Measurement Systematic Error Decreasing Under Electrical Impedance Tomography

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Abstract - **For decreasing of measurement systematic errors of an electrical impedance tomographic experiment an in-phase method of the ensemble realization analysis are used. The method of decreasing of impedance measurement systematic errors has built. A suppose about measuring channels parameters variation considered. Results of method application on an experimental data approved.**

Keywords - **Electrical Impedance Tomography, In-phase Method, Invariant Estimator, Stochastic Process.**

I. INTRODUCTION

Electrical impedance tomography (EIT) is one of noninvasive methods for flat sections imaging of conducting bodies [1]. A problem of image reconstruction from initial data (we will name them an EIT signal) is essentially inverse and ill posed. It means that even small changes of the measured signal will result in large changes on a reconstructed image [2].

The error of measurement in EIT contains random and systematic components. A systematic error is the hardware features arrangement of a tomograph measurement transducer.

As a rule for the electrical impedance measurement by an one pair of measuring electrodes together with the impedance of a body of two multiplexer channels is connected (Fig. 1) [2].

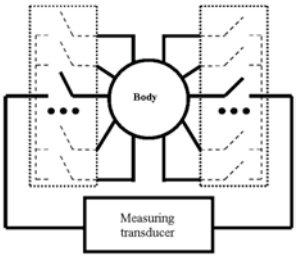

Fig.1 Connecting of a conducting body to the measuring transducer

A resistance of the opened key of the multiplexer of CMOS-structure is variable and for the different keys even one crystal of semiconductor limits (1-6) % of a nominal resistance value changes. When the resistance of a conducting body is approximately equal to resistance of a multiplexer open channel a substantial source of error is appear.

II. DECREASING OF SYSTEMATIC ERROR

For realization of the opposite measurement within the bounds of research on the department of the biotecnique system the test mockup of impedance tomograph is developed.

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The commutation circuit realized an integral CMOS multiplexer 74HC4067, with 5% resistance variation (ΔR_{MUX}) of their open channels resistance. The tomographic experiment realized via an alternate commutation of measurement electrodes [3]. As resistance of the open channels is not dependent from the time, e.g. are a constant, then the mentioned error removed (stands systematic one). For its decreasing in-phase analysis of the realization ensemble of tomographic experiment is used.

For the two-dimension array-observation of tomographic experiment $\Omega_{obs}^{TEST}(i, j)$ where $i \in N \subset Z$ is an index within the bounds of the one experiment, j is an index of the tomographic experiment in the ensemble, correction array is compute as estimation of mathematical expectation

$$\delta(i) = \hat{m}_i(\Omega_{obs}^{TEST}(i, j)) = \frac{1}{Q}\sum_{j=1}^{Q}\Omega_{obs}^{TEST}(i, j) \qquad (1)$$

and the standard deviation as a measure of a stochastic component

$$\hat{\sigma}_i(\Omega_{obs}^{TEST}(i, j)) = \sqrt{\frac{1}{Q}\sum_{j=1}^{Q}[\Omega_{obs}^{TEST}(i, j) - m_i(\Omega_{obs}^{TEST}(i, j))]^2} \ . \qquad (2)$$

The correction array for preprocessing of the tomographic data applied:

$$\Omega_{meas}(i) = \Omega_{obs}(i) - \delta(i) \qquad (3)$$

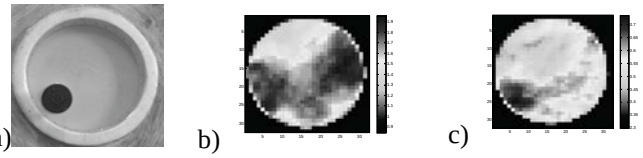

Fig. 2 The result of the tomographic data preprocessing a) model of tomographic experiment b) the data with systematic error; c) the preprocessed data without systematic error

III. CONCLUSION

The analysis of data from impedance tomograph as in-stationary signal with the use of energy theory of stochastic signals allows efficiently the systematic error of impedance measuring to decrease (Fig. 2).

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