

## Metal-marked Tumor Tracking in Less than 90degree Two Pair Stereo X-ray System Simulation

Hanseong Jeong<sup>1\*</sup>, Seho Lee<sup>1</sup>, Youngju Kim<sup>1</sup>, Ohsung Oh<sup>1</sup>, Jeongho Kim<sup>1</sup> and Seung Wook Lee<sup>1</sup>  
<sup>1</sup> School of Mechanical Engineering, Pusan National University, Busan 609-735, South Korea  
\*Corresponding author: seunglee@pusan.ac.kr

### 1. Introduction

Cancer occurrence probability grows up continuously, and three therapy methods are used to treat a tumor like cancer: invasive surgery, anti-cancer drug, and radiation therapy. The goal of radiation therapy is to be exposed to radiation for only cancer tissues. To give accurate therapy, recently, variable forms of guidance system are loaded on radiation therapy equipment. [1]

In Vero SBRT system, included angle of two kV imaging system is 90degree. [2,3,4] In current progressing research, two-pair kV imaging system at angle less than 90degree is needed to increase moving range of a MV beam head. In this study, our study simulated tracking metal marker inserted into tumor at angle less than 90degree. [3,4]

### 2. A XCAT phantom and projection

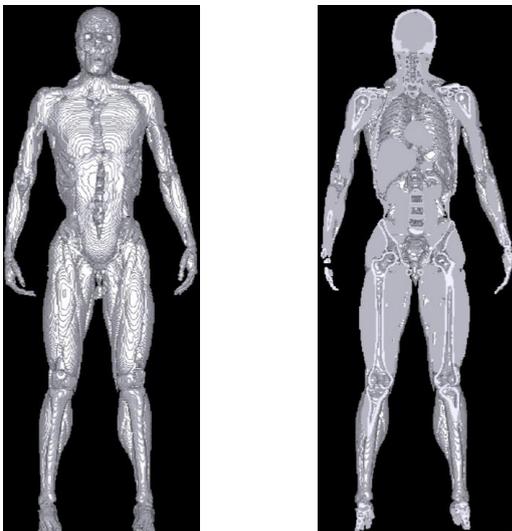


Fig 1. A XCAT phantom simulation visualized as VX3D

#### 2.1 XCAT phantom

This figure in VX3D is XCAT phantom that has been made into commercial software by Duke University. XCAT was used in this study [5]. Body and lesion phantom are made and combined.

Instead of gold, a material of the lesion was changed from muscle to iron to detect easily.

Voxel size of the XCAT used in this simulation is  $256 * 256 * 100$ . Pixel size and slice size are 0.3125 cm /voxel and 0.3125 cm/voxel, and spherical lesion's diameter is 5mm. These parameters can be changed in text file. Later, the center of the phantom is the center of a long simulation system.

#### 2.2 projection

Projection is used by CT\_projector, and this, as XCAT, has been made by Duke University. This program has many options: translation, projection angle, parallel, cone, and fan beam projection, etc.



Fig 2. Projecting XCAT phantom inserted metal marker by CT\_projector

In this simulation, Detector's size is  $410*410$ mm and  $256*256$ pixel. SOD(source to the center of the phantom) is 1510.4mm, and SDD(source to the center of the detector) is 1800mm. An energy spectrum defined in the program is 120kVp x-ray spectrum. In Figure 2, a lesion is inserted into phantom and projected at 0 and 90 degrees.

### 3. Tracking the lesion's position

#### 3.1 Detecting a metal marker

This simulation has two source, two detectors, and a phantom. At 90 degree, there are sources and detectors rotated as much as  $\pm 30$  degree, because lateral direction of the phantom is 0 degree. But it is easier to rotate the phantom than the sources and detectors. Therefore, the phantom is rotated for the sources and detectors.

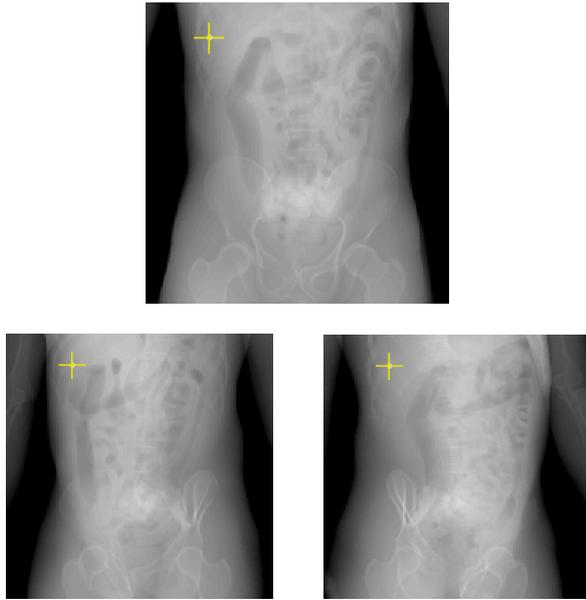


Fig 3. Tracking metal marker by Matlab

Intensity value in the phantom is the lowest on the marker. Using that, a computer program can find a value, and it can find the point position ( $u$ ,  $v$ ) in the detector easily. It can be possible tumor tracking in real-time. Like above figure, the computer program can find metal-marker and display + sign on the position.

### 3.2 Tracking the lesion's position

The point's coordinates are used to find a position of the lesion. In this study, the source projects a phantom on two methods. One method is parallel projection. When parallel projection,  $v$  equals the lesion's  $z$ -direction position. Due to  $z$ -axis rotation, a marker's point position ( $SOD$ ,  $u$ ) is detected in  $xy$ -plane.

The other method is cone beam projection. In cone beam projection, detected marker point is same with parallel beam. But original source points are ( $SOD$ ,  $0$ ), and is rotated on  $z$ -axis direction as much as 30degree.

Source and detected marker's points are used to find the lesion's location. Two pairs of points get two straight line's equations. These lines meet in a point, and the point is the lesion. The lesion's location is found by two line's equations.

## 4. Conclusion

In this simulation, a lesion, marked as a metal, is inserted into a phantom, and two images rotated are taken by two-pair sources and detectors at less than 90degree. Our laboratory has been studying dual head gantry system. In the study, angle less than 90degree is needed to have

more moving range for therapy beams. The lesion location is found by two sources and two points that are detected in detectors. When a lesion located in the middle depth of a phantom, marker is exactly tracked and tracking error is lower than 2mm. ( $x$ ,  $y$ ,  $z$ ) each unit error is lower than 1mm. In this simulation, if another depth and  $x$ -coordinate translation is larger, error is larger, too. These are improvement points. In addition, the simulation will be performed in another condition: depth, source size and detector tilting, without metal marker. And, in a real system, it will be tested on two pair X-ray and detector system.

## REFERENCES

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