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Development of a Computer-Based Stand for Testing Algorithms of Electrical Impedance Tomography

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Abstract: The study describes the materials on the development and testing bench for the study of algorithms and methods of processing the results of measurements of the electrical parameters of the object for subsequent visualization of its internal structure. To implement the hardware configuration is chosen platform national instruments PXI. The platform is equipped with an additional set of input-output modules to provide a controlled supply of AC signals to the object of measurement capabilities. Calculation of the resistance distribution of the internal structure and its visualization is performed using special software.

Key words: PXI, test stend, electrical impedance tomography, experimental-simulation approach, AC

INTRODUCTION

The current developments in the field of electrical impedance tomography based mainly on approaches for solving inverse problems using finite element methods (Sherina and Starchenko, 2014; Zhao *et al*., 2009). This method can be the basis for the use of experimental-simulation approach (Shaykhutdinov *et al*., 2013). The disadvantage of these approaches is a longer duration of time spent in the data processing operation in a high degree of uncertainty. This situation requires finding new ways of solving the problem of electrical impedance tomography (Aleksanyan *et al*., 2014; Grayr *et al*., 2014). For testing different methods of solving the problem of determining the internal structure of the object, must be created a universal laboratory facilities-research booth which can provide both supply electric current pulses to the object as a multi-channel data acquisition and processing. In this formulation of the problem is the most promising approach based on the use of hardware (Gorbatenko *et al*., 2011a, b) and software of national instruments.

MATERIALS AND METHODS

Creating software for the task carried out in the programming environment NI LabVIEW 2013 using the module NI LabVIEW RealTime. To implement the system uses the platform NI PXI real-time controller with NI PXI-8133, a multi-functional device NI PXI-6341, NI PXI-source 4322 installed in the chassis NI PXIe-1078. Block diagram of the developed stand is shown in Fig. 1.

In the block diagram in Fig. 1 shows the following elements: 1 = the test object and 1.1 = the volume of his presentation, 1.2 = one of the transverse sections; 2.1, 3.1 = some items which are located in controlled object and the different electrical resistances from each other and from the rest of the surrounding space object 1 filler with those 2.2, 2.3 = the projection of the data items in a slice; 4 = the current electrodes; 5 = electrodes for determination of the potential on the surface of the object. From the rest of the surrounding space object 1 filler, with those 2.2 and 2.3 = the projection of the data items in a slice; 4 = the current electrodes; 5 = electrodes for determination of the potential on the surface of the object. Software, pledged to stand provides process control and data processing to reconstruct the internal structure of an

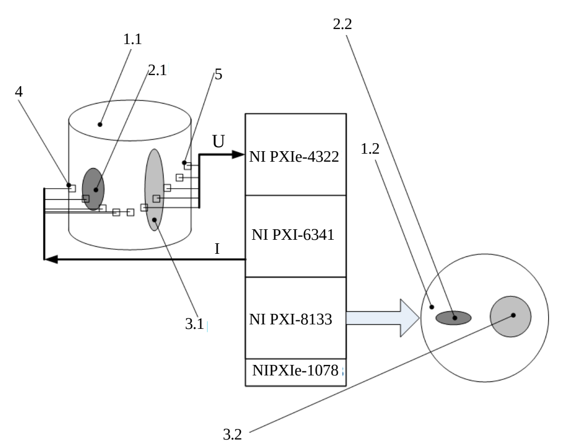

Fig. 1: Block diagram stand for research methods electrical impedance tomography

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object in a certain slice. Stand operates as follows. In the first stage one of the current electrodes supplied with alternating current with a frequency of 45 kHz, a rectangular pulse amplitude of 2-5 mA. The measured potentials are stored in memory then a current is supplied to the next electrode, etc. The saved data can be analyzed by solving the inverse problem of the finite element method.

Alternative, currently being studied is a method based on applied current simultaneously on all current-carrying electrodes and measuring potentials and stored in memory of controller. Then grid electrodes 90° rotated around the object and measuring the potentials in the transverse direction. Calculated longitudinal and transverse linear resistance and the obtained values are then added to each, resulting after crossing longitudinal and transverse dimensions "cells".

RESULTS

The result of applying this method to the case of one object inside the body shown in Fig. 2. The result of applying this method to the case of two object inside the body shown in Fig. 3. The data of Fig. 2 and 3 of the location of objects within the body an experimental data are confirmed.

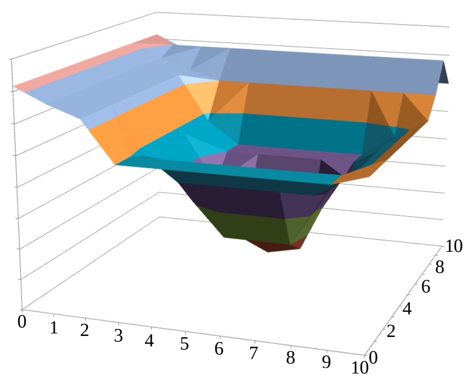

Fig. 2: The result of analyzing the internal structure of the body with one object

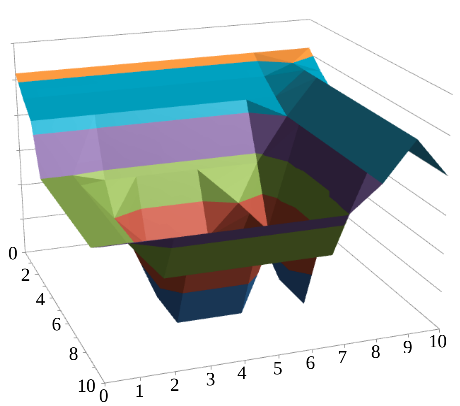

Fig. 3: The result of analyzing the internal structure of the body with two object

DISCUSSION

A comparison with the real state of the body and analysis of research results leads to the following conclusion. To effective positioning of the body inside the object, the number of electrodes (measuring and current supply) must be such that the controlled one electrode "line" was at least 3 times less than the size of the object in that direction. These results can be particularly useful as a first approximation for the subsequent calculation using the finite element method.

CONCLUSION

The necessary number of electrodes for the effective application of the investigated algorithm is made.

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