Simulated Annealing Approach in Electrical Impedance Tomography

Z. Giza, S.F. Filipowicz, J. Sikora

Department of Electrical Engineering, Warsaw University of Technology, Koszykowa 75, 00-662 Warsaw, POLAND

***Abstract* – New method of the image reconstruction inside the body for Electrical Impedance Tomography (EIT) is presented in this paper. The advantage of this approach is to eliminate calculations of objective function's gradient and the opportunity to search the whole space of possible values of decision parameters to find the lowest value of the objective function.**

***Key words:* Electrical Impedance Tomography, Inverse Problems, Optimisation**

I. INTRODUCTION

The Inverse Problems have been intensively developed in recent years. In many technical problems we are not able to collect enough measuring data to achieve satisfactory solution. Especially such situation is difficult in Electrical Impedance Tomography. This is the kind of Inverse Problems, which relay on identification of material coefficients inside the region under consideration. There is a strict assumption that data could only be collected from the periphery of the object, not from the internal part. Due to this assumption the problem is difficult to solve.

II. INVERSE PROBLEM FORMULATION

In order to use Simulated Annealing Algorithm in Electrical Impedance Tomography image reconstruction, let us consider the following model (schematically presented in the fig.2).

Let's assume that vector **u** represents the value of electric potentials and vector **g** represents conductivity distribution inside the region under consideration [2].

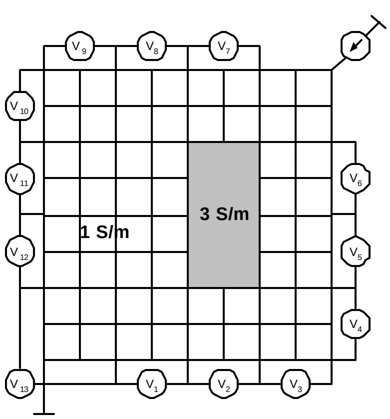

Fig.1. Region consideration with data collecting system

The inverse transformation $\{T^{-1}\}$ gives us **g** distribution, which minimize the objective function defined as follows [3]:

$$F = \sum_{j=1}^{p} F_j = \sum_{j=1}^{p} \frac{1}{2} \left(f_j - v_{0j}\right)^T \left(f_j - v_{0j}\right) = \frac{1}{2} \sum_{j=1}^{p} \sum_{i=1}^{n_{de}} \left(f_{ji} - v_{0ji}\right)^2$$

where: j – projection angle (positions of the energy source), $\mathbf{f}_j$ and $\mathbf{v}_{0j}$ – the vectors of calculated and measured potentials at the boundary for the j-th projection angle respectively; n_{de} – the number of measurements collected according the protocol presented in fig.2.

III. SIMULATED ANNEALING ALGORITHM

The simulated annealing image reconstruction algorithm for EIT can be formulated as follows. The algorithm will iteratively reconstruct the image that difference between measured data represented with vector $\mathbf{f}_j$ fits best the values in vector $\mathbf{v}_{0j}$ for each j-th projection angle. We assume that, minimizing the difference between the measured voltage data and calculated data, the reconstructed image will coverage towards the sought-after original image. Therefore, as the objective function was chosen a function that expresses the difference between both data sets [1].

At the starting point all of values of material coefficients have the same value of background conductivity. During cooling process all the values of decision variables are slightly disturbed. If the set of such values corresponds better the real material coefficient distribution, the values of calculated voltage data **f** fit better the measured data $\mathbf{v}_0$ and the value of objective function F is lower. After finite number of iterations, the value of objective function is lower then the value at the starting point. This means that distribution of material coefficient has became more similar to the original distribution.

IV. REFERENCES

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