Purpose:
Vessel and bronchial bifurcations are ubiquitous in the lung and their respiration-induced motions are visually apparent in 4D CT images. Manual and semi-automated identification of bifurcations has been done previously, but this procedure is labor-intensive, subjective, and not practical for routine use. Here, we propose a novel fully-automated method for this task.

Methods:
Given a reference image, we first segment the lung region by adaptive thresholding and morphological operations. The blood vessels in the lungs are then segmented by a multi-scale enhancement filtering and region growing. With the segmented vessels, we analyze the local shape profiles within the concentric spheres for all voxels. If the number of disconnected components is more than three, the particular voxel is classified as a bifurcation candidate and its distance to the vessel boundary is recorded as the candidate size. Since several bifurcation candidates can associate with one bifurcation, two candidates are selected to merge if their corresponding regions overlap. Finally, the candidate which has the largest bifurcation size among all candidates of the same bifurcation is labeled as the bifurcation point and its size is treated as the bifurcation size. We implement our method in parallel.

Results:
We tested our method in 5 cases. All detections are completed in less than 1 minute. On average, we are able to detect more than 500 bifurcations with accuracy greater than 90%, as determined by a quantitative comparison with the data identified by an experienced human observer. The number of bifurcations is far more than that can be accomplished by manual and semi-automated approaches within the same time.

Conclusions:
The proposed approach can detect the bifurcations in lung CT images fast and accurately. The technique provides a prerequisite step for studying 4D motion of tissues in the different parts of the lungs using bifurcations as landmarks.