A feasibility study for High Resolution EIT imaging

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Abstract: EIT is a new imaging technology that is open to many applications with its advanced natures with no ionising radiation, relatively low cost. The main disadvantage of EIT is the low spatial resolution that limits its application areas. This paper presents a new methodology that has achieved a significant improvement of the spatial resolution, enabling "high resolution" EIT imaging.

1 Introduction

The Electrical Impedance Mammography (EIM) is a 3D EIT based system for breast cancer detection. The ability to detect a suspicious lesion of less than 20mm in diameter and down to pathological Grade-1 is clinically very advantageous. Being able to do so is a current major challenge of the EIM technology. This study proposes a new novelty method to have increased the spatial resolution of EIM for meeting the clinical requirement.

2 Methods

Cambridge EIM systems have been designed to use either 85 or 89 planar electrodes deployed in hexagonal and squared pattern respectively (Fig. 1a,1c). The distance between the adjacent electrodes is 17mm. The current excitation and voltage measurements are achieved in a small hexagonal area (Fig.1 b) with up to 1416 measurements made [1] at each frequency. In all illustrations in this paper, the yellow dots indicate the excitation pair electrodes while blue dots connected by red arrows indicate measuring pairs of electrodes..

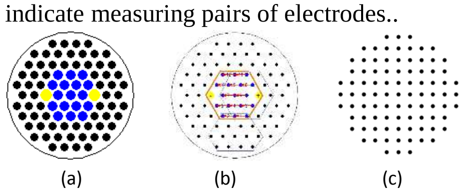

Fig 1. The planar electrodes system of Cambridge EIM (a) the hexagonal electrodes. (b) the electrode drive and receive hexagon.(c) squared based electrode configuration

The concept of this novelty method is to reconstruct an high-resolution (HR) image, based on obtaining very HR frames data, to be achieved by shifting the electrode plate of the scan-head via a group of digital stepper motors, where the planar electrodes are implanted into any option proposed (Fig 2,3). All measurement frames are combined together as one set of data and processed by the image reconstruction algorithm on an HR mesh. To avoid moving artefact during multi-frame shifting data collection, patient breast is held by a rigid holder on the top of the electrode planar in the tank, which is made of a matched conductivity materials. The following figures relating to 3 options as examples to show how to achieve an HR EIT images, based on "squared-shaped electrode" configuration. As shown in Fig 2-3, each movement is represented by an arrow, Fig 2 represents 4 shifted frames resulting one HR "virtual" electrode arrays (Fig 2 (right)).

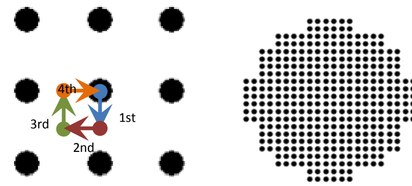

Fig 2. Option 1: Electrodes array with 4-shift HR frames with 1 interpolation, to achieve the combined numbers of all the electrodes: 89*4 = 356 (right)

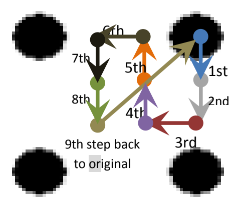

Fig 3. Option 2,3 and Option N: Electrodes with 9 or 16-shift HR frames (2 or 3-interpolation) will achieve total 801 or 1424 combined virtual electrodes respectively. Similarly, electrodes with N-interpolation would generate $(N+1)^2$ shifting to achieve total $(N+1)^2$ x89 combined electrode effect.

The preliminary results of HR image is shown in Fig 4.

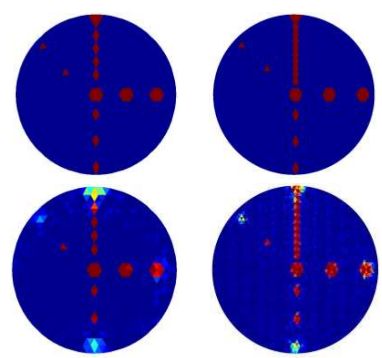

Fig 4. Result of 85-electrode EIM simulation. Original model: hexagonal mesh (top left) and 4-shit based HREIM mesh (top right). The results of reconstructed noise-free images: hexagonal mesh (bottom left) and the HREIM mesh (bottom right)

3 Conclusions

The preliminary results have shown that the HR EIT is feasible and significant improvement has been made.

References

[1] Xiaolin Zhang, Wei Wang and Chris Chatwin, "The Data Acquisition Method of the Sussex MK4 EIM System", EIT2014 conference, Canada 2014