

# [Lung nodule classification: computed tomography (ct) scans](https://assignbuster.com/lung-nodule-classification-computed-tomography-ct-scans/)

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## ABSTRACT

This paper proposes a novel framework for the classification

of lung nodules using computed tomography (CT) scans. The proposed

framework is based on the integration between (i) the geometric

shape features, in terms of construction error of modeled

spherical harmonics (SHs); (ii) the appearance feature in terms of

Gibs energy modeled using the 7th ô€€€ order MGRF; and (iii) the

size feature using the k -nearst neighbor ( k -NN) classifier. The

final classification is obtained by using the deep autoencoder neural

networks. The geometric feature is extracted by calculating

the construction error between the original nodule mesh and the

SHs-based constructed ones. To calculate this error curve at each

point, the surface mesh for each nodule is modeled using different

SHs, from 1 to 70, and calculate the difference as the error.

Secondly, the appearance feature is modeled using the novel 7th-

order Markov-Gibbs random field (MGRF) model in addition to

the size feature using k -NN classifier. Finally, a deep autoencoder

(AE) classifier is applied to distinguish between the malignant and

benign nodules. To evaluate the proposed framework, we used

the publicly available data from the Lung Image Database Consortium

(LIDC). We used a total of 116 nodules that were collected

from 60 patients. By achieving a classification accuracy of

96 . 00%, the proposed system demonstrates promise to be a valuable

tool for the detection of lung cancer.

Index Terms -CT, 7th-order MGRF, Spherical Harmonics,

Lung nodules

1. INTRODUCTION

Lung cancer is considered the leading cause of cancer death

among both genders in the United States with about 1 out of 4

cancer deaths resulting from lung cancer [1]. Although there are

several imaging modalities used for the diagnosis of lung cancer,

e. g., magnetic resonance imaging (MRI), chest radiograph

(X-ray), and many other modalities, computed tomography (CT)

imaging is the most common and appropriate modality for examining

the lung tissues due to its high resolution and clear contrast

compared to other techniques [2]. Recently, the number of lung

cancer cases have increased exponentially, and its early detection

can increase the chance of survival [3]. Furthermore, an automated

assistive tool for the radiologists is of great importance to

help in the analysis of the large amount of data available from

CT scans. Thus, the computer aided diagnosis systems (CADx)

is of great interest and high importance. Recently, a plethora of

methods for automated diagnosis of pulmonary nodules in CT

scans have been introduced. Various researchers have used image

processing and data mining techniques to diagnose the pulmonary

nodules. Namely, Macedo et al. [4] have proposed the use of

different classifiers, such as the support vector machine (SVM),

and rule-based system, to distinguish between malignant and

benign lung nodules. They used texture, shape, and appearance

features that were extracted from the histogram of oriented gradient

(HOG) from the region of interest (ROI). Kumar et al. [5]

used deep features extracted from multi-layer autoencoders for

the classification of lung nodules. Although they have proved the

effectiveness of extracting high-level features from the input data

in their experiments, they disregarded the morphological information,

e. g., perimeter, skewness, and circularity of the nodule,

which couldn’t be extracted by the conventional deep models.

Jia et al. [6] have proposed a rule-based classification system

based on growth rate changes and registration technique. Lee et

al. [7] have proposed a lung nodule classification system using

a random forest classifier aided by clustering. First they merged

all the data, then they divided it into two clusters, then divided

each cluster into two groups, nodule and non-nodule, based on the

training set labels. Finally a random forest classifier was trained

for each cluster to distinguish between benign and malignant

nodules. Farahani et al. [8] have proposed an ensemble-based

system to classify each pulmonary nodule by integrating multiple

classifiers like SVM, K-nearest-neighbors, and neural networks.

The classifiers have learned over five morphological features and

the output of these classifiers is combined using majority voting.

Huang et al. [9] have proposed a system to differentiate malignant

from benign pulmonary nodules based on fractal texture features

from Fractional Brownian Motion (FBM) model using (SVM).

Elsayed et al. [10] have proposed a system that uses different

classifiers, e. g., Linear, Quadratic, Parzen, Neural Networks, and

their different combinations such as mean, median, maximum,

minimum, and voting, to enhance the performance of the classification

of malignant and benign pulmonary nodules. Kim et

al. [11] have proposed a system which uses a deep neural network

to extract abstract information inherent in raw hand-crafted imaging

features. Then, the learned representation is used with the

raw imaging features to train the classifier. Narayanan et al. [12]

also used deep neural network to classify the pulmonary nodules

after training on morphological features. Bayanati et al. [13] tried

to identify which features on CT images could differentiate between

malignant and benign nodules. They used both texture and

shape analysis features and found an enhancement in accuracy

but without significant change in the false positive.

The existing methods for the classification of lung nodules have