

Chapter 12

HE Stain Image Segmentation Using an Innovative Type-2 Fuzzy Set-Based Approach

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ABSTRACT

HE stain images are widely used in medical diagnosis and often considered a gold standard for histology and pathology laboratories. A proper analysis is needed to have a critical decision about the status of the diagnosis of the concerned patient. Segmentation is always considered as an advanced stage of image analysis where objects of similar properties are put in one segment. But segmentation of HE stain images is not an easy task as these images involve a high level of fuzziness with them mainly along the boundary edges. So, traditional techniques like hard clustering techniques are not suitable for segmenting these images. So, a new approach is proposed in this chapter to deal with this problem. The proposed approach is based on type-2 fuzzy set and is new. The experimental results prove the superiority of the proposed technique.

INTRODUCTION

Image Segmentation is the basic and critical tasks during any medical image analysis task (Ho, 2012). Segmentation means the formation of different homogeneous regions based on some homogeneity criteria. These homogeneity criteria may be texture, color etc. So, with the help of segmentation, it is possible to outline different ROIs (Region of Interests). This will help to focus on particular ROI which

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is specific to one particular application. With the help of mathematical equations, we can define segmentation as follows:

$$(i) \bigcup_{i=1}^n R_i = R \quad (1)$$

$$(ii) R_i \cap R_j = \phi \quad (2)$$

$$(iii) H(R_i) = TRUE \forall i \quad (3)$$

$$(iv) H(R_i \cup R_j) = FALSE \forall R_i \& R_j \text{ adjacent} \quad (4)$$

According to the property (i), the summation of all the divided regions will produce image back. Property (ii) stands on the fact that two separate regions should be disjoint. The Property (iii) implies that within a region the homogeneity criteria should be satisfied. And the property(iv), says that two adjacent regions should not be homogeneous.

HE Stain images are regarded as of gold standard in histology and pathology laboratories (Paxton et al, 2003). In general, most cells are colorless and transparent. There arise difficulties to analyze them. So, staining is done in the histological sections to make the cells distinct and visible (Paxton et al, 2003). One such popular and commonly adopted technique is HE stain which involves the usage of hematoxylin and eosin which color nuclei and cytoplasm differently (Paxton, et al, 2003). Hematoxylin is generally a dark blue or violet stain which is basic/ positive. Eosin is a red or pink stain and is Acidic / Negative. When hematoxylin and eosin are combined, then it produces blues, violets, and reds. Now, through segmentation, HE Stain image is divided into different segments. And from those segments, it will be easy to analyze the particular ROI for which diagnosis is conducted.

There exist many different techniques from different domains of segmentation (Jain et al, 1989). But, clustering is the most commonly adopted one. Clustering may be hard or soft (Bora, 2017). The main difference between the two is that in case of hard clustering an element should belong to only one particular cluster it has been assigned. While in case of soft clustering, one data element may contribute to more than one cluster depending on the membership grade it possesses. K-Means is a

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