Towards automated analysis of nucleolar and centromere shapes in Indirect immunofluorescence images

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Introduction:

Automated analysis of HEp-2 images is considered topical in contemporary research owing to its ability to aid physicians to a greater extent. Delineation of nucleus and the classification of patterns in these images are necessary steps towards computer aided diagnosis. In this work, an attempt has been made to analyze two staining patterns namely, nucleolar and centromere using shape based features and machine learning techniques.

Methods:

598 HEp-2 cell images acquired from the public database are considered for the study. The images are preprocessed using contrast enhancement technique. The nucleolar and centromere patterns are extracted by multiplying with the ground truth binary mask. Conventional geometric, Laplace Beltrami Eigen value and distance based features are derived from the segmented nucleus and two level thresholded images. Finally, the patterns are classified using Multi-Layer Perceptron, Support Vector Machine and Random Forest algorithm.

Results and discussions:

HEp-2 cells are observed to be low in contrast especially in intermediate intensity images. Therefore HEp-2 cell images are contrast enhanced and the nucleus regions are extracted using the ground truth binary mask. Six shape based features are extracted at three levels namely ground truth, first and second level thresholded masks. Total of 18 features are fed to the classifiers in order to differentiate the patterns. The classifier performance is validated using accuracy, precision and recall measures. The classification accuracy of 91.5% is observed using multilayer perceptron whereas random forest and SVM resulted in an accuracy of 90.5% and 87% respectively.

Conclusions:

In this study, centromere and nucleolar patterns of HEp-2 cells are classified using shape based features. After preprocessing, nucleus is segmented and shape based features are extracted. Results show that the extracted features are capable of differentiating centromere and nucleolar patterns with a maximum accuracy of 91.5% using MLP classifier. Thus, it appears that the proposed framework can be used for screening autoimmune diseases automatically and further aid the diagnosis procedure.

Key Words: HEp-2 cells, IIF, Laplace Beltrami, random forest, support vector machine and multilayer perceptron