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# Realistic 3D Finite Element Mesh of the Adult Human Pelvis for Electrical Impedance Tomography

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**Abstract:** The finite element method is a numerical technique used to solve forward models for electrical impedance tomography. To date, realistic finite element models (FEMs) have been created for the head and thorax, but pelvic models for bladder imaging are lacking. This paper presents a high quality, first-order, tetrahedral FEM of 25004 nodes and 129157 elements for the adult male pelvis, with mean and standard deviation stretch values of 0.752 and 0.082, respectively.

## 1 Introduction

The finite element method is commonly employed in the forward problem of electrical impedance tomography (EIT). To resolve the ill-posed problem within EIT, the finite element model (FEM) provides information on the geometry of the region of interest. The position and the geometry of the attached electrodes are included in the FEM when in use for a specific forward problem.

Realistic 3D FEMs for EIT applications have been created for the head [1] and the thorax [2]. However, to date, a model for the pelvic region does not exist. Applications such as bladder volume monitoring using EIT have instead employed cuboid [3], circular [4] and cylindrical [5, 6] FEMs for the boundary of the pelvis. Li et al. [4] based their 2D FEM for patient bladder volume monitoring using a single slice from a CT scan.

Discrepancies between the FEMs and the geometry of the true subject can significantly and negatively affect the reconstructed image, with inconsistency between the boundary of the subject and the FEM leading to potential image artefacts [1, 7].

This paper presents a realistic 3D FEM of the adult male pelvis to support applications in EIT bladder imaging.

## 2 Methods

Computed tomography (CT) slices of the adult male pelvic anatomy were gathered from the Visual Human Project [8]. Slices were selected from above the genitals to the top of the navel. The slices were taken at 10 mm increments, imported into the computer aided design software, AutoDesk<sup>TM</sup> Fusion 360, and stacked at 10 mm spacings in order to create the surface model.

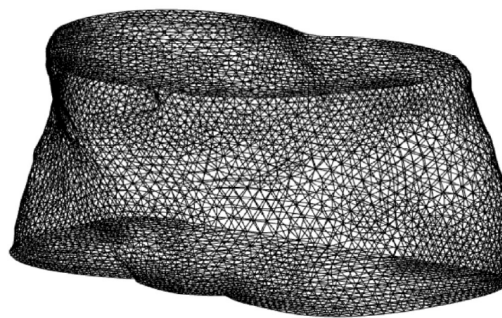
The procedure used to form the surface model was similar to one used for the head model by Tizzard et al. [1]. The procedure involved placing points on the boundary of each image and using splines to interpolate through the points to form the curved contours. The 3D surface model was then formed by lofting the curve contour profiles and exported in Initial Graphics Exchange Specification (IGES).

The first-order, tetrahedral mesh was created in SimScale [9]. SimScale is a Salome-based numerical simulator that op-

erates in the cloud, allowing for faster mesh generation.

## 3 Results

The generated mesh of the male pelvic anatomy consists of 25004 nodes and 129157 tetrahedral elements. The number of elements of the mesh is greater than the recommended minimum of  $10^6$  elements for 3D FEMs [7]. The model is 20 cm in height. The stretch values are between 0.292 and 0.989 with a mean and standard deviation of 0.752 and 0.082, respectively. The mesh is illustrated in Figure 1.



**Figure 1:** The generated first-order, tetrahedral mesh of a male adult pelvis, from above the genitals to the top of the navel.

## 4 Conclusions

A realistic 3D FEM of an adult male human pelvis has been developed for EIT image reconstruction. This work has the potential to benefit bladder imaging applications in EIT.

## 5 Acknowledgements

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