The aim of the project was to take an outline concept for a novel medical ultrasound test phantom through to a prototype for further evaluation. The study involved a partnership between the Department of Medical Physics at Ninewells Hospital, Dundee and Diagnostic Sonar Ltd (DSL) in Livingston.

BACKGROUND

Ultrasound is used for almost 30% of medical imaging scans yet, unlike other modalities, there is no obligation to carry out Quality Assurance. Best practice does suggest that this is done and certainly quantitative performance assessment on a stable test object is valuable. Indeed DSL produces the classic Cardiff phantom.

Such Quality Assurance procedures especially the thorough, baseline testing are both labour intensive and time consuming. Present test objects are inflexible and do not allow fine gradations in assessment. The aim of the development was to address both of these limitations by automating the process using a dynamic phantom. Although developed for the medical field it is anticipated there is similar potential for use in veterinary and Non-Destructive Testing (NDT) markets.

The concept of the dynamic phantom was originally developed as part of an undergraduate project for Strathclyde University and offered the possibility to obtain a single figure of merit for medical ultrasound scanners using an automated, digitised process. Such a figure of merit was developed by the Medical Physics Department of NHS Lothian in Edinburgh and can be obtained using their novel “pipe phantom”. The aim of the project was to take this concept to the stage of a working prototype. This would then be used to acquire real data and hence assess the benefits and limitations in practice.

DESCRIPTION OF WORK

The proposed phantom design uses a pair of parallel wires in a test tank filled with fluid that mimics the acoustic properties of tissue. The ultrasonic probe under test is mounted in a fixture that holds it just dipped into the fluid so as to image the pair of wires whose range and separation can be independently controlled via motors. The image from the scanner under test is acquired and analysed by the controlling software. The work was therefore broken down into well-defined sections:

- Design and fabrication of the tank and wire assembly;
- Design and coding of the motor control;
- Acquisition of the ultrasound image from the scanner under test;
- Analysis of the acquired image;
- Design and coding of the User Interface and of the test sequence control.
The tank and motor systems were both based on the designs assessed in the original concept. The positioning of the wires is done by motor control of matching magnets outside the tank, which preserves the integrity of the tank wall. The control and interface for the targets had to be refined to make it robust and precise. To this end improved mechanics incorporating stepper motors were designed and a USB interface incorporated.

National Instruments LabVIEW® software was chosen for the User Interface and control and its associated Vision module was used for the interface to the image acquisition hardware and also for the image analysis capability. DSL already had considerable experience with both hardware and software for the imaging requirements. The software suite also provided an integrated approach for controlling the motors that would be beneficial when incorporating target positioning and image analysis in a feedback loop – a key requirement for the goal of automated operation.

Image analysis is performed to determine whether the targets are resolved or not. If they are, the position of the targets is returned and the motors move to the next vertical position and the process is repeated.

CONCLUSIONS

A working prototype has been developed that can be used to acquire data from a variety of scanners. There have been significant improvements in the mechanics over the original concept and these will continue to be assessed so as to determine an optimum production specification. It is already anticipated that this will include:

- The electronics moved to the side of the tank.
- A probe holder incorporated in the design.
- Other image input options to take into account the connectivity of the latest scanners.
- Additional functionality for NDT array testing.
- Addition of anatomically realistic motion to assess Doppler measurement.

Results can be compared with that from other sources e.g. published data taken with an Edinburgh pipe phantom.