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The shape reconstruction of unknown objects for inverse problems

Abstract. *The proposed solution of the inverse problem in the Electrical Impedance Tomography was based on a numerical scheme for the identification of the piecewise constant conductivity. The representation of the shape of the boundary and its evolution during an iterative reconstruction process is achieved by the level set function. The forward problem was solved by the finite element method.*

Streszczenie. *Proponowane rozwiązanie zagadnienia odwrotnego w tomografii impedancyjnej zostało oparte na algorytmach numerycznych identyfikujących obiekty o różnych konduktywnościach. Reprezentację kształtu brzegu oraz jego ewolucję podczas procesu rekonstrukcji opisuje metoda zbiorów poziomicowych. Zagadnienie proste zostało rozwiązane za pomocą metody zbiorów poziomicowych (**Rekonstrukcja kształtu nieznanych obiektów w zagadnieniach odwrotnych**).*

Keywords: Electrical Impedance Tomography, Level Set Methods, Inverse Problem
Słowa kluczowe: tomografia impedancyjna, metoda zbiorów poziomicowych, zagadnienie odwrotne

Electrical Impedance Tomography

In this paper was proposed several of numerical techniques with different advantages to solve the inverse problem in the electrical impedance tomography (EIT) [2]. The level set method is known to be a powerful and versatile tool to model the evolution of interfaces [3,4,5]. The algorithm was base on an active contour model without edges based on a 2-phase segmentation [1].

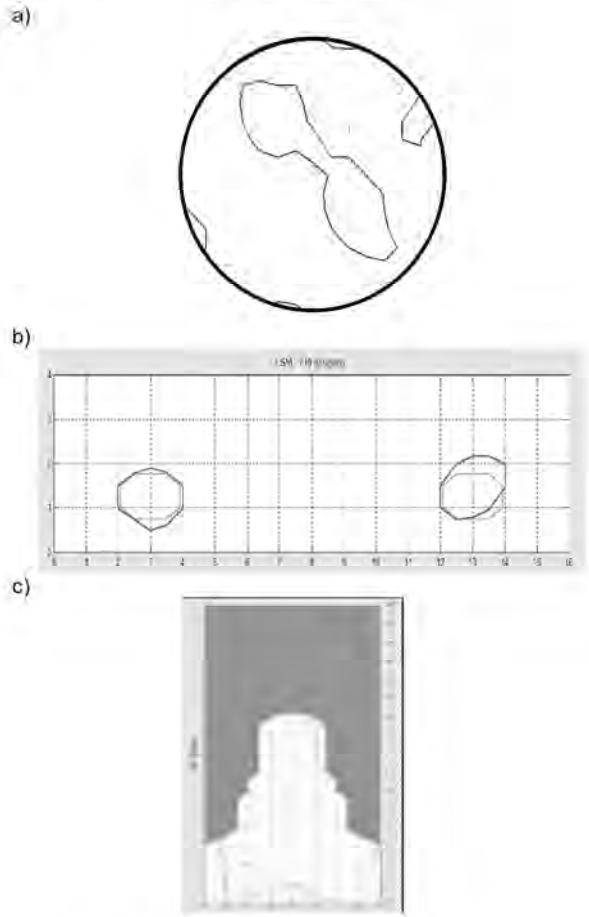

Fig. 1. The image reconstruction: a) the tree trunks, b) the copper-mine ceiling, c) the moisture wall

The idea is merely to define a smooth function , that represents the interface:

$$\frac{\partial \phi}{\partial t} + \mathbf{v} \cdot \nabla \phi = 0 \tag{1}$$

where **v** is the desired velocity on the interface.
The following steps are used in numerical algorithm:

- Initialize the level set function
- Calculate the electric potential by using the finite element method)
- Compute the difference of the computed solution with the observed data
- Solve the Poisson equation (adjoint equation)
- Find the component of the normal velocity of the surface due to the electric potential
- Find the normal velocity of the level set function
- Calculate the velocity
- Update the level set function
- Reinitialize the level set function.

The figure 1 presents an image reconstruction in EIT. The pictures show a few of the practical examples (the tree trunks, the copper-mine ceiling, the moisture wall) with different objects and their process reconstruction. The images show the original object and the reconstructed shape after the process iterations.

REFERENCES

[1] Chan T. and Vese L., "Active contours without edges", IEEE Trans. Imag. Proc., vol. 10, pp. 266-277, 2001.
[2] Ito K., Kunish K., Li Z., "The Level-Set Function Approach to an Inverse Interface Problem", Inverse Problems, Vol. 17, No. 5, pp. 1225-1242, October, 2001.
[3] Osher S., Fedkiw R.: Level Set Methods and Dynamic Implicit Surfaces. Springer, New York 2003.
[4] Osher S., Sethian J.A., Fronts Propagating with Curvature Dependent Speed: Algorithms Based on Hamilton-Jacobi Formulations. Journal of Computational Physics, 79, 12-49, 1988
[5] Sethian J.A.: Level Set Methods and Fast Marching Methods. Cambridge University Press 1999.

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