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Characterization of Ultrasonic Transducers Using Pattern Recognition Techniques

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CHARACTERIZATION OF ULTRASONIC TRANSDUCERS
USING PATTERN RECOGNITION TECHNIQUES

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ABSTRACT

This paper describes an automated method for characterizing ultrasonic transducers. A computer based test system will collect test data for a given transducer. This data set is then subjected to a pattern recognition algorithm. The results from this classification will place the transducer in a group of similar units. All the transducers in a group will have similar performance characteristics.

INTRODUCTION

The importance of having a well characterized ultrasonic transducer has been discussed in a significant amount of literature¹⁻⁵. In order to fully understand the information collected by an ultrasonic test system, the test probe must be fully understood as well⁶. This involves quantifying such parameters as focal length, focal spot diameter, center frequency, bandwidth, insertion loss, cross-sectional uniformity, etc. This paper describes an automated system that collects this pertinent data for ultrasonic transducers.

Pattern recognition has also been successfully used in the ultrasonic testing field⁷⁻⁹. However, this work focuses on interpreting the resulting signals from a test specimen. This paper will report the results of using these pattern recognition techniques on the data collected from the characterized transducers. This will sort transducers of like properties into groupings. Transducers in a group should have similar testing properties and thus similar test results.

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APPROACH

Based on the needs of our laboratory, a set of characteristics to be tested were developed. They include the following: focal length, slope of near field and far field amplitude, insertion loss, center frequency, peak frequency, bandwidth, focal spot diameter, focal spot length, beam uniformity, and impulse response. Once these parameters were established, a computer controlled data acquisition system was created to collect information for over 200 transducers.

Figure 1 shows a block diagram of the system. The scanning segment consisted of an immersion tank with three orthogonal motorized axes of motion. This scanner is run by a programmable controller that is interfaced to the computer via the IEEE 488 bus. A pulser/receiver rated to 50 MHz is used to energize the transducer. Also built into the pulser unit is a gated peak detector. The marked RF signal produced is sent to a 1 GHz digitizing oscilloscope which connects to the computer via the IEEE 488 bus also. The gated RF signal is sent to a 2.9 GHz digitizing spectrum analyzer which in turn is connected to the computer via the IEEE 488 bus. The computer workstation consists of a 30 MHz 68030 processor with a 30 MHz 68882 math coprocessor with a 2D color image processing engine. The computer has over 750 Mbytes disk storage and 8 Mbytes of RAM. The system uses the UNIX operating system, but the software is written in BASIC. All the data collected is presented on the 1280 x 1024 color CRT. Each graph is stored as a bit map and can be dumped via a batch process to a 180 dpi color ink jet printer. The software for the system ULSUR, Ultrasonic Laboratory Search Unit Recorder, was written in house.

Once developed, this system was used to collect the test information for over 200 different focused immersion transducers. All the data sets are stored on the system's hard disks for instant retrieval. A back up copy was also saved to tape cartridges. The data was also dumped to the color printer and this physical record is available to the engineers and technologists when developing a new test procedure. It also is useful when the original transducer has worn out and a near exact duplicate is required. All of these transducers

Figure 1 - Data Collection System

have been grouped into like units. This was done by applying some of the standard pattern recognition algorithms to the test data collected by ULSUR.

Two different approaches will be tried to characterize the data sets. One uses a sample set of transducers as training data and groups the remaining transducers into these norms. The other technique to be used will not have any training data, but sorts all the transducers into as many groups as necessary. Some data compression techniques will also be applied in an attempt to reduce the number of variables required to separate the transducers into their respective groups.

CONCLUSION

By applying conventional pattern recognition algorithms to classify the data collected from the computer controlled characterization system, ultrasonic transducers can be sorted in to groups with similar properties. This will provide the information necessary to properly configure an ultrasonic test system for optimum test results. This system can also be used to observe when a given transducer has begun to wear. The final work on this project is under way.

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