AN ADAPTIVE ACO-BASED FUZZY CLUSTERING ALGORITHM FOR NOISY IMAGE SEGMENTATION

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Abstract. The fuzzy c-means (FCM) has been a well-known algorithm in machine learning/data mining area as a clustering algorithm. It can also be used for image segmentation, but the algorithm is not robust to noise. The possibilistic c-means (PCM) algorithm was proposed to overcome such a problem. However, the performance of PCM is too sensitive to the initialization of cluster centers, and often deteriorates due to the coincident clustering problem. To remedy these problems, we propose a new hybrid clustering algorithm that incorporates ACO (ant colony optimization)-based clustering into PCM, namely ACOPCM for noisy image segmentation. Our ACOPCM solves the coincident clustering problem by using pre-classified pixel information and provides the near optimal initialization of the number of clusters and their centroids. Quantitative and qualitative comparisons are performed on several images having different noise levels and bias-fields. Experimental results demonstrate that our proposed approach achieves higher segmentation accuracy than PCM and other hybrid fuzzy clustering approaches.

Keywords: Unsupervised fuzzy clustering, Ant colony optimization, Image segmentation

1. Introduction. Image segmentation plays an important role in image analyses, and is considered as one of the difficult and challenging problems in image processing technology [1, 27]. It is a process of partitioning an image into non-overlapped and consistent regions which are homogeneous with respect to some image property such as intensity, color, texture, and so on [9, 11]. Image segmentation has a wide range of applications such as image content analysis, object recognition, and computer-assisted medical diagnosis [5, 6]. In particular, it has become an increasingly important pre-processing step in medical image analysis. Related research has reported considerable progress over the past decade [5, 6, 7]. However, since in many cases images contain a significant amount of noise causing the segmentation difficult, we need a robust method to noise.

There are many approaches to image segmentation such as histogram-based methods, edge detection, region growing methods, split-and-merge methods, PDE-based methods and clustering methods [4]. Among them, we are interested in clustering based approaches, where each image pixel is assigned to a cluster such that all members in the same cluster are similar in the defined feature space. Once similar pixels are clustered together, the image can be segmented into distinct regions. The fuzzy c-means (FCM) has been one of the widely used clustering methods for image segmentation [12, 13]. Minimizing square of error, FCM produces good segmentation results for relatively easy images without estimating the density distribution of the image. Although FCM is a very useful image segmentation method, fuzzy data membership does not always correspond well to the actual degree of membership, and it is inaccurate in a noisy environment. To remedy