行政院國家科學委員會補助專題研究計畫成果報告

自心臟高速斷層掃描重建準確大動脈之研究

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計畫主持人：荊宇泰
共同主持人：

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Abstract

We construct the geometric model for the pulmonary artery from a set of electron beam cardiac CT scan. We also need the model is in rectangular meshes. The main difficulties in this work are insufficient resolution along z-direction and the requirement of the rectangular meshes. We present a method that is based on estimation the medial axis and the radii of the vessel along the axis. We verify the proposed method using a phantom data set. The proposed method can achieve good reconstructed result for the phantom data set.

Keywords: cardiac CT scan, 3D model reconstruction.
2. Method
We assume that the pulmonary artery (PA) consists of two tubes. The LPA and PT is a tube and the RPA and PT is another tube. The boundary points in these pair of tubes in the CT images are identified by user assistant.

These pair of tubes are reconstructed by first identifying the media axis. We then estimate the radii of the tube along the media axis.

**Media axis estimation**

There are two cases as shown in figure 2.

**Case1:** Observe that, if a plane that is almost perpendicular to the media axis of a tube, the intersection of the tube with the plane should be closed to an ellipse. We approximate the contour obtained by an ellipse. The center point of the ellipse is an estimation of a point on the medial axis. The length of the short axis is the radius of the tube centered at the point. Furthermore, the orientation of the plane that is perpendicular to the media axis can be found about rotating about the short axis. The angle of rotation is obtained from the ratio of the length of the long axis and the short axis.

**Case 2:** If the plane is almost parallel to the media axis. We find parallel planes that are perpendicular to the contours as shown in Figure 3. The intersection of a plane and the contours can be approximated using an ellipse. We then have the case that is the same as case 1. We use the same method mentioned above to estimate the point on the media axis, the radius, and the true orientation of the plane.

The next step is to construct the media axis for a tube. We first connect the points along the media axis to form a polygonal path. We approximate the polygonal path using a spline curve as shown in Figure 4.
merged paths are as shown in Figure 5.

![Figure 5 The merged media axis](image)

The merging process is carried out by designing the junction of the branch which is as shown in Figure 6.

![Figure 6 the designed junction.](image)

Finally, we connect LPA, RPA, and PT to form the boundary representation of the pulmonary arteries as shown in Figure 7.

![Figure 7 The constructed junction.](image)

3 Result

The method was applied to reconstruct the pulmonary arteries from a set of CT images. The result is shown in Figure 8.

![Figure 8 the reconstructed pulmonary arteries](image)

In order to verify the accuracy of the proposed method, we built a phantom data set. We filled contrast agent into a hose. We then took CT scan of the hose. Since we know the radius of the hose, we can evaluate the accuracy of the proposed method. Figure 9 shows the phantom data obtained from the volume rendering of the volume data. Figure 10 shows the reconstructed tube by using the proposed method.

![Figure 9 the image obtained using the volume rendering of the volume data.](image)

![Figure 10 the reconstructed tube.](image)
4 References


