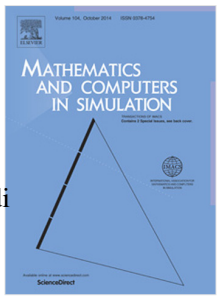
Accepted Manuscript



Hybrid intelligent approach for diagnosis of the lung nodule from CT images using spatial kernelized fuzzy c-means and ensemble learning

Farzad Vasheghani Farahani, Abbas Ahmadi, Mohammad Hossein Fazel Zarandi

PII: S0378-4754(18)30027-2
DOI: https://doi.org/10.1016/j.matcom.2018.02.001
Reference: MATCOM 4539

To appear in: *Mathematics and Computers in Simulation*

Received date : 12 January 2017
Revised date : 2 January 2018
Accepted date : 1 February 2018

Please cite this article as: F.V. Farahani, A. Ahmadi, M.H.F. Zarandi, Hybrid intelligent approach for diagnosis of the lung nodule from CT images using spatial kernelized fuzzy c-means and ensemble learning, *Math. Comput. Simulation* (2018), https://doi.org/10.1016/j.matcom.2018.02.001

Hybrid intelligent approach for diagnosis of the lung nodule from CT images using spatial kernelized fuzzy c-means and ensemble learning

Farzad Vasheghani Farahani, Abbas Ahmadi, Mohammad Hossein Fazel Zarandi

Department of Industrial Engineering and Management Systems, Amirkabir University of Technology, Tehran, Iran

Abstract

Lung cancer is one of the most common forms of cancer leading to over a million deaths per year throughout the world. The aim of this paper is to identify the pulmonary nodules in computed tomography (CT) images of the lung using a hybrid intelligent approach. At first, the proposed approach utilizes a type-II fuzzy algorithm to improve the quality of raw CT images. Then, a novel segmentation algorithm based on fuzzy c-means clustering, called modified spatial kernelized fuzzy c-means (MSFCM) clustering, is offered in order to achieve another representation of lung regions through an optimization methodology. Next, nodule candidates are detected among all available objects in the lung regions by a morphological procedure. This is followed by extracting significant statistical and morphological features from such nodule candidates and finally, an ensemble of three classifiers comprising Multilayer Perceptron (MLP), K-Nearest Neighbor (KNN), and Support Vector Machine (SVM) is employed for the actual diagnosis and determining whether the nodule candidate is nodule (cancerous) or non-nodule (healthy). The effectiveness of the hybrid intelligent approach is evaluated using a public data set for lung CT images, viz.: Lung Image Database Consortium (LIDC). The experimental results positively demonstrate that the modified spatial kernelized FCM segmentation is superior to the other techniques existing in the literature. More importantly, a number of useful performance measurements in medical applications including accuracy, sensitivity, specificity, confusion matrix, as well as the area under the Receiver Operating Characteristic (ROC) curve are computed. The obtained results confirm the promising performance of the proposed hybrid approach in undertaking pulmonary nodules diagnosis.

Keywords: Image processing; Fuzzy type-II; Fuzzy c-means; Ensemble classification; Computed tomography; Diagnosis; Lung nodules.

1. Introduction

Cancer is one of the top deadliest diseases on the planet like heart diseases and diabetes [67]. The noteworthy statistics conducted in the United States in 2015 show that lung cancer is the most driving reason of deaths in both women and men among a wide range of cancers [12]. According to these statistics, there are 221,200 instances of lung and bronchus cancer and 158,040 deaths among these cases which form 27.2% of all cancer deaths [12]. Lung cancer arises from an intractable irregular growth of cells in lung tissue. Lung nodules, also known as pulmonary nodules, are deformities in the lung tissue that are small, spherical and radiographic opacities with a diameter of less than or equal to 30mm [7]. Pulmonary nodules are classified into two main groups comprising benign and malignant ones. Benign