Proceedings of the 28th IEEE
EMBS Annual International Conference
New York City, USA, Aug 30-Sept 3, 2006

The GGO Lesions Detected by Computer-Aided Detection System on Chest MDCT Images

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Abstract— **The detection of abnormal lesions in the early stages of lung cancer is important to improve survival. Computer-aided detection (CAD) system can be useful for early detection of pulmonary nodules on computed tomography (CT) images for screening. Moreover, CAD system can be 'second opinion' when a radiologist detects the pulmonary nodules on multi-slice CT images. We developed a computer-aided detection system for pulmonary nodule detection on multi-detector row computed tomography (MDCT) images. We applied the nodule isolation technique using radial distribution function and additional algorithms. In this paper, we reported the ground-glass opacity (GGO) lesions detected by self-developed computer-aided pulmonary nodule detection system.**

Keywords— computer-aided detection, nodule, GGO, MDCT

I. Introduction

In recent years, MDCT has been used for lung cancer detection. The analysis of CT images to detect lung nodules is a demanding task for radiologists. The interpretation of screening images is a repetitive, burdensome task involving mostly normal images – a situation prime for oversight errors. Limitations in nodule identification on CT have been noted that may translate to missed cancers. On screening CT overlooked nodules were small, on the order of 4-6 mm, faint, in attenuation, adjacent to vessels, and adjacent to findings of prior tuberculosis.

Computer-aided detection, defined as a detection made by a radiologist who uses the output from a computerized analysis of medical images as a 'second opinion' in detecting lesions, characterization, follow up of pathology, and making diagnostic decisions, is expected to improve the interpretation component of medical imaging.

In this paper, we reported the GGO lesions detected by self-developed computer-aided pulmonary nodule detection system on MDCT.

II. Methods

First, we segmented the lung regions from the CT image data. The segmentation method was applied to each 2D slice image. Since the CT values of the lung region are lower than the CT values of the chest wall, the lung regions were identified by using gray-level thresholding technique [1]. We used mathematical morphology algorithms to identify regions of interest in CT data. The candidates were extracted by 3D region growing with a threshold and each candidate was labeled by connected component labeling technique. 3D shape features such as volume, elongation factor, compactness were calculated to consider 3D shape of the candidates.

During developing process, we recognized that the most of nodules missed by a CAD system were in contact with other structures such as vessels. Therefore, we designed the nodule isolation algorithm to improve detection rate. The aim of NIRD is to enhance performance in detecting nodules attached to other structures by separating nodule-like objects from other structures. If a candidate was estimated to include core part through the analysis of the radial distribution function, the candidate was to be separated into the core part and the tail part. Then we could analyze the feature of the true nodule without being confounded by near redundant objects such as vessel parts [4]-[5].

III. Results

We applied nodule detection system to the MDCT case including the four GGO lesions. The CT study was obtained with contiguous slices with 1.0 mm collimation. The number of total slice images were 325. The diameters of four GGO were 10 mm, 11 mm, 14 mm, 15 mm respectively.

Our computer-aided detection system detected all of four GGO lesions and the processing time was 114 seconds.

The GGO lesion shown in Fig. 1 has relatively high density and well-defined margins. This is an easy task.

The GGO lesions shown in Fig. 2 and Fig. 3 are very difficult cases. These lesions are connected to large vessels. Because the vessels have higher density than GGO lesion, it is difficult to detect GGO lesion except vessels. However, our nodule detection system using NIRD technique can separate the GGO lesions from vessels. The NIRD algorithm was effective to detect GGO lesions connected vessels.

The GGO lesion shown in Fig. 4 has non-spherical shape. However, it is not difficult case. Our detection algorithm is robust enough to detect non-spherical nodules or GGO lesions.

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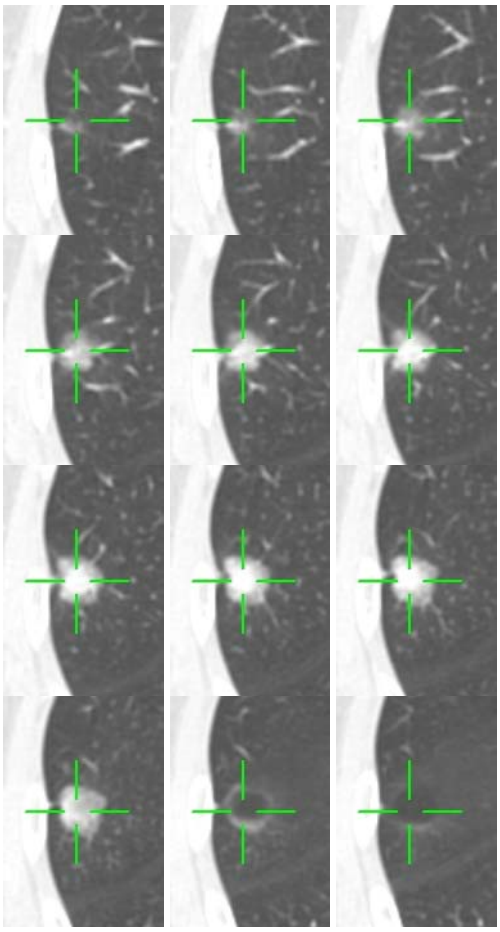
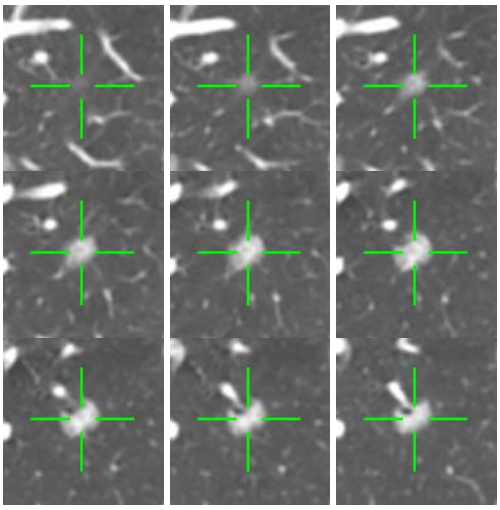


Fig. 1. The CAD system detected the GGO lesion (10 mm diameter). This GGO lesion has relatively high density and well-defined margins. The crop images of continuous 12 slices were aligned sequentially.



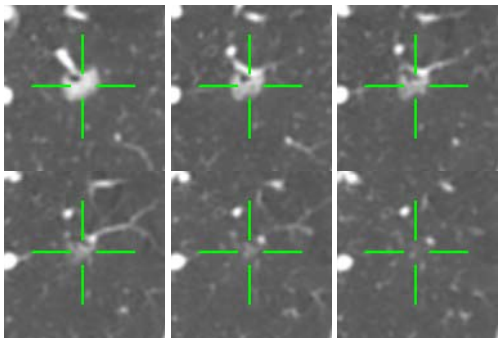


Fig. 2. The CAD system detected the GGO lesion (14 mm diameter). This GGO lesion is connected with vessel. The crop images of continuous 15 slices were aligned sequentially.

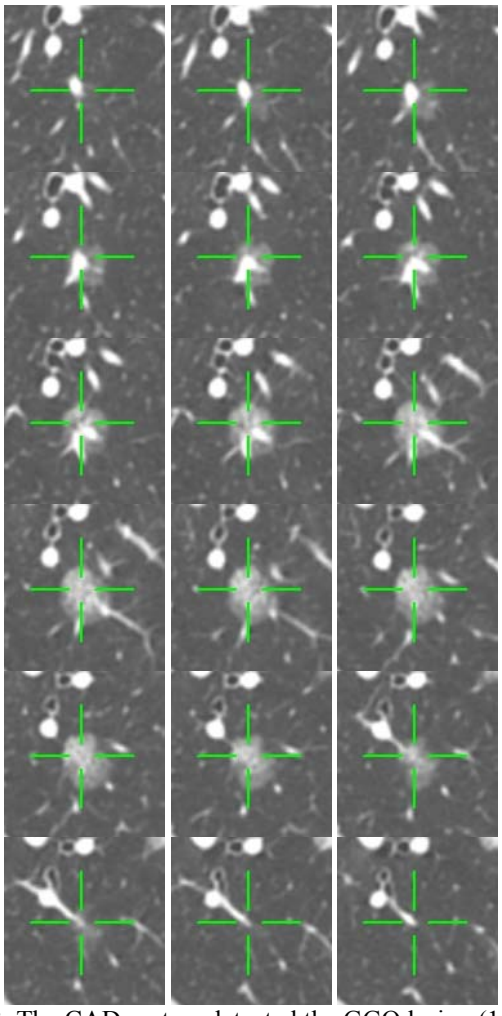


Fig. 3. The CAD system detected the GGO lesion (15 mm diameter). This GGO lesion is connected with vessel. The crop images of continuous 18 slices were aligned sequentially.

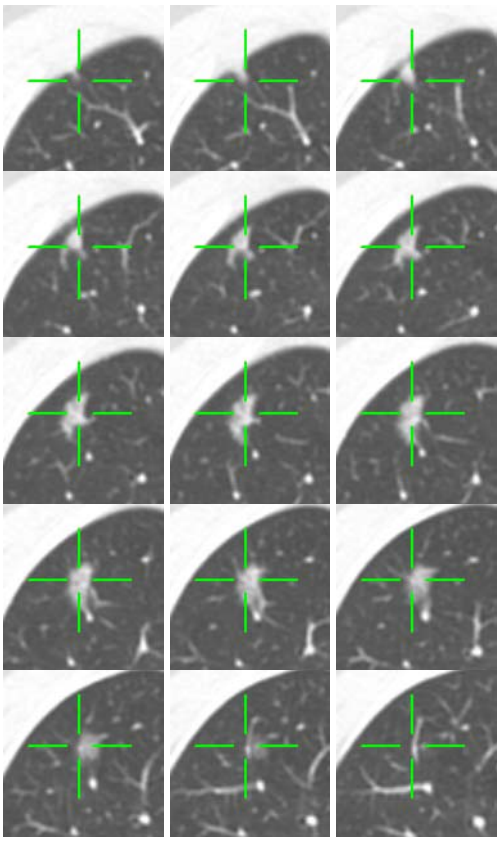


Fig. 4. The CAD system detected the GGO lesion (10 mm diameter). This GGO has non-spherical shape. The crop images of continuous 15 slices were aligned sequentially.

IV. Conclusions

We developed a nodule detection algorithm using advanced multiple gray-level thresholding technique. We set initial threshold to be low, so that GGO lesions with relatively high density were detected as nodule candidates. And the NIRD algorithm helped to detect the GGO lesions with large vessels.

Acknowledgment

This work has been supported by the Ministry of Information and Communication of Korea.

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