of using HIFU is to focus continuous ultrasound at the focal point and a temperature increase beyond a certain point creates a lesion without damaging the surrounding tissue. For successful HIFU operation, it is important to have a reliable method for guidance and monitoring of the treatment such as ultrasound imaging. Most ultrasound image-guided HIFU systems need separate imaging and HIFU transducers, and require a cooling system due to properties of piezoelectric transducers such as narrow fractional bandwidth and self-heating. As an alternative, capacitive micromachined ultrasonic transducers (CMUTs) have a distinctive advantage over piezoelectric transducers in respect to self-heating and a wide fractional bandwidth. Thus, CMUTs are especially beneficial in dual-mode operations where a single transducer is used for both imaging and therapy. By taking advantage of this CMUT technology, I developed a compact dual-mode ultrasound system that can perform both ultrasound imaging and HIFU with a single 2-D CMUT array. A dual-mode ultrasound probe is equipped with a dual-mode application-specific integrated circuit (ASIC) and a 2-D 32x32-element CMUT array. The dual-mode ASIC consists of pulsers, transmit beamforming circuitry, and low-noise amplifiers for imaging mode and high voltage (HV) switches for HIFU mode. By turning HV switches on and off, the system can alternately operate imaging mode and HIFU mode on demand. A 2-D 32x32-element CMUT array was fabricated to have a center frequency of 5 MHz in immersion. Both ASIC and CMUT array were flip-chip bonded to a custom-designed flexible printed circuit board (flex PCB). After polydimethylsiloxane (PDMS) encapsulation, the acoustic performance of the probe was evaluated. I successfully demonstrated the imaging mode of the dual-mode probe using nylon wire phantom. Using HIFU mode, I measured 7.4 MPa peak-to-peak pressure at 8 mm focal depth. To get higher pressure for the ablation, high AC and DC voltage were used, and CMUT arrays got shorted due to the insulator breakdown. With this probe, obtaining high pressure levels needed for tissue ablation was problematic with CMUTs due to device failure at high voltages. Therefore, I re-optimized a CMUT design that can produce higher output pressure without breakdown or device failure. With CMUT simulation software, the design parameters of CMUT element were optimized with a gap height of 0.13 um and a top plate thickness of 1 um. After it was fabricated and integrated, the dual-mode probe was tested again in an acoustic setup. Compared with previous results, the device shows improved performance without device failure. The focused pressure at F-1 (8 mm) was measured to 16 MPa peak-to-peak. More importantly, most of the device can produce high pressure levels reliably without device failure. Using HIFU simulation software, the specification for HIFU ablation was explored if the dual-mode probe can ablate the tissue. It shows that even with 10 MPa peak-to-peak the dual-mode probe can create the lesion. An ablation test was successfully performed on HIFU phantom gel and ex-vivo tissue using HIFU mode of the dual-mode probe. Another important evaluation as a HIFU probe was the heating of the device. While CMUT array has very low self-heating, because of the power dissipation on HV switches of dual-mode ASIC, the ASIC was heated during HIFU mode. To reduce the heating of dual-mode ASIC, the copper heat sink rod, the chiller, and the water circulation heat sink were added to the system and it significantly reduced the heating. With the thermal management system, the probe was thermally stable around the body temperature during HIFU mode and imaging mode. Lastly, I successfully demonstrated ultrasound image-guided HIFU on HIFU phantom gel with guide wires by switching between imaging mode and HIFU mode using dual-mode ultrasound system. Our studies established a dual-mode HIFU system that will improve the non invasive ablation of tissue. This work of the dual mode system certainly shows the possibility of the new treatment application that was impossible to achieve using the conventional image-guided HIFU system. Practice Match the answers and prepare for ARDMS Sonography Principles and Instrumentation (SPI) exam. Get the results you deserve. This book is devoted to the ARDMS SPI exam and the material is based on the ARDMS physics exam outline. It explains the concepts in very simple and easy to understand way. If you are preparing to take ARDMS Ultrasound Physics Exam and looking for an ultrasound book which can help you, the Pass Ultrasound Physics Exam Math the Answers is for you. You can increase your chances to pass ARDMS Ultrasound Physics and Instrumentation exam by practicing and memorizing these match the answers. It is simple, effective, and fast so that you can succeed on your ARDMS test with a minimum amount of time spent preparing for it. Developed from the authors' highly successful annual imaging physics review course, this new Second Edition gives readers a clear, fundamental understanding of the theory and applications of physics in radiology, nuclear medicine, and radiobiology. The Essential Physics of Medical Imaging, Second Edition provides key coverage of the clinical implications of technical principles--making this book great for board review. Highlights of this new edition include completely updated and expanded chapters and more than 960 illustrations. Major sections cover basic concepts, diagnostic radiology, nuclear medicine, and radiation protection, dosimetry, and biology. A Brandon-Hill recommended title. This Pass Ultrasound Physics Exam Study Guide Review Volume I is in easy to understand question and answer format with over 400 questions. This study guide review is designed to help students and sonographers practice and prepare for the questions which appear on the ARDMS Sonography Principles and Instrumentation exam. It is divided into two Volume I and Volume II. The Volume I contains questions and answers from chapters such as Pulse Echo Instrumentation, Ultrasound Transducers, Sound Beam, Bioeffects, Intensity, and Resolution. The material is based on the ARDMS exam outline. It explains the concepts in very simple and easy to understand way. You can increase your chances to pass Ultrasound Physics and Instrumentation SPI exam by memorizing these questions and answers. After studying this study guide review you will feel confident and will be able to answer most of the questions easily which appear on the ARDMS Sonographic Principles and Instrumentation Exam. The Pass Ultrasound Physics Exam Study Guide Notes Volume I will be a great compliment to this study guide review and I highly recommend it if you are preparing to sit for ARDMS Sonographic Principles and Instrumentation exam. In this monograph, the authors reports the current advancement in high frequency piezoelectric crystal micromachined ultrasound transducers and arrays and their biomedical applications. Piezoelectric ultrasound transducers operating at high frequencies (>20 MHz) are of increasing demand in recent years for medical imaging and biological particle manipulation involved therapy. The performances of transducers greatly rely on the properties of the piezoelectric materials and transduction structures, including piezoelectric coefficient (d), electromechanical coupling coefficient (k), dielectric permittivity (e) and acoustic impedance (Z). Piezo-composite structures are preferred because of their relatively high electromechanical coupling coefficient and low acoustic impedance. A number of piezo-composite techniques have been developed, namely "dice and fill," "tape-casting," "stack and bond," "interdigital phase bonding," "laser micromachining" and "micro-molding". However, these techniques are either difficult to achieve fine features or not suitable for manufacturing of high frequency ultrasound transducers (>20 MHz). The piezo-composite micromachined ultrasound transducers (PC-MUT) technique discovered over the last 10 years or so has demonstrated high performance high frequency piezo-composite ultrasound transducers. In this monograph, piezoelectric materials used for high frequency transducers is introduced first. Next, the benefits and theory of piezo composites is presented, followed by the design criteria and fabrication methods. Biomedical applications using piezo composites micromachined ultrasound transducers (PC-MUT) and arrays will also be reported, in comparison with other ultrasound transducer techniques. The final part of this monograph describes challenges and future perspectives of this technique for biomedical applications. This popular text provides a comprehensive, yet accessible, introduction to the physics and technology of medical ultrasound, with high quality ultrasound images and diagrams throughout. Covering all aspects of the field at a level that meetings the requirements of accredited sonography courses, it is ideal for both trainee and qualified healthcare professionals practising ultrasound in a clinical setting. Building on the content of previous editions, this third edition provides the latest guidance relating to ultrasound technology, quality assurance and safety and discusses the latest techniques. Since Paul Langevins discovery of active sonar in 1917, ultrasound transducers have evolved in multiple forms that include single element, single element on a wedge, single element with cylindrical lens, single element with spherical lens, linear arrays, annular arrays, two- dimensional (2D) arrays, and phased arrays, among others. They have been applied in sound navigation and ranging (SONAR), structural health monitoring (SHM), nondestructive testing (NDT), nondestructive evaluation (NDE), medical/biomedical sensing/imaging, and biometric sensing/imaging. This dissertation focuses on the development of high frequency phased array transducers for two specific applications scanning acoustic microscopy, and biometric imaging for small electronics. Closed-loop finite element studies were conducted in three dimensions using PZFlex, a commercial finite-element method software. A 5 MHz, thickness-mode, linear array for an acoustic microscope, and a flexible 10 MHz, bending-mode, piezoelectric, micromachined ultrasonic transducer (PMUT) 2D array, plus a flexible 38 MHz bending-mode, PMUT 2D array for finger-print and finger-vein imaging, were virtually prototyped and their respective performances were predicted. The scanning acoustic microscope (SAM) has been a well-recognized tool for both visualization and quantitative evaluation of materials at the microscale, since its invention in 1974. While there have been multiple advances in SAM over the past four decades, some issues still remain to be addressed. First, the measurement speed is limited by the mechanical movement of the acoustic lens. Second, a single element transducer acoustic lens only delivers a predetermined beam pattern for a fixed focal length and incident angle, thereby limiting control of the inspection beam. Here, a development of a phased array probe as an alternative is proposed to overcome these issues. Preliminary studies to design a practical, high frequency, phased array, acoustic microscope probe were explored. A linear phased array, comprising 32 elements and operating at 5 MHz, was modeled using PZFlex. This phased array system was characterized in terms of electrical input impedance response, pulse-echo and impulse response, surface displacement profiles, mode shapes, and beam profiles.PMUT using lead-zirconate-titanate, PbZr0.52Ti0.48O3 (PZT), thin films are currently being investigated for miniaturized, high frequency, ultrasound systems, and their microfabrication processes explored. For example, Liu et al. developed a process to remove the PZT from an underlying rigid Si substrate, creating the potential for developing curved arrays [138, 139]. This dissertation aims to improve the design of flexible PMUT arrays by developing 3D models using PZFlex. A 10 MHz 2D array PMUT device, working in 3-1 bending mode, was designed. A circular unit-cell was structured from the top, comprising a platinum (Pt) electrode, a PZT active layer, a bottom Pt electrode and a titanium (Ti) passive layer, all placed concentrically on a polyimide (PI) substrate. The active PZT layer had a diameter of 46 m and a thickness of 1 m. The passive Ti layer was 59.8 m diameter and 1 m in thickness. The PI substrate was 20 m thick. Below the passive Ti layer, another 7 m thick PI passive layer and 13 m deep cavity with 46 m diameter was added concentric to the PZT layer. The dimensions were selected to have a resonance frequency at 10 MHz under water load and air backing. The pulse-echo and spectral response analysis of the unit-cell predicted its bandwidth to be 87%. Mode shapes of the unit-cell were modeled to discover undesirable cross coupling to higher modes. A 2D array, consisting of 256 (1616) unit-cells, was created and characterized in terms of pulse-echo response, spectral response, surface displacement profile, cross-talk, and beam profiles.Iterations to find a robust design of the flexible PMUT array with increased resonance frequency and low operating voltage were continued. A PMUT array has to be operated at very low voltage to be embedded and run in small electronic devices, such as smart-phones, and smart-watches. A 38 MHz, flexible, PMUT array operating at 3 Volt peak-to-peak (Vpp) driving voltage was designed. To achieve these goals, a unit-cell, consisting of four 3-1 bending mode diaphragms, were devised. The quad diaphragm unit-cell was structured with 40 m 40 m 500 nm PZT layer on top of 40 m 40 m 1 m Ti elastic layer which had four (22)10 m 10 m 5 m cavities beneath it. The cavities had 11 m of interspacing to next cavities. Four pairs of 10 m 10 m top and bottom Pt electrodes were placed concentrically with the cavities by sandwiching the PZT layer. The top and bottom Pt electrodes had thicknesses of 50 nm and 100 nm, respectively. A PI substrate was placed beneath the Ti layer, surrounding the cavities, with 8 m thick, including the 5 m deep cavities. The pulse-echo and spectral response analysis of the quad diaphragm unit-cell revealed its bandwidth to be 32.2 %. A 2D array was constructed with 1616 unit-cells, consisting of 1024 (3232) diaphragms. This array was evaluated in terms of pulse-echo response, spectral response, surface displacement profile, cross-talk, and beam profiles. Abstract: Three dimensional (3D) ultrasound has become an increasingly popular medical imaging tool over the last decade. It offers significant advantages over Two Dimensional (2D) ultrasound, such as improved accuracy, the ability to display image planes that are physically impossible with 2D ultrasound, and reduced dependence on the skill of the sonographer. Among 3D medical imaging techniques, ultrasound is the only one portable enough to be used by first responders, on the battlefield, and in rural areas. There are three basic methods of acquiring 3D ultrasound images. In the first method, a 2D array transducer is used to capture a 3D volume directly, using electronic beam steering. This method is mainly used for echocardiography. In the second method, a linear array transducer is mechanically actuated, giving a slower and less expensive alternative to the 2D array. The third method uses a linear array transducer that is moved by hand. This method is known as freehand 3D ultrasound. Whether using a 2D array or a mechanically actuated linear array transducer, the position and orientation of each image is known ahead of time. This is not the case for freehand scanning. To reconstruct a 3D volume from a series of 2D ultrasound images, assumptions must be made about the position and orientation of each image, or a mechanism for detecting the position and orientation of each image must be employed. The most widely used method for freehand 3D imaging relies on the assumption that the probe moves along a straight path with constant orientation and speed. This method requires considerable skill on the part of the sonographer. Another technique uses features within the images themselves to form an estimate of each image's relative location. However, these techniques are not well accepted for diagnostic use because they are not always reliable. The final method for acquiring position and orientation information is to use a six Degree-of-Freedom (6 DoF) tracking system. Commercially available 6 DoF tracking systems use magnetic fields, ultrasonic ranging, or optical tracking to measure the position and orientation of a target. Although accurate, all of these systems have fundamental limitations in that they are relatively expensive and they all require sensors or transmitters to be placed in fixed locations to provide a fixed frame of reference. The goal of the work presented here is to create a probe tracking system for freehand 3D ultrasound that does not rely on any fixed frame of reference. This system tracks the ultrasound probe using only sensors integrated into the probe itself. The advantages of such a system are that it requires no setup before it can be used, it is more portable because no extra equipment is required, it is immune from environmental interference, and it is less expensive than external tracking systems. An ideal tracking system for freehand 3D ultrasound would track in all 6 DoF. However, current sensor technology limits this system to five. Linear transducer motion along the skin surface is tracked optically and transducer orientation is tracked using MEMS gyroscopes. An optical tracking system was developed around an optical mouse sensor to provide linear position information by tracking the skin surface. Two versions were evaluated. One included an optical fiber bundle and the other did not. The purpose of the optical fiber is to allow the system to integrate more easily into existing probes by allowing the sensor and electronics to be mounted away from the scanning end of the probe. Each version was optimized to track features on the skin surface while providing adequate Depth Of Field (DOF) to accept variation in the height of the skin surface. Orientation information is acquired using a 3 axis MEMS gyroscope. The sensor was thoroughly characterized to quantify performance in terms of accuracy and drift. This data provided a basis for estimating the achievable 3D reconstruction accuracy of the complete system. Electrical and mechanical components were designed to attach the sensor to the ultrasound probe in such a way as to simulate its being embedded in the probe itself. An embedded system was developed to perform the processing necessary to translate the sensor data into probe position and orientation estimates in real time. The system utilizes a Microblaze soft core microprocessor and a set of peripheral devices implemented in a Xilinx Spartan 3E field programmable gate array. The Xilinx Microkernel real time operating system performs essential system management tasks and provides a stable software platform for implementation of the inertial tracking algorithm. Stradwin 3D ultrasound software was used to provide a user interface and perform the actual 3D volume reconstruction. Stradwin retrieves 2D ultrasound images from the Terason t3000 portable ultrasound system and communicates with the tracking system to gather position and orientation data. The 3D reconstruction is generated and displayed on the screen of the PC in real time. Stradwin also provides essential system features such as storage and retrieval of data, 3D data interaction, reslicing, manual 3D segmentation, and volume calculation for segmented regions. The 3D reconstruction performance of the system was evaluated by freehand scanning a cylindrical inclusion in a CIRS model 044 ultrasound phantom. Five different motion profiles were used and each profile was repeated 10 times. This entire test regimen was performed twice, once with the optical tracking system using the optical fiber bundle, and once with the optical tracking system without the optical fiber bundle. 3D reconstructions were performed with and without the position and orientation data to provide a basis for comparison. Volume error and surface error were used as the performance metrics. Volume error ranged from 1.3% to 5.3% with tracking information versus 15.6% to 21.9% without for the version of the system without the optical fiber bundle. Volume error ranged from 3.7% to 7.6% with tracking information versus 8.7% to 13.7% without for the version of the system with the optical fiber bundle. Surface error ranged from 0.319 mm RMS to 0.462 mm RMS with tracking information versus 0.678 mm RMS to 1.261 mm RMS without for the version of the system without the optical fiber bundle. Surface error ranged from 0.326 mm RMS to 0.774 mm RMS with tracking information versus 0.538 mm RMS to 1.657 mm RMS without for the version of the system with the optical fiber bundle. The prototype tracking system successfully demonstrated that accurate 3D ultrasound volumes can be generated from 2D freehand data using only sensors integrated into the ultrasound probe. One serious shortcoming of this system is that it only tracks 5 of the 6 degrees of freedom required to perform complete 3D reconstructions. The optical system provides information about linear movement but because it tracks a surface, it cannot measure vertical displacement. Overcoming this limitation is the most obvious candidate for future research using this system. The overall tracking platform, meaning the embedded tracking computer and the PC software, developed and integrated in this work, is ready to take advantage of vertical displacement data, should a method be developed for sensing it. The most comprehensive book on electroacoustic transducers and arrays for underwater sound Includes transducer modeling techniques and transducer designs that are currently in use Includes discussion and analysis of array interaction and nonlinear effects in transducers Contains extensive data in figures and tables needed in transducer and array design Written at a level that will be useful to students as well as to practicing engineers and scientists Noninvasive and multi-purposed, with uses ranging from fetal monitoring to cancer detection, medical ultrasound is one of the most widely utilized diagnostic tools in medicine today. Recent trends to proliferate its use and improve patient care require that ultrasound systems become more portable and less expensive. However, high resolution images needed in medical ultrasound rely on multichannel ultrasonic transducers requiring expensive, dedicated hardware to perform beamforming. This dissertation explores the reduction of hardware requirements for multi-channel ultrasound image formation through the use of software-based beamforming. First, the requirements and computational complexity of software-based ultrasound image formation are investigated. Then, a new beamforming algorithm is presented, introducing sparse upsampling as a means to reduce computational complexity. Performance and noise implications of this new algorithm are also investigated. Finally, a framework for parallelizing beamforming and other image processing functions is introduced. This framework is used to implement real-time, software-based ultrasound image formation for an annular array use case. This new beamforming algorithm, used in conjunction with the parallel processing framework eliminates the need for hardware-based beamforming, reducing the overall cost and complexity of multichannel ultrasound probes. The interstitial gaps between transducers in an array present an extremely difficult feature of the overall problem of acoustic radiation from Sonar arrays. Accurate solutions in practical cases can probably be obtained only by numerical finite element methods, although Mangulis has obtained some useful results for infinite planar arrays by a more analytical approach. It is usually possible to divide the region between transducers in an array into separate interstitial gaps such that behind each gap there is a certain volume filled with water and bounded by transducer housings and other parts of the structure. In the finite element approach the entire interstitial volume can be included in the analysis. In Mangulis' approach the interstitial surface facing the pen medium is divided into imaginary rigid elements with some specified internal impedance accounting for the remainder of the interstitial volume. He then makes use of the special properties of the infinite planar array to solve the problem. Any array can be approached in the same fashion. The basic informlation required before this approach can be applied, or before Mangulis' results can be used, is the interstitial impedance. The objective of this memorandum is to discuss some methods of estimating this impedance. (Author). This beautifully illustrated and formatted book covers all of the established and developing indications for the use of color Doppler ultrasound in gynecology and obstetrics. In gynecology the modality is used to measure blood flow in benign changes of the endometrium as well as malignant tumors of the uterus; screening for ovarian carcinoma, including 3D-power doppler for the assessment of angiogenesis of ovarian tumors; and as an adjunct examination in assessing tumors of the breast.In obstetrics, the imaging method is useful in screening for gestosis and placental insufficiency in early pregnancy; evaluating the umbilical cord; fetal echocardiography and much more.More recent developments show the modality to be helpful in infertility diagnosis and reproductive medicine, providing information on the patency of the fallopian tubes, the quality of the vascularization of the uterus and more.With almost 600 illustrations and 90 useful tables, as well as a text that is highly structured for efficient reading, this text provides practitioners with technical and methodological basics as well as advanced tips for experienced users. Comprehensive coverage of the applications & advantages of breast ultrasound in the evaluation of breast disorders. Topics include sonographic anatomy of the breast; sonographic criteria for the differential diagnosis of masses; appearance of inflammatory, benign & malignant lesions; color Doppler ultrasound for the evaluation of vasculature; & the use of ultrasound in interventional procedures. Individual transducer elements of large sonar arrays are subject to electrical impedance changes as a result of acoustical interactions between neighboring driven elements. In order to transmit acoustic power, the elements are driven individually or in groups by power amplifiers. When a prototype amplifier is constructed, an entire array of transducers and amplifiers may not be available for testing the amplifier. A passive electrical dummy load was constructed to have impedance characteristics equivalent to the particular type of transducer which a prototype current-source switching amplifier was to drive. An active port was added to the electrical dummy load to change the amplifier's load impedance at all frequencies of interest, thereby simulating different positions in a transducer array in which more than one element is driven. The dummy load design technique is described. (Author). This book describes in detail the physical and mathematical foundations of ultrasonic phased array measurements. The book uses linear systems theory to develop a comprehensive model of the signals and images that can be formed with phased arrays. Engineers working in the field of ultrasonic nondestructive evaluation (NDE) will find in this approach a wealth of information on how to design, optimize and interpret ultrasonic inspections with phased arrays. The fundamentals and models described in the book will also be of significant interest to other fields, including the medical ultrasound and seismology communities. A unique feature of this book is that it presents a unified theory of imaging with phased arrays that shows how common imaging methods such as the synthetic aperture focusing technique (SAFT), the total focusing method (TFM), and the physical optics far field inverse scattering (POFFIS) imaging method are all simplified versions of more fundamental and quantitative imaging approaches, called imaging measurement models. To enhance learning, this book first describes the fundamentals of phased array systems using 2-D models, so that the complex 3-D cases normally found in practice can be more easily understood. In addition to giving a detailed discussion of phased array systems, Fundamentals of Ultrasonic Phased Arrays also provides MATLAB® functions and scripts, allowing the reader to conduct simulations of ultrasonic phased array transducers and phased array systems with the latest modeling technology. Ultrasound in Medicine is a broad-ranging study of medical ultrasound, including ultrasound propagation, interaction with tissue, and innovations in the application of ultrasound in medicine. The book focuses specifically on the science and technology-the underlying physics and engineering. It examines the most closely related aspects of these basic sciences in clinical application and reviews the success of technological innovations in improving medical diagnosis and treatment. The book bridges the gap between tutorial texts widely available for ultrasound and medical training and theoretical works on acoustics. A comprehensive reference and practical guide on the technology and application of ultrasound to the musculoskeletal system. It is organized into two main sections. The first is devoted to general aspects, while the second provides a systematic overview of the applications of musculoskeletal ultrasound in different areas of the body. Ultrasound scans are correlated with drawings, photographs, images obtained using other modalities, and anatomic specimens. There is a generous complement of high-quality illustrations based on high-end equipment. This book will acquaint beginners with the basics of musculoskeletal ultrasound, while more advanced sonologists and sonographers will learn new skills, means of avoiding pitfalls, and ways of effectively relating the ultrasound study to the clinical background.