# Assessment of EIT/CT Fusion Imaging using a Biological Phantom

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**Abstract:** A cylindrical slice of seeded winter melon with an air-cavity was imaged using CT and EIT imaging systems. The structural regions were extracted from the CT image using morphological image processing algorithms and fused with the functional information of its EIT image. Fusion performance showed a detectability increase of 67% along with a structural similarity increase of 26%.

## 1 Introduction

Conductivities of biological tissues provide useful functional information in many areas clinical applications. Conductivity images are acquired using EIT but limited by poor spatial resolution. The limitation can be overcome by fusing the functional information of EIT with the morphological features of a CT image. Earlier, we demonstrated the potential of fusion by imaging a phantom with radiotherapy bolus as medium [1]. In the present study, we use winter melon based biological phantom. For simplicity we measure conductivity part of the impedance using 2D approach along with an assumption that the winter melon shape is circular.

## 2 Methods

A cylindrical slice of winter melon was cut from the whole vegetable and a cavity of 4.5 cm diameter was made as shown in Fig. 1.

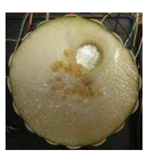

**Fig.1. Winter melon Phantom**

EIT data was acquired using sixteen electrodes around the phantom, injecting a current of 0.4mA at 66 KHz . Images were reconstructed in differential imaging mode using one-step Gaussian Newton minimization solver [2]. CT image of the melon was obtained using a Phillips CT Scanner. A binary mask image was generated from the CT-image using automatic thresholding. The mask and the EIT images were resized based on the reference electrode position and the CT image dimensions. The mask image was then segmented for different regions of interest and labelled for the user to specify. The region selected by the user was fused with the CT image through logical indexing. The CT, EIT and EIT/CT imaging performance was evaluated using detectability and structural similartity measures. Detectability is measured as

$$D = \frac{\mu_{roi}}{SD_{background}} \quad (1)$$

$\mu_{roi}$ is the mean of the ROI pixels and $SD_{background}$ is the standard deviation of the background pixels of the image [3].The structural similarity index is a widely used measure in signal and image processing applications, derived from the visual impact of changes in luminance, contrast and structure in an image [4]. It is calculated as a single metric using

$$SSIM = \frac{(2\mu_x\mu_y+C_1)(2\sigma_{xy}+C_2)}{(\mu_x{}^2+\mu_y{}^2+C_1)(\sigma_x{}^2+\sigma_y{}^2+C_2)} \quad (2)$$

Where, $\mu_x$ and $\sigma_x$ are the mean and standard deviation of the CT image $\mu_y$ and $\sigma_y$ are the mean and standard deviation of the EIT image. $\sigma_{xy}$ is the Correlation coefficient between the CT and EIT image under assessment and $C_1$, $C_2$ are computational constants..

## 3 Results

Fig. 2 shows the images obtained before and after fusion for the circular inhomogeneity. Detectability and structural similarity evaluations of the CT, EIT and the EIT/CT images, evaluated using (1) and (2) show an increase in structural similarity by 26% along with a detectability increase of 67%.

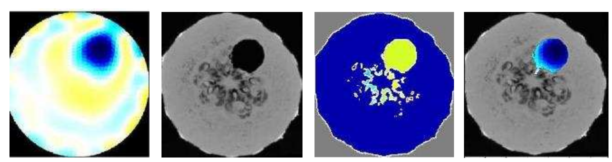

**Fig.2. EIT/CT Fusion Imaging of seeded winter melon. From left to right: EIT Image, CT Image, Image with labelled ROIs, and Fused EIT/CT image**

## 4 Conclusions

Imaging winter melon phantom through co-registration and fusion of functional Electrical Impedance Tomography (EIT) and Computed Tomography (CT) improved detectability by 67% and structural similarity by 26%, thereby showing enhanced potential to use in radiation therapy treatment planning.

## References

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[4] Wang Z,Bovik A.C, Sheikh H.R, and Simoncelli E.P" IEEE Trans on Image Processing **13** (4), 600-612,(Apr 2004).