Chapter 12
Image Reconstruction of Electrical Impedance Tomography Using Fish School Search and Differential Evolution

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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 and bioinspired computation have

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become a source of methods for solving inverse problems. In this chapter, the authors investigate the performance of fish school search (FSS) and differential evolution (DE) using non-blind search (NBS) considering meshes of 415, 3190, and 9990 finite elements. The methods were evaluated using numerical phantoms consisting of electrical conductivity images with objects in the center, between the center and the edge, and on the edge of a circular section. Twenty simulations were performed for each configuration. Results showed that both FSS and DE are able to perform EIT image reconstruction with large meshes and converge faster by using non-blind search.

INTRODUCTION

The most commonly medical image machines, such as Mammography, Positron Emission Tomography and X-Rays, use ionizing radiation in their process. Using those electromagnetic waves may provide benefits to the quality of the image obtained from these methods, however there are many associated risks to whom operates those machines or is submitted to these kind of exams. In addition to that, the prolonged exposition to ionizing radiation may cause many diseases, such as cancer (Rolnik & Seleghim Jr, 2006). Given the importance of this issue to Public Health throughout the world, the search for imaging technologies that are efficient, low-cost, simple and safe to those that uses them becomes of the utmost importance.

Within these circumstances, Electric Impedance Tomography (EIT) has earmarks of being a promising imaging technique, considering that it does not uses ionizing radiation (Bera & Nagaraju, 2014; Rolnik & Seleghim Jr, 2006). EIT consist in a non-invasive technique that builds images of inside a body (or any object), using electrical properties, measured over the surface of interest. Applying a low amplitude current through some electrodos disposed around the transverse section of interest induces an electric potential, known as ”border potential”. This low-voltage signal is measured from these same electrodos and conveyed to a computer that uses them in a reconstruction algorithm to rebuilds the image of this region of interest. (Rasteiro, Silva, Garcia & Faia, 2011; Tehrani, Jin, McEwan & van Schaik, 2010; Brown, Barber & Seagar, 1985).

EIT has many applications in several fields of knowledge, such as medical sciences, botanic, industry and geology. In medical science, it is utilized to detect pulmonary embolism or blood clots in the lungs (Cheney, Isaacson & Newell, 1999), pulmonary ventilation monitoring (Alves, Amato, Terra,Vargas & Caruso, 2014), and also to detect breast cancer (Cherepenin et al., 2001). Examples of its application in other fields are: generating images of the trees' trunks' insides, allowing the knowledge of its biological conditions without damaging it (Filipowicz & Rymarczyk, 2012); monitoring multiphasic outflow in pipes (Rolnik & Seleghim Jr, 2006) and find underground storage of mineral and different geological formations (Cheney et al., 1999).

Considering that Electrical Impedance Tomography requires only an equipment able to generate and measure current and electrical potential and a computer able to rebuild the image, look as though it is an advantageous method due to it relatively low cost when compared to other methods like Magnetic Resonance, Tomography or X-Rays (Tehrani et al, 2010). Another benefit of this imaging method is that it uses only the electrical properties (conductivity and permittivity) of the body, it does not use ionizing radiation, in such manner that there is no associated risk to its use.

However, image reconstruction in EIT is something that still needs to be improved, since that it has a low resolution and undefined borders, which harms its popularity and diffusion among the imaging field