A deep learning approach to the non-alcoholic fatty liver disease binary classification problem using patient's gender and features derived from B-mode ultrasound images regarding speed of sound and echogenicity

Abstract No: 18-026

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Purpose:

Non-alcoholic fatty liver Disease (NAFLD) is one the most widespread type of chronic liver diseases in the western countries. Different approaches have been developed on features derived from US B-mode image analysis in order to automate classification of a patient's liver steatosis stage (S=S0, S≥S1). These approaches fail to achieve all scores: accuracy, sensitivity, specificity and AUC greater than 0.90. The aim of this study was to define an algorithm, design and tune a deep neural network (DNN) in order to automate classification of a patient's liver steatosis stage (S=S0, S≥S1) with accuracy, sensitivity, specificity and AUC greater than 0.90.

Materials/Methods Used:

Our dataset consisted of 99 subjects from which 30 were healthy (S0) and 69 were liver biopsy validated NAFLD patients (S≥S1). A set of five B-mode images in different speed of sound {1420,1480,1540,1600,1660} m/s set by the radiologist in the same area containing parts of liver parenchyma and right kidney cortex for each patient were acquired. Four features were extracted from radiologist's selected ROIs of liver parenchyma (LP) and right kidney cortex (RK): lateral sharpness (LS), lateral speckle size (LSS), echogenicity of LP (EL) and RK (ERK) accordingly. Input parameters for our model were: {patient gender}, max(LS), min(LSS), EL and ERK. We normalized the values of these features, did some feature engineering and designed a DNN with two hidden layers and a few nodes. A 10-fold cross validation (CV) technique was used in order to manage underfitting, overfitting, bias and variance issues.

Results:

A 10-fold CV provided the following results: Accuracy: 0.9596+/-0.0869, F1-score: 0.9706, Sensitivity: 0.9565, Specificity: 0.9667, AUC: 0.9616 with 95% CI [0.833 – 1.0].

Conclusions:

In this study we proposed a new approach on NAFLD assessment using deep learning. Our preliminary results demonstrate improved accuracy, sensitivity, specificity, and AUC (all > 0.95) compared to other methods. Our implemented algorithm using DNN could be used as a decision support tool to assist radiologists on their medical report. Larger data sets are required to further validate our algorithm.

Primary Category:

Informatic Innovations

Area of Focus:

Diagnostic Radiology