Electrical Impedance Tomography: Topology Optimization

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ABSTRACT

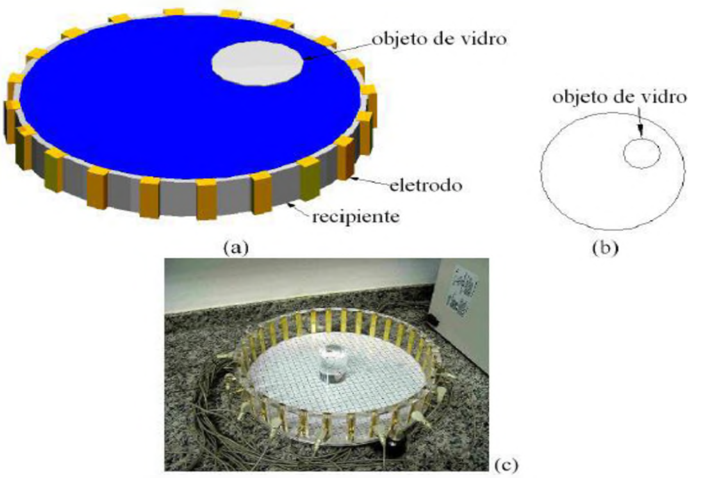
The Electrical Impedance Tomography (EIT) is a study of body parts who use electric current. Is studied through computers resistance or conductivity of these parts, producing an image used for medical diagnosis. A body is wrapped in a blanket placed with small electrodes and receivers of electric current, potential difference. Based on data obtained from a series of measurements at the electrodes, one by one, sending and receiving, you can perform a numerical phantom, where each "voxel" of the image formed computationally represents the impedance of biological tissue. In Brazil, studies on electrical impedance tomography (EIT) has not yet started. Such equipment are measured tensions - potential difference - between each electrode / sensor one by one, as a way to Simple Combinatorial Analysis. The sequence and the way it is measured strains are in the final image quality. Finite Element Method Interactive, whose algorithm is based on Dialectical Method. [Wellington Pinheiro dos Santos]. We use an initial function with the objective of maximizing the data quantitatively, for better qualitative analysis. Topology Optimization methods are used to improve the image reconstruction. Currently the study is quite primitive related to the theory that shows how to power the new science studied. The high quality images requires a difficulty in obtaining. This work is not intended for detailed for analysis ins any tissue or organ specif, but in general terms. And the formation of the 2D image. 3D need a reconstructor to part.

1. INTRODUCTION

The Electrical Impedance Tomography (EIT) is a study of body parts spelled using electric current and studied, using computers, by measuring the resistance or conductivity of these parts, producing an image used for medical diagnosis. A body is placed wrapped in a blanket with small electrodes senders and receivers of electric current, subjected to a potential difference. Based on data obtained from a series of measurements of the electrodes, one by one, sending and receiving, it is possible to realize a phantom (simulated body) number, where each "voxel" (smallest unit of an image) image formed is the computationally impedance of the biological tissue. In Brazil, studies on Electrical Impedance Tomography (EIT) are still preliminary. In the proposed equipment are measured tensions - potential difference - between each electrode / sensor one by one, in the form of Simple Combinatorial Analysis. The sequence and manner of how the voltages are measured are final image quality. Our procedure is called Finite Element Method Interactive, whose algorithm is based on Dialectical Method We use a function with the initial goal of maximizing data quantitatively better for qualitative analysis. Topology optimization methods are used to improve the image reconstruction. Currently the study is quite primitive related to the potential theory shows how the new science studied. To obtain high quality images in topology optimization is required to obtain data and the method being user to polish the data forming the image. This work is not intended for detailed analysis in any tissue or organ specific, rather than generic. And the formation of the 2D image. 3D require a reconstructor part.

2. Materials and Methods.

An experimental phantom is used by a cylindrical vessel with 32 electrodes in bar (see Figure 1) 35mm by 10mm. The container is filled with 35mm saline (NaCl) concentration equal to 0.3 g / L. The resistivity of the solution is approximately 17 ohms and the diameter is 220mm, equal to the internal diameter of the container. The small circle in Figure 1 (b) represents an object present in the glass container. This example represents a high contrast again pneumothorax. A new pet mesh with 11,623 four-node tetrahedral elements is generated. Pixel or Voxel image is formed its impedance or Electrical Resistivity. The images are generated using values of voltages (ddp) electrodes encased in the body, trying to figure out the electrical conductivity of the same. Sequences of electric currents of 10mA are generated in the electrodes one by one. Several current and current application settings with several different excitation protocols were tested in order to increase the fidelity of the image obtained.

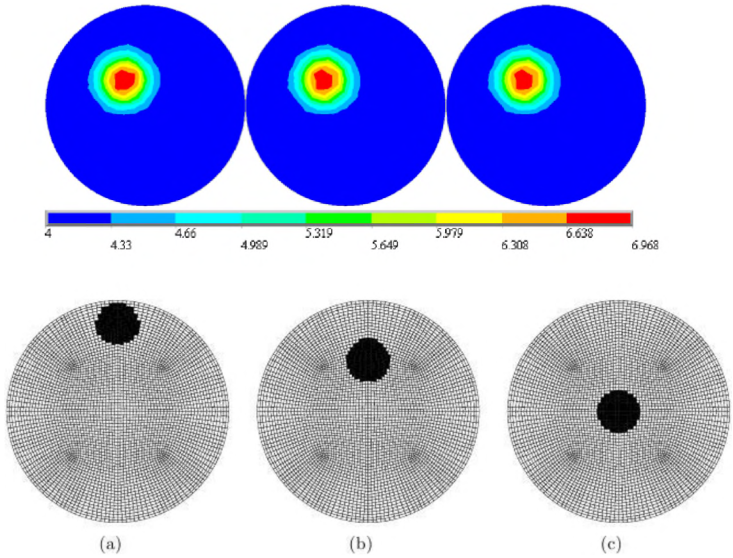


Resuldados

Considering the experimental responses, the images suggest that the algorithm is potentially capable of monitoring ventilation imposed by mechanical ventilation, including the possibility of detecting a pneumothorax.

The experimental results (as compared to numeric) indicate that the effect of the use of the electrodes has effectively. It is believed that this is due to the contact resistivity values of the experimental apparatus are negligible.

As a means of improving the image, it is suggested the imposition of restrictions on the distribution of nodal conductivities, based on distance to the electrodes. The distance is given as the sensitivity to changes in resistivity peripheral regions is greater than in regions further away (BACRIE; GOUSSARD; Guardo, 1997; AYA et al. 2006). Further, we suggest adaptively refine the mesh to increase spatial resolution in specific locations in the model, and segmentation of the image to obtain an image with higher resolution in resistivity (Mello et al. (2010).



3. CONCLUSIONS

The responses show the difficulty of working with the technique and suggest that uncertainties in regions considered to be deterministic even stricter than those considered in the current work, so the job of the approach is effective. Further, although it is possible to theoretically and as suggested responses, accurate estimation of array elements with the average of "pixels" image proved impracticable with respect to processing time. The conclusion is that variances unknowns must be obtained in advance by an alternative method. Finally, it is concluded that measuring potential differences between electrodes, the model TIE becomes immune to the positioning error of the reference electrode (or electrode of fixed potential). Still, it is not necessary to use multiple arrays of finite elements in the estimation process, one for each reference. You can choose any reference (node and value of any electric potential) and use it, whatever the position of the reference electrode real (attached to the experimental apparatus or body tomografado).

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