Decision support system for fatty liver disease using GIST descriptors extracted from ultrasound images

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A B S T R A C T
Steatosis or fatty liver disease (FLD) is characterized by the abnormal retention of large vacuoles of neutral fat in the liver cells, either due to alcoholism or metabolic syndrome. Succession of FLD can lead to severe liver diseases such as hepatocellular carcinoma, cirrhosis and hepatic inflammation but it is a reversible disease if diagnosed early. Thus, computer-aided diagnostic tools play a very important role in the automated diagnosis of FLD. This paper focuses on the detection of steatosis and classification of steatotic livers from the normal using ultrasound images. The significant information from the image is extracted using GIST descriptor models. Marginal Fisher Analysis (MFA) integrated with Wilcoxon signed-rank test helps to eliminate the trivial features and provides the distinctive features for qualitative classification. Finally the clinically significant features are fused using classifiers such as decision tree (DT), support vector machine (SVM), adaBoost, k-nearest neighbor (kNN), probabilistic neural network (PNN), naive Bayes (NB), fuzzy Sugeno (FS), linear and quadratic discriminant analysis classification of normal and abnormal liver images. Results portray that PNN classifier can diagnose FLD with an average classification accuracy of 98%, 96% sensitivity, 100% specificity and Area Under Curve (AUC) of 0.9674 correctly.

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1. Introduction
Accretion of triglyceride fat in the hepatocytes is called fatty liver and it results in Fatty Liver Disease (FLD) or steatosis when the fat deposition on the liver exceeds 10% or more than its total weight [1]. Fatty liver is universally linked to chronic alcoholism, metabolic disorders, inflammatory bowel disease, drugs and toxins [2]. Alcoholic fatty liver disease (AFLD) and non-alcoholic fatty liver disease (NAFLD) are two categories of FLD caused either due to excessive alcohol consumption or excessive fat deposition [3]. Accumulation of undue fat may lead to hepatic inflammation, cirrhosis, steatohepatitis and hepatocellular carcinoma irrespective of its type [4].

According to the recent statistics, 25 million US citizens are affected by liver or biliary disease and out of these, approximately 50% population have no symptoms. In United Kingdom, around 25% deaths from liver disease are due to excessive alcohol consumption [5]. Rising rate of obesity is the major cause factor of NAFLD and it is reported that by 2050, the incidence rate of NAFLD would rise by 50% [6].

Steatosis or fatty liver disease (FLD) is a common liver disorder and is curable if diagnosed early. Physical examination, blood tests, liver biopsy, computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound are some of the diagnostic tests in the assessment of FLD. Physical examination and blood test may not lead to efficient analysis. Liver biopsy is the standard estimation tool in steatosis but it is hardly preferred for being an invasive technique and is prone to sampling errors. Non-invasive techniques such as CT and MRI are insensitive in identifying steatosis of less than 25–30% [7]. Ultrasound has a higher sensitivity than CT, around 82–94% and specificity higher than 82% but it has poor visualization in obese patients.