Chapter 82
Reconstruction of Electrical Impedance Tomography Using Fish School Search, Non-Blind Search, and Genetic Algorithm

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ABSTRACT

Electrical Impedance Tomography (EIT) is a noninvasive imaging technique that does not use ionizing radiation, with application both in environmental sciences and in health. Image reconstruction is performed by solving an inverse problem and ill-posed. Evolutionary Computation and Swarm Intelligence have become a source of methods for solving inverse problems. Fish School Search (FSS) is a promising

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search and optimization method, based on the dynamics of schools of fish. In this article the authors present a method for reconstruction of EIT images based on FSS and Non-Blind Search (NBS). The method was evaluated using numerical phantoms consisting of electrical conductivity images with subjects in the center, between the center and the edge and on the edge of a circular section, with meshes of 415 finite elements. The authors performed 20 simulations for each configuration. Results showed that both FSS and FSS-NBS were able to converge faster than genetic algorithms.

INTRODUCTION

Ionizing radiation is commonly used in medical image machines, as mammography, positron emission tomography or x-rays. Besides the benefits that using those electromagnetic waves may provide, there are many associated risks to whom operates those machines or is submitted to these kind of exams. Also, the prolonged exposition to ionizing radiation may cause many diseases, such as cancer (Rolnik & Seleghim Jr, 2006). Possibly, this issue is one of the most debated subjects in Public Health all over the world, strengthening the search for imaging technologies that are: efficient, low-cost, simple and safe to those that uses them.

A promising imaging technique, that does not use ionizing radiation, is Electric Impedance Tomography (EIT) (Bera & Nagaraju, 2014; Rolnik & Seleghim Jr, 2006). EIT is about a non-invasive technique that builds images of an interior body (or any object), using electrical properties, measured over the surface of interest. Those measurements are acquired from electrodes' disposition around the transversal section of interest, and the application of a low amplitude and high frequency current through them creates an electric potential, known as "border potential". This low-voltage signal is measured and, in a computer, they are used in a reconstruction algorithm that rebuilds the image of the body's inside region of interest (Rasteiro, Silva, Garcia, & Faia, 2011; Tehrani, Jin, McEwan, & van Schaik, 2010; Brown, Barber, & Seagar, 1985).

In medical sciences, EIT can be applied in several situations, such as: breast cancer (Cherepenin et al., 2001), pulmonary ventilation monitoring (Alves, Amato, Terra,Vargas, & Caruso, 2014), in the detection of pulmonary embolism or blood clots in the lungs (Cheney, Isaacson, & Newell, 1999). Likewise, it can be applied in fields as Botanics, generating images of the trees' trunks' insides, allowing the knowledge of its biological conditions without damaging it (Filipowicz & Rymarczyk, 2012); in monitoring multiphasic outflow in pipes (Rolnik & Seleghim Jr, 2006); in Geophysics, EIT is largely used to find underground storage of mineral and different geological formations (Cheney et al., 1999).

When compared with techniques, like Magnetic Resonance Tomography, or X-Ray Tomography, EIT has a relatively low cost, since, in simple manners, it needs an equipment able to generate and measure current and electric potential, and a computer, able to rebuild the image (Tehrani et al., 2010). Also, since it uses only the electrical properties (conductivity and permittivity) of the body, there are no associated risk to its use, unlike acquisition methods that uses ionizing radiation.

However, Electric Impedance Tomography images have, still, low resolution and undefined borders, which harms its popularity and diffusion among the imaging field. This motivates researchers of EIT to seek new methods of image reconstruction that are also able to overcome these techniques disabilities, creating images with good resolution and low computational cost, making of it a reliable and easy tool on diseases' diagnostics.