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HIGH ACCURACY MEASUREMENTS OF PROFILES BY MEANS OF AIR-COUPLED ULTRASONICS

In the paper a novel contactless techniques for measurement of profile on a non-planar surfaces is presented. The technique is based on application of focussed ultrasonic waves and precise measurement of the distance between an ultrasonic transducer and the surface. The technique developed enables to perform measurements when the object with non-planar surface is moving with respect to the ultrasonic transducer. For radiation and reception novel composite piezoelectric transducers are used. The technique enables to perform measurements on-line with uncertainty <0.1mm

1. OBJECTIVES

The measurement of surface profile with high accuracy is widely used in different branches of industry and science. Most impressive and effective are contactless measurements. For that purpose the techniques based on the propagation of light and ultrasonic waves are used. The advantage of ultrasonic meters is lower requirements to the surface of the object. The advanced ultrasonic microscopes can achieve very high resolution better than 1μm [1, 2]. However, direct implementation of such a system in industrial conditions usually causes problems related to the temperature variations, orientation of the probe with respect to the surface, vibrations, etc. On the other hand, usually in the technological lines there is no need for so high accuracy. But there are many other requirements such as simultaneous measurement in several positions, data acquisition capabilities and other. The objective of this work was development of the precise (with accuracy better than 0.1mm) multi channel contacless meter, suitable for industrial conditions.

2. THE PRINCIPLE OF MEASUREMENTS

The principle of the developed measurement technique is based on measurement of ultrasonic waves propagation time using pulse-echo technique. The focused transducers are used to increase the spatial resolution of the equipment and ensure reliable detection of the signal in the case of curved surfaces. The reference channels are used to avoid the influence of ultrasound velocity variations caused by the different conditions of the media, such as

humidity, temperature and pressure. In the case of precise measurements of the surface profile, the dimensions of the measured surface area, covered during the single measurement, is very important. The high resolution of the distance measurement is necessary. For that purpose the air coupled focused transducers of high frequency and small focus spot must be used [3, 4].

3. MEASUREMENT TECHNIQUE

The structure of the developed multi channel ultrasonic meter is presented in Fig.1. The measurement system consists of up to 64 ultrasonic transducers, exiting generators, amplifiers of received signals, delay time measurement unit, processor and personnel computer for data acquisition, presentation and analysis. Any number of transducers or channels can be selected as a reference channel. The processor performs control of generators, amplifiers and timers, which can perform distance measurements in different modes. The processor program enables to send the measured data or directly to PC, or previously acquisite data in the internal memory and later to transmit them to the PC. The processor has the special detection option, which enables to start measurement data acquisition only when the object under investigation is positioned in front of the transducer. Focused concave air-coupled piezocomposite transducers with the central frequency of 1 MHz, the focus distance 50mm and focal spot 1mm^2 are used. The transducer consists of the two acoustically isolated parts – transmitter and receiver, which are situated in the same metal case. The diameter of the transducer is 25 mm.

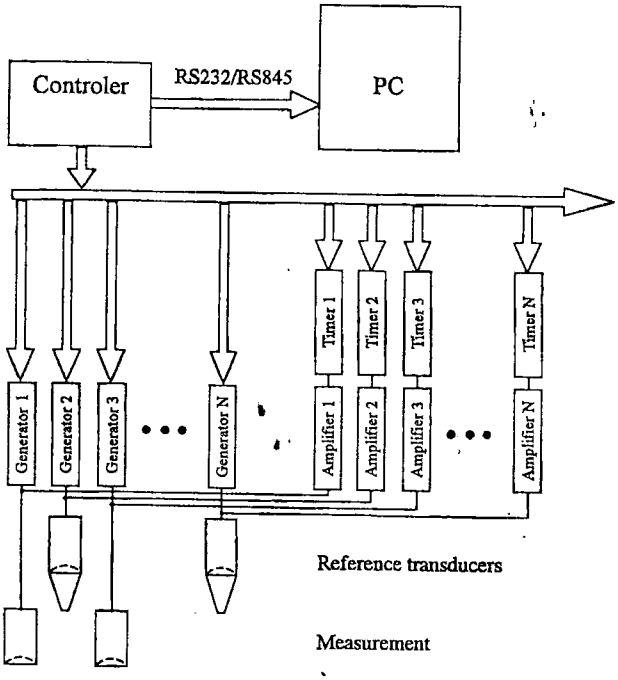

Fig.1 The structure of multi channel distance meter

4. APPLICATION

The results of scanning the Lithuanian 5 cent coin with diameter of 25 mm, and the height of the surface relief 0.1 mm is presented as the example of possibilities of developed measurement technique.

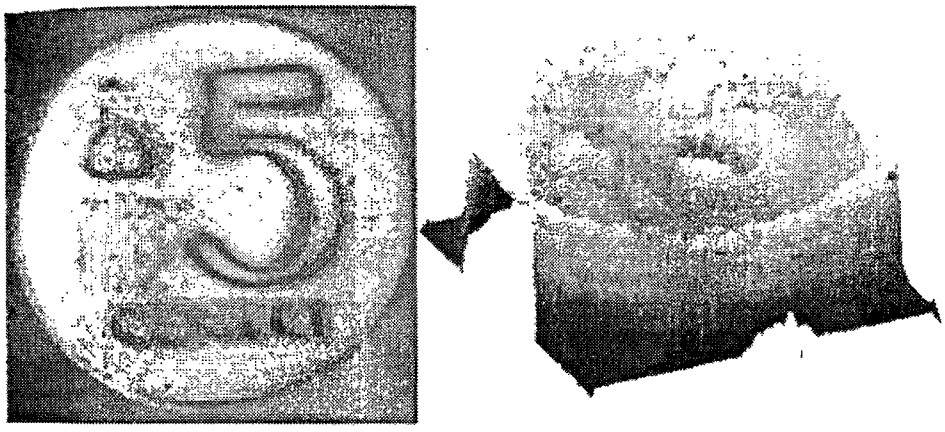

Fig.2 The reconstructed image of the Lithuanian 5 cent coin, using contactless measurement. Scanning was performed with a step 0.2 mm

5. REFERENCES

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