Schistosomal Hepatic Fibrosis Classification

Dalia S. Ashour, Department of Medical Parasitology, Faculty of Medicine, Tanta University, Tanta, Egypt
Dina M. Abou Rayia, Department of Medical Parasitology, Faculty of Medicine, Tanta University, Tanta, Egypt
Nilanjan Dey, Techno India College of Technology, West Bengal, India
Amira S. Ashour, Department of Electronics and Electrical Communication Engineering, Faculty of Engineering, Tanta University, Tanta, Egypt
Ahmed Refaat Hawas, Department of Electronics and Electrical Communication Engineering, Faculty of Engineering, Tanta University, Tanta, Egypt
Manar B. Alotaibi, Computers and Information Technology, Taif University, Ta’if, Saudi Arabia

ABSTRACT

Schistosomiasis is serious liver tissues’ parasitic disease that leads to liver fibrosis. Microscopic liver tissue images at different stages can be used for assessment of the fibrosis level. In the current article, the different stages of granuloma were classified after features extraction. Statistical features extraction was used to extract the significant features that characterized each stage. Afterward, different classifiers, namely the Decision Tree, Nearest Neighbor and the Neural Network are employed to carry out the classification process. The results established that the cubic k-NN, cosine k-NN and medium k-NN classifiers achieved superior classification accuracy compared to the other classifiers with 88.3% accuracy value.

KEYWORDS
Classification, Decision Tree, Features Extraction, Fibrosis, Image Processing, Nearest Neighbor Classifier, Neural Network, Schistosomiasis

INTRODUCTION

Schistosomiasis is a serious endemic disease in 78 countries worldwide especially in tropical and subtropical areas. It affects more than 200 million people and about 800 million populations are at a great risk (Yorston & McGavin, 2009; WHO, 2014). Liver fibrosis quantitative assessment via image analysis was implemented for enhancing conventional assessment (Gailhouste et al., 2010; Tai et al., 2009). The quantitative assessment advantages are the gain of minimization of inter-observation variations and early detection of liver fibrosis stage (Bedossa, 2010).

Stanciu et al. (2014) used nonlinear microscopy for liver fibrosis quantitative assessment. In the microscopic images, the cellular and tissue information quantification of fibrosis progression have been used for diagnostic purposes. However, new diagnostic techniques should be established to overcome the limited resources (Mabey et al., 2004).

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Recently, ambient intelligence (AmI) is an evolving restraint that passes intelligence to our daily life environments to make these environments sensitive to the humans. Several researches are interested to develop different systems based on AmI and image processing (Samanta et al., 2016; Saba et al., 2016; Belgharb, & Boufaida, 2017; Juneja et al., 2017; Alenljung et al., 2017; Achariya, & Anitha, 2017; Sharma, & Virmani, 2017; Manogaran, & Lopez, 2017; Ahmed et al., 2017). AmI research is based on developments in sensors, prevalent computing, and artificial intelligence. Artificial intelligence techniques along with medical image processing are employed for computer-aided diagnosis for the liver tissues classification. Ghoneim (2011) investigated the texture analysis (TA) accuracy results at different resolutions on three color spaces, namely RGB (Red, Green, Blue), conventional grey scale and the Hue-Saturation-Intensity (HSI) for texture classification of liver images. The RGB provided accurate results at low resolution. Additionally, the green channel provided several characterizing features for the fibrosis images. At high resolution, the grey scale space formed superior results; though, errors increased with decreased resolution. However, the HSI space provided high error percentage at all resolutions. Thus, it is insufficient for fibrosis characterization.

Therefore, the contribution of current work is to use the conventional microscopy images for assessment and staging of liver fibrosis using image processing techniques based on statistical features extraction and classification using different classifiers, namely Decision Tree (DT), Nearest Neighbor (k-NN) and the Neural Network (NN). Such classification is employed to quantify and automate the liver fibrosis staging using animal model liver samples. The comparative study of the decision tree, neural network and the nearest neighbor classifiers performance of liver fibrosis staging are performed.

**METHODOLOGY**

A total of 50 mice were obtained from Theodore Bilharz Research Institute (TBRI), Giza, Egypt. They were infected with Schistosoma mansoni cercariae. Then liver sections’ images of different fibrosis levels, namely cellular granuloma (level 1), fibrocellular granuloma (level 2), and fibrotic granuloma (level 3) along with normal samples were subjected to image processing classification after features extraction. Consequently, the proposed system steps are as follows: i) capture the liver images using the microscopy for normal and fibrosis samples at different levels, ii) convert the colored image to binary for simple processing, iii) apply the threshold technique to the binary image, iv) analyze the image using ImageJ tools after segmentation using watershed, v) extract the statistical features from the analyzed result and finally vi) perform the classification step for the four cases using different classifiers as a comparative study. The classification output is normal liver, cellular granuloma, fibrocellular granuloma, or fibrotic granuloma.

An automated procedure to analyze and to extract the statistical features was performed using ImageJ software. Various statistical features were measured in the image analysis step for further recognition and classification for the different fibrosis levels as well as the normal case. These features are the area of the fibrosis in the whole image, mean, mode, perimeter, circularity, Feret, IntDen and the median.

From the extracted statistical features, some significant features, which provide salient difference between the different classes, were selected for further classification process. Such selected features are the ‘Area’, ‘Minor’, ‘Feret’ and ‘IntDen’. After word, the classification process was deployed to classify the different fibrosis levels as well as the normal case.

**Liver Fibrosis Classification**

Machine learning has been a central research area in the artificial intelligence. Learning offers a prospective procedure for constructing high performance systems. Classification is a significant machine learning domain that is continually developed due to the promising applications including medical, financial forecasting, and bioinformatics. Formerly, various classification algorithms have been employed, such as the decision tree induction, nearest- neighbor, error back-propagation, rule-
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