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INCREASING OF DATA PROCESSING SPEED FOR PHASED ARRAY SYSTEMS

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Ultrasonic testing is widely used in non-destructive testing due to its safety and versatility. Advanced Phased Array systems with high speed scanning have become promising for 3D object imaging.

A phased array system is a multi-channel ultrasonic system, which uses the principle of a time-delayed triggering of the transmitting transducer elements combined with a time corrected receiving of detected signals. The main advantage of phased array systems is their ability to vary the insonification angle in the inspection object (sound beam sweeping and focusing). This in turn reduces the number of inspection units required for any automated system.

The Sampling Phased Array (SPA) technique, a novel Phased Array technology, was developed in the Fraunhofer Institute for Non-Destructive Testing (IZFP) and subsequently it was patented. SPA permits the meaningful reconstruction of defects at high inspection speed and facilitates the inspection of anisotropic materials. The technique provides higher sensitivity for inspection of heavy-wall components and along with corresponding high resolution enables quantitative NDT. The development of SPA results in a substantial contribution to the improved inspectability of lightweight construction material (2) and increases the probability of detecting small discontinuities in highly stressed materials [1].

Currently an urgent task is minimization of the information processing algorithm for the SPA method. The need to increase the processing speed, an acceptable complexity of the process and its cost are new challenges for scientists.

The received ultrasonic signals for each transducer array for each position are saved and subsequently are used as the baseline data for imaging of the area under control.

In the first tact of array operation, the first transducer is excited, and then all elements of the array receive the returned signal. The resulting A-scans are recorded in memory for subsequent processing. In the second tact, the second element is excited. All the array elements receive reflected signals. This process continues until all the elements of the array are enumerated.

After saving A-scans for all combinations of the source/receiver, the imaging process starts. For each A-scan, its value is chosen in accordance with the signal propagation time. The resulting amplitude point is obtained by summing the amplitudes of the points of all the A-scans.

To increase the data processing speed many operations are to be performed simultaneously.

If array consists of 16 sensors, after radiation and receiving of all the signals, 256 A-scans need to be processed. To reconstruct the image of 1000x1000 pixels more than 25.6 billion operations must be performed. If the system works at a frequency of 200 MHz consistently, 32 seconds are required to get a flat image. To obtain a 3-dimensional image of the control object will take more time. Application of this method compels to search the ways to increase the data processing speed. Using a large number of processors to provide parallel processing of multiple A-scans substantially increases the cost of the device, and only 10% of the actual performance of the processor is used.

Using FPGA, several channels are made. All the channels perform the same action simultaneously. This is done to increase the processing speed.

The number of the channel is determined by the number of the element in the array.

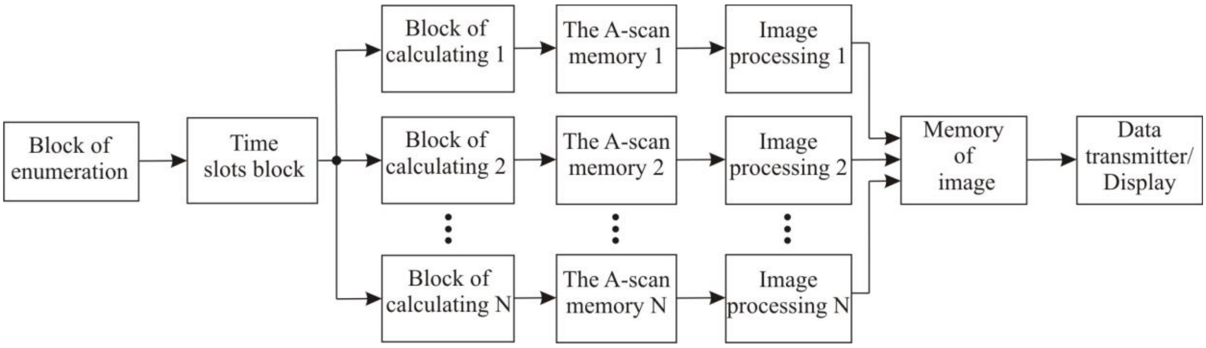

Fig. 1. Block diagram for data processing.

To increase the device operation speed, the time intervals are calculated before processing. In its memory, FPGA stores only calculations results which are required to construct the object image.

The *block of enumeration* is responsible for determining the estimated number of the current point.

The *Time slots block* is a memory which stores the ultrasonic propagation time for each point of the control object.

The *Calculating block* calculates the required addresses for the A-scan memory.

The *A-scan memory* stores the digitized signal reflected from the control object.

The *Image processing block* reconstructs the control object image, and the *data transmission block* is used to send the result to the display device or to the computer.

The result of data calculation is the sector of the object image which indicates its defects.

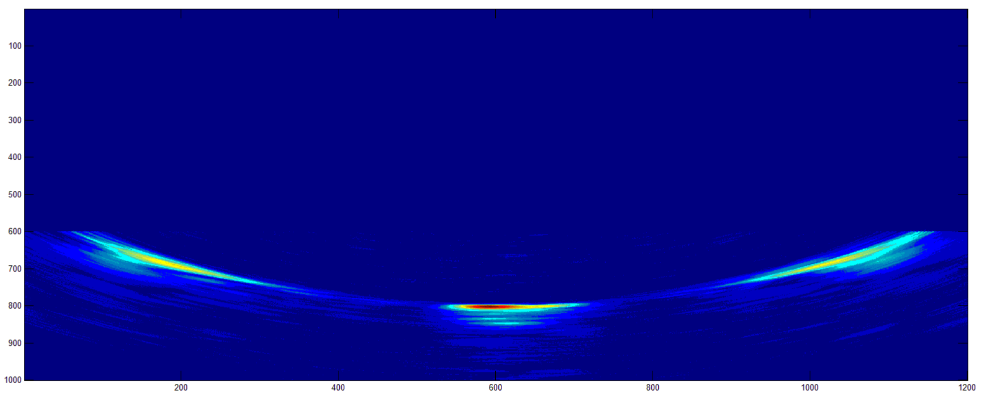

Fig.2. Image of the control object.

Application of programmable arrays allows increase in the processing speed keeping the cost of the product within an acceptable range.

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NEW GENERATION ACOUSTIC BOREHOLE DEPTH GUIDE

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Blasting operations are the main step in the preparation process of mining coal, iron ore and other mineral resources. Expenses to carry out the blasting operations comprise a significant part of the mined rock cost. Hence the errors in the hole-depth measurement lead to increase in the mined rock cost, as well as it might result in the top horizon downfall where mining occurs.

A basic error in ultrasonic depth-gauge measurement is caused by inaccuracy in determination of the ultrasonic pulse arrival. Generally the moment of ultrasonic pulse arrival is determined with a comparator. However, due to the complex shape of reflected ultrasonic pulse the comparator operating time does not coincide with the pulse initiation.

Nowadays, the existing ultrasonic hole depth-gauges have measurement errors and a high value of uncontrolled area. However, the major issue concerning the hole formation depth measuring lies in low measurement accuracy related to the hole shape changes due to earth movement. Therefore, the research objective of the current study is the development of a universal