Generation of a 3D Human Phantom with Random Internal Structures for CT Image Testing

Po-Kai Chen, Maryia Zhyrko

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1 Introduction

Medical imaging techniques, such as CT scans, require realistic phantoms for testing and calibration. In this work, we present a method for generating a 3D human phantom with randomized internal structures using procedural content generation. This phantom can be used to simulate CT images by incorporating randomly positioned internal structures in the head and torso.

2 Methodology

The phantom is composed of multiple geometric primitives:

- The **head** is modeled as a sphere.
- The **torso** is modeled as an ellipsoid.
- The **arms and legs** are modeled as cuboids.
- Random internal structures (e.g., small spheres) are added inside the head and torso.

The parameters of the phantom are determined randomly within predefined biological constraints, ensuring a diverse set of human-like figures.

2.1 Head and Torso Generation

The head is generated as a sphere with a radius proportional to the total height of the phantom. The torso is represented by an ellipsoid with width and depth proportional to the body height. The dimensions follow:

$$\begin{aligned} h &= \text{random height between 150 and 190 cm}, \\ r_{\text{head}} &= \frac{h}{6} \text{ to } \frac{h}{8}, \\ L_{\text{torso}} &= 0.5h \text{ to } 0.53h. \end{aligned}$$

2.2 Internal Structure Placement

To simulate variability in CT scans, we introduce random internal structures within the head and torso. Each structure is a sphere with a radius selected from a range of 20% to 50% of the enclosing body part. The structure center is randomly positioned within the respective volume while ensuring it does not protrude outside.

3 Results and Visualization

Figure 1 illustrates a sample generated phantom with random internal structures. The head and torso contain gray-colored internal anomalies for CT image simulation.

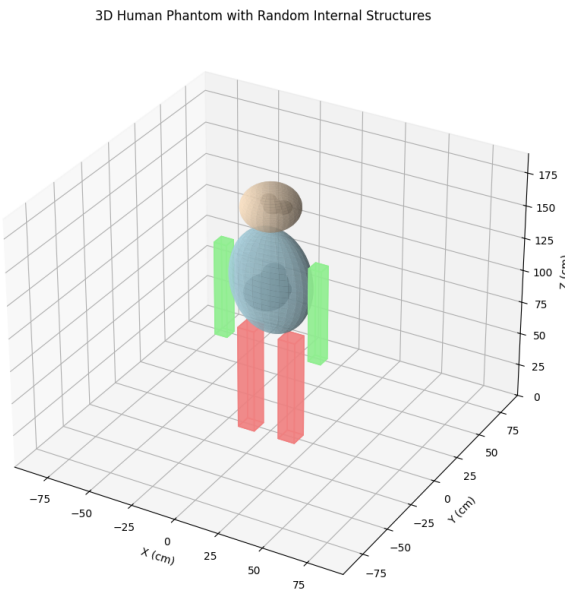

Figure 1: Generated 3D human phantom with random internal structures.

4 Conclusion

This method provides a procedural way to generate human phantoms with realistic structural variations for CT image testing. The random internal structures allow for diverse testing scenarios, making it a useful tool for medical imaging research.