Reconstruction of Conductivity Changes Using an Advanced Compensation Method in Electrical Impedance Tomography

Yang Pu and Tao Dai

Sealand Technology (Chengdu), Ltd., Chengdu, China. ypu@eitchina.net

Abstract: Element displacement and contact impedance changes are compensated in the reconstruction approach. Images have been reconstructed using the proposed method with the data from numerical simulation, saline phantom and *in vivo* human measurement.

1 Introduction

One of the key difficulties of Electrical impedance tomography (EIT) imaging is the modelling error, such as shape deformation and contact impedance changes. When a deformable medium is investigated, not only boundary elements (including electrodes) but also internal elements displace. Moreover, when the voltages are measured on the electrodes, the contact impedance that exists in the interface causes a voltage drop. If difference imaging techniques are involved, these difficulties can be partly solved [1-3], but in order to obtain a better imaging quality, element displacement and contact impedance changes have to be taken into account.

2 Methods

An augmented Jacobian $\mathbf{J} = [\mathbf{J_c}\ \mathbf{J_d}\ \mathbf{J_t}]$ is obtained by concatenating conductivity change Jacobian $\mathbf{J_c}$, element displacement Jacobian $\mathbf{J_d}$ and contact impedance changes Jacobian $\mathbf{J_t}$. A modified NOSER prior $[\mathbf{R}]_{i,i} = [\mathbf{J}'^T\,\mathbf{J}']^p_{i,i}$ is established, where $\mathbf{J}' = [\mathbf{J_c}\ \ \mu^2\mathbf{J_d}\ \ \tau^2\mathbf{J_t}]$, we define μ and τ as the model hyperparameters to represent the different weights. The one-step linear Gauss-Newton (GN) method is implemented to solve the inverse problem.

2.1 Numerical Simulation

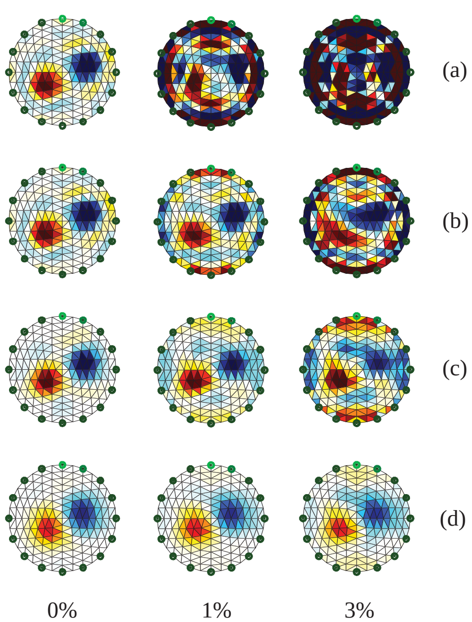

Figure 1: Image reconstructions. (a) Standard GN method; (b) Electrode movement model; (c) Proposed method with $\mu = 1$ and $\tau = 1$; (d) Proposed method with $\mu = \sqrt{0.1}$ and $\tau = 0.1$. From left to right, distortion amplitude increases from 0%, 1% to 3% of model diameter respectively.

2.2 Saline Phantom Measurement

The saline phantom is a plastic cylindrical tank with 14cm diameter and 12cm height, being filled with 0.9% saline solution. A small non-conductive spherical object of 1cm diameter was statically suspended. The proposed method successfully obtained the inhomogeneous target without introducing any artefacts.

2.3 *In vivo* Human Measurement

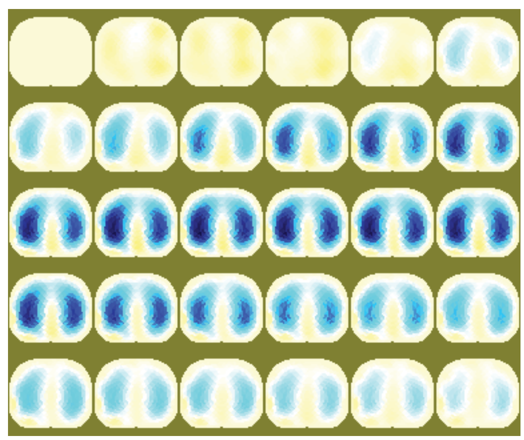

Figure 2: Images of lung ventilation. The breathing cycle from end inspiration to end expiration was approximately 5 seconds. Each second was shown in the same row.

3 Conclusions

An advanced compensation method which is more robust to shape distortion is proposed in this paper by an improved version of the electrode movement model [1]. The algorithm performed well and showed significant improvements of artefact resistance. One key advantage is that, once pre-calculations are completed, images can be reconstructed by a single regularized inverse, and it requires little additional time over traditional methods. Considering the reconstructed images from *in vivo* human measurement, this method shows potential to be applied in real time monitoring of lung ventilation and may be useful to increase the accuracy and reliability of EIT technique in routine clinical applications.

References

[1] M. Soleimani, *Physiol. Meas.* 27 S103-S13, 2006
[2] T. Dai, *Physiol. Meas.* 29 S77-S88, 2008
[3] A. Adler, *Physiol. Meas.* 32 823−834, 2011

Excerpted from:

Proceedings
of the
15th International Conference on
Biomedical Applications of

ELECTRICAL IMPEDANCE TOMOGRAPHY

Edited by Andy Adler and Bartłomiej Grychtol

April 24-26, 2014
Glen House Resort
Gananoque, Ontario
Canada

This document is the collection of papers accepted for presentation at the 15th International Conference on Biomedical Applications of Electrical Impedance Tomography.

Cover design: Bartłomiej Grychtol
Photo credit: ©1000 Islands Photo Art Inc. / Ian Coristine

Printed in Canada

ISBN 978-0-7709-0577-4

Systems and Computer Engineering
Carleton University, 1125 Colonel By Drive
Ottawa, Ontario, K1S 5B6, Canada
adler@sce.carleton.ca
+1 (613) 520-2600

www.eit2014.org