Bone metastasis, one kind of complications, which are easily caused by advanced cancers, could be manually
detected by radiologists using medical imaging techniques in the past years. However, it takes up much labor force,
and has low detection rate of early bone metastasis because radiologists cannot become aware of imperceptible changes
on vertebrae of patients. Computer Aided Diagnosis (CAD) systems, that are based on highly complex pattern
recognition, can assist doctors to make relative efficient and accurate diagnosis. As one of several important steps in
CAD system, the performance of segmentation of Region of Interest (ROI) has direct influence on following image
processing even on diagnosis precision of bone metastasis. There are some algorithms having been proposed until now
to realize objective segmentation which is required to have higher accuracy. Mathematical morphology is an automatic
segmentation method which can guarantee that the segmentation result has clear boundary. However, there is a
limitation for it to segment multiple regions from medical image. Graph Cuts algorithm has interactive platform, and
can extract all ROIs in case that some seed points in foreground (object) and background are chosen by radiologists
manually. However, the similar gray level between vertebrae and other regions in Computed Tomography (CT) images
causes the failure of segmenting border with Graph Cuts.

In order to obtain vertebral segmentation with higher efficiency and accuracy, a method combining mathematical
morphology based on labeling algorithms and Graph Cuts, is proposed in this thesis. It inherits high precision edge
extraction with mathematical morphology and labeling algorithm, and also applies the interactive interface of Graph
Cuts algorithm. The segmentation processes for vertebrae are initiated performing format conversion, initial
segmentation of ROI and binary with appropriate threshold. Mathematical morphology is applied to denoising after the
region of vertebra being filled with connected component labeling algorithm. Final segmentation of vertebrae can be
acquired with Graph Cuts in which some seed points should be chosen from foreground (object) and background,
respectively.

The method was tested on 100 CT slices chosen from 10 patients, and the results of vertebral segmentation were
assessed quantitatively by comparing with segmentation performed independently by radiologists. About evaluation of
vertebral segmentation with the proposed method, True Positive Rate (TPR) is 96.72[\%], and False Positive Rate (FPR)
is 1.84[\%], that both have better performance than conventional Graph Cuts algorithm, 90.07[\%] of TPR and 2.32[\%]
of FPR. Besides, the efficiency of Graph Cuts in the proposed method, 379.58 [ms/slice] based on the similar seed
points and 338.50 [ms/slice] based on the adaptive seed points, is also better than conventional Graph Cuts algorithm,
408.98[ms/slice].

Fig. Vertebral segmentation with Graph Cuts algorithm