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Label Propagation Algorithm for the Slices Detection of a Ground-Glass Opacity Nodule

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ABSTRACT

A radiologist must read hundreds of slices to recognize a malignant or benign lung tumor in computed tomography (CT) volume data. To reduce the burden of the radiologist, some proposals have been applied with the ground-glass opacity (GGO) nodules. However, the GGO nodules need be detected and labeled by a radiologist manually. Some slices with the GGO nodule can be missed because there are many slices in several volume data. Although some papers have proposed a semi-supervised learning method to find the slices with GGO nodules, the was no discussion on the impact of parameters in the proposed semi-supervised learning. This article also explains and analyzes the label propagation algorithm which is one of the semi-supervised learning methods to detect the slices including the GGO nodules based on the parameters. Experimental results show that the proposal can detect the slices including the GGO nodules effectively.

KEYWORDS

Computed Tomography (CT) Volume Data, Detection of the Slices Including the Ground-Glass Opacity Nodule, Ground-Glass Opacity Nodules (GGO), Label Propagation Algorithm, Lung Nodules, Semi-Supervised Learning

1. INTRODUCTION

Lung cancer is a malignant lung tumor in tissues of the lung. The 85% of lung cancer cases is due to long-term tobacco smoking (Alberg, 2016). The remaining 10%-15% is caused by a combination of genetic factors and exposure to radon gas, asbestos, second-hand smoke, or other form of air pollution (Alberg, 2016; O'Reilly, 2007; Carmona, 2006). Worldwide in 2012, lung cancer occurred in 1.8 million people and resulted in 1.6 million deaths. In 2016, American Cancer Society estimated the 224, 390 people died of lung cancer in United States (Siegel, Miller & Jemal, 2016). In 2015, the mortality of lung cancer cases is 610, 200 in China (Chen, 2016). Although the primary method of

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prevention is avoidance of risk factors including smoking and air pollution, treatment and long-term outcomes are important to patients who have already lung cancer. As we know, if lung tumor has been found early, survival rate of lung cancer can up to 90% in 5 years (Elsayed, 2015).

Computed Tomography (CT) screening is one of the ways to detect lung tumors (Ali, 2016). The volume data can be generated less than 1 second with the development of CT technology. The volume data include many slices. The number of the slices in a volume data depends on the thickness of the slices. There will be generated a lot of slices when the slices have a smaller the thickness. In order to confirm malignant or benign of the lung tumor, several volume data with different parameters would be checked to a patient. In other words, a radiologist must read at least hundreds of slices to recognize malignant or benign of the lung tumor. Thus, there is a high risk to judge malignant or benign of the lung tumor.

Computer-aided detection or diagnosis (CAD) had been proposed to assist doctors to reduce the burden. Some CAD systems are for detection of lung nodules in CT (Arimura, 2004; Suzuki, 2003) and for diagnosis (Suzuki, 2005; Nakamura, 2000). Some approaches (Elsayed, 2015; Yaguchi, 2015) have been proposed to detect lung cancer based on some features of solid nodules (MacMahon, 2005) by image processing methods. Especially, with the development of artificial intelligence, deep learning algorithms had been applied with detection of malignant or benign of the lung tumor (Jiang, 2017; He, 2016). However, the system of CAD cannot be applied, even if the system has a high detection rate. This is two reasons as follows. First, the detection rate of lung nodules is change based on different training data. Secondly, the result of detection on lung nodules cannot be explained to patients. Moreover, although some lung nodules had been applied with CAD such as solid nodules, there are some lung nodules cannot be recognized depended on the size and types of lung nodules such Ground-Glass Opacity (GGO) nodules.

GGO nodules have two types based on a hazy opacity (Hansell, 2008). The first type is part-solid GGO nodules which have solid part in GGO nodules. The second one is pure GGO nodules which have no solid part in GGO nodules. GGO nodules have been encountered in clinical practice with widespread use of CT. GGO nodules can be showed from different characters to malignant or benign tumors (Park, 2007). However, the lesion of GGO nodules may be the lung cancer or their precursor lesions according to no change in the disappearance (Takashima, 2003). Until now, the malignant or benign of GGO nodules are determined based on two ways. One is CT screening, and the other is pathology. Some features of GGO nodules (Chae, 2014) can help a radiologist to distinguish malignant or benign of GGO nodules. The GGO nodules should be segmented, and then be extracted their features based on segmentation. The GGO nodule was segmented by a radiologist manually. It took 20 min. to obtain the region of the GGO nodule. The boundary of the whole GGO nodule was obtained by the radiologist in Figure 1. This paper (Philips Healthcare 2013) only has the 3D viewer of a lung nodule showed at Figure 2 without the size of solid part in a GGO nodule. Some proposals (Miao, 2016; Miao, 2017) had been applied with GGO nodules. However, the GGO nodules need be detected and labeled by a radiologist manually. The slice with the GGO nodule can be missed, as there are many slices in several volume data. Although this paper (Yuan, 2017) had proposed a semi-supervised learning to find the slices with GGO nodules, this paper (Yuan, 2017) has no discussion on the impact of parameters in the proposed semi-supervised learning. This paper also explained and analyzed the label propagation algorithm which is one of the semi-supervised learning methods to detect the slices including the GGO nodules based on the parameters (Yuan, 2017). The GGO nodules were experimented from 21 patients, which are provided by Tianjin chest hospital, China. Experimental results show that the proposal can detect the slices including the GGO nodules effectively.

This paper is organized as follows. An overview on detection of malignant or benign of the GGO nodules is showed in Section 2. The section 2 introduces background of this paper. The proposed model will be explained in Section 3 with toy data. In Section 4, the effectiveness of the proposed