1.3.75. REAL IMPLEMENTATION OF ULTRASONIC PHASED ARRAY TECHNOLOGY USING ADVANCED SIGNAL PROCESSING ALGORITHMS

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Introduction. During the last two years, we have been developing a new ultrasonic non-destructive testing portable instrument. The main goal was to develop the highly robustness ultrasonic portable instrument using conventional ultrasonic testing, EMAT testing and testing based on phased array ultrasonic technology. All these non-destructive methods were successfully implemented into one device called "DEFECTOBOOK DIO1000'.

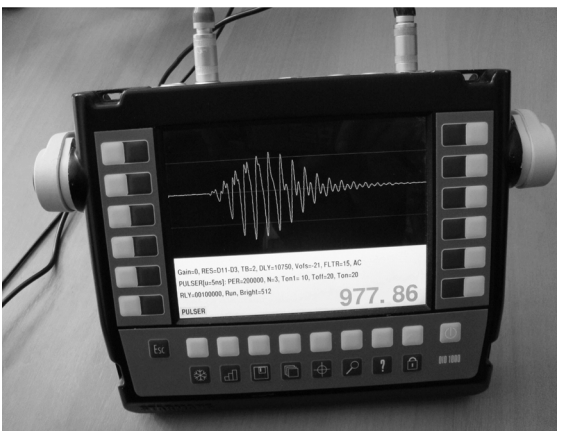

Fig. 1. Ultrasonic portable instrument DEFECTOBOOK DIO1000

All these non-destructive testing methods were implemented based on previous research. First of all, we have implemented conventional ultrasonic method and EMAT testing method. As all acquired ultrasonic signals are corrupted with relatively higher noise level, methods used for effective noise reduction were searched. During the research we have tested many algorithms used for noise reduction but the main goal was to find efficient noise reduction method which could be easily implemented as algorithm processing the signals in real time. This goal was successfully achieved and averaging, digital filters and correlation methods were implemented into DIO1000 signal processor. Next step was to implement the advanced ultrasonic phased array technology to visualize tested material in detail. Phased array holds the promise of being able to efficiently detect all significant flaws by combining many angles and focus depths into one probe and image the resulting reflections in an understandable way. Flaw acceptance still requires the comparison of flaw reflections represented as an A-scan with the A-scan of a known artificial reflector such as a side-drilled or flat-bottomed hole, or a spark-eroded notch. The use of special signal processing and image reconstruction algorithms allows generating A-scans of several angles and/or sector-scans, which can be implemented in real time. With parallel computing structures, this principle is used for automatic testing systems at very high inspection speed.

Fig. 2. Material scanning using phased array technology

Image reconstruction using phased array technology. The proposed algorithms can be briefly described in the following steps:

1. Ultrasonic signal acquisition

Signals were acquired using phased array transducer containing 16 elements. All acquired signals are stored in matrix which is the basis for image construction.

2. Noise reduction

As all signals are corrupted with relatively high efective noise level noise reduction method has to be applied to have higher signal to noise ratio. All ultrasonic signals stored in the matrix are processed.

3. Image reconstruction Using sampling phased array algorithm to obtain valuable information about flaw presence with consequent visualization.

Using the described steps we achieved correct information about flaw presence. Advanced ultrasonic phased array technology was implemented including signal processing algorithms.

Summary. With our developed ultrasonic portable system it is possible to efficiently detect all subsurface flaws in tested materials. As our proposed and created ultrasonic instrument DIO1000 includes conventional ultrasonic method, EMAT testing and ultrasonic phased array technology this makes the system versatile in many industrial applications. To make our system really unique and accurate we implemented advanced signal processing algorithms to process all acquired signals in real time.