CS767 Medical Image Analysis - Final Project Proposal

Problem

Lung cancer is the second most common cancer. It is usually visible in the area of lung nodule. A nodule is a "spot on the lung," seen on an X-ray. Around every 500 x-ray images would contain one image with lung nodules. A malignant nodule will lead to lung cancer. Most chest exams are radiographs and it can be hard to detect lung nodules in them (both by human eyes and by machine), especially when the size of nodule is small. Another issue is that even if we know where the lung nodule is, it could be hard to know if it is benign or malignant. Determining whether a nodule is a benign tumor or an early stage of cancer is very important. Therefore, it is a problem which is worthwhile to be solved to help provide early treatment for people with lung cancer.

Possible Solution and Evaluation

The proposed solution for this would be an application (or algorithm) that detects lung nodules in x-ray, or Computed Tomography (CT) images, and that possibly classify the benign and malicious nodules. We would prefer to X-ray images since it is a more affordable examination for people. The X-ray image dataset is from Japanese Society of Radiological Technology (JSRT). One option for the expected process would be first using blob detection or segmentation to locate the position of lung nodules. Then, use some combination of existing classification method to distinguish benign or malicious lung nodules. This could be extracting features by Scale-invariant feature transform (SIFT), histogram of oriented gradients (HOG), convolutional neural network (CNN) and then use support vector machine (SVM) or other kind of classifiers to classify the features. Another option would be trying to build CNN (and using existing CNN as well) to learn the feature directly to locate and classify lung nodules.
For the evaluation, we would check the accuracy that the algorithm detects the correct location of nodules. If the detected position is wrong, we might also want to know how far the distance from it to the correct position is. Similarly, we would like to see the accuracy of the test data for the classification part. And for both cases, it would be good to compare the results to the existing methods in the paper.

State-of-the-Art

Anirudh et al. [1] used 3D Convolutional Neural Networks to detect lung nodule on CT images and achieved 80% of success for 10 false positives per scan. Shen et al. [2] investigated the problem of diagnostic lung nodule classification using CT screening and demonstrated the effectiveness on classifying malignant and benign nodules without nodule segmentation. Tajbakhsh and Suzuki [3] had compared CNN and other deep learning method for detecting and classifying lung nodules on X-ray images.

Expected Result

The expected delivery would be an open source application which can detect or classify lung nodules on x-ray or CT images. People who help doctors diagnose lung cancer would benefit from the application. We hope to see some improvement compared to state-of-the-art (or at least the performance is close to the state-of-the-art).

Reference

[1] Lung Nodule Detection using 3D Convolutional Neural Networks Trained on Weakly Labeled Data

[2] Multi-scale Convolutional Neural Networks for Lung Nodule Classification

[3] Comparing two classes of end-to-end machine-learning models in lung nodule detection and classification: MTANNs vs. CNNs