



An effective color image segmentation approach using neutrosophic adaptive mean shift clustering

Yanhui Guo^{a,*}, Abdulkadir Şengür^b, Yaman Akbulut^b, Abriel Shipley^c

^a Department of Computer Science, University of Illinois at Springfield, Springfield, IL, USA

^b Firat University, Technology Faculty, Electrical and Electronics Engineering Dept., Elazığ, Turkey

^c Department of the Office of the Vice Chancellor for Research, University of Illinois at Urbana-Champaign, Champaign, IL, USA

ARTICLE INFO

Keywords:

Color image segmentation
Mean shift clustering
Neutrosophic set
Indeterminate filter

ABSTRACT

Color image segmentation can be defined as dividing a color image into several disjoint, homogeneous, and meaningful regions based on the color information. This paper proposes an efficient segmentation algorithm for color images based on neutrosophic adaptive mean shift (NAMS) clustering. Firstly, an image is transformed in neutrosophic set and interpreted by three subsets: true, indeterminate, and false memberships. Then a filter is designed using indeterminacy membership value, and neighbors' features are employed to alleviate indeterminacy degree of image. A new mean shift clustering, improved by neutrosophic set, is employed to categorize the pixels into different groups whose bandwidth is determined by the indeterminacy values adaptively. At last, the segmentation is achieved using the clustering results. Various experiments have been conducted to verify the performance of the proposed approach. A published method was then employed to take comparison with the NAMS on clean, low contrast, and noisy images, respectively. The results demonstrate the NAMS method achieves better performances on both clean image and low contrast and noisy images.

1. Introduction

Image segmentation divides an image into homogenous, disjoint and meaningful regions which has been deduced as an important and challenging application in image processing community [1,2]. Many techniques have emerged for image segmentation [3–5]. These techniques generally use gray scale intensity, color information or texture information. Color is an important quantity which can be used to improve the image segmentation quality compared to the methods only using intensity. More segmentation approaches have been conducted on color images with demanding needs.

Various segmentation algorithms have been proposed in the last decade can be broadly categorized into three groups: feature based, region based, and graph based methods [5]. Feature based algorithms generally use the color or texture information to group the similar features into well separated clusters [6]. This separation issue is handled by a pre-defined distance measure. Clustering based image segmentation approaches are generally efficient. However, some of them do not consider the spatial information which causes under-segmentation. Region based segmentation methods are capable of preserving the edge or spatial information to produce more homogeneous and compact regions [7]. The watershed algorithm [8] is a

popular region based segmentation approach. However, it might lead to over segmentation. This drawback can be eliminated by using a further merging procedure to construct more meaningful regions [7,9]. Graph based techniques are quite successful in image segmentation because these techniques generally fuse both feature and spatial information to produce more compact and well defined regions [10,11]. The graph based approaches define a graph whose vertex corresponds to a region and weight of edge is defined as the likelihood to segmentation. A graph is separated into components according to the cost function of vertices and edges. Graph based methods require high computation complexity disables them in use of real-time applications.

Mean shift (MS) is an iterative and robust clustering technique [12]. It seeks the local modes by shifting data to the average of its neighborhood. It has been applied to image filtering [13], video tracking [14] and image segmentation [15]. For image segmentation task, MS produces homogeneous areas by fusing the sufficiently close convergence points. Comaniciu et al. [15,16] used the mean shift to segment color images and track objects. Ozertem et al. [17] combined the MS algorithm and the spectral clustering method to produce an effective segmentation method. Tao et al. [18] incorporated MS and shortest spanning tree for effective segmentation of the ships in

* Corresponding author.

E-mail address: yanhui.guo@aggiemail.usu.edu (Y. Guo).

Table 1

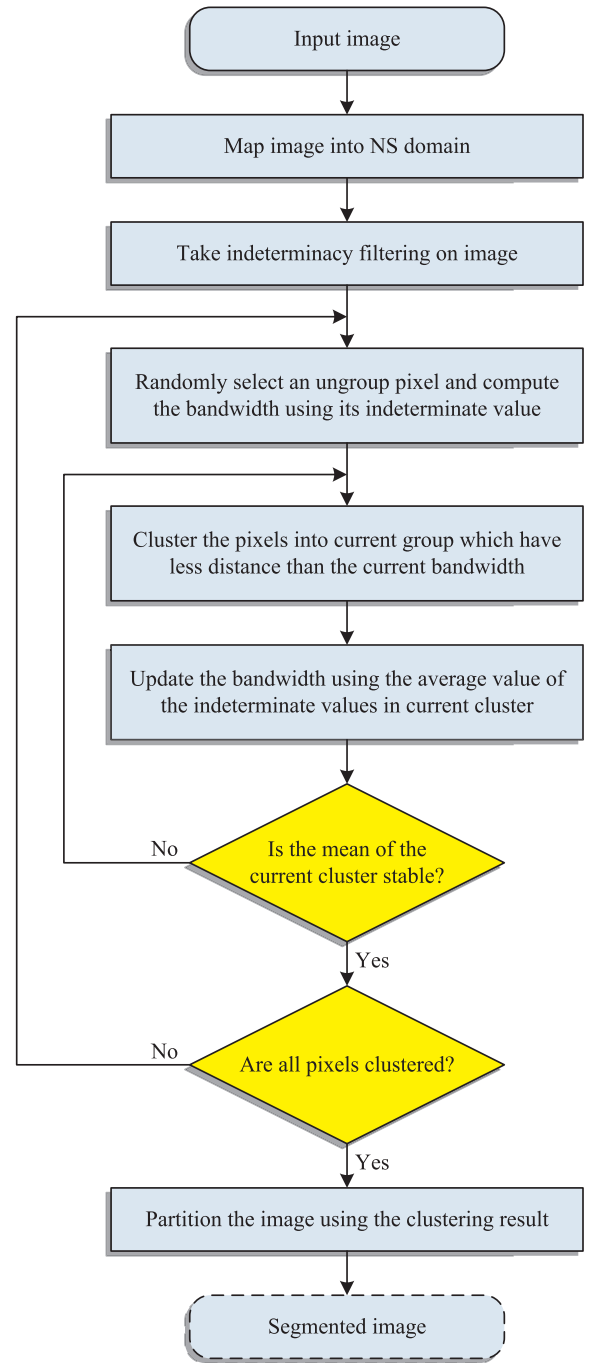
Detailed steps of the NAMS.

Input: Color image
Output: Segmented image
Step 1: Map each channel of an image to neutrosophic set; Step 2: Convolute each channel using the indeterminacy filter; Step 3: Compute the indeterminate values of the channels; Step 4: Randomly select an ungroup pixel P_i and compute the bandwidth bw using its indeterminate value; Step 5: Cluster the pixels into current group which have less distance than the bandwidth bw; Step 6: Update the bandwidth bw using the average value of the indeterminate values in current cluster; Step 7: Go to Step 5 until the mean of the current clustering become unchanged; Step 8: Go to Step 4 until all pixels are clustered; Step 9: Separate the image using the clustering result.

infrared images. Tao et al. [5] combined MS with normal graph cut method to perform robust color image segmentation. Park et al. [19] proposed an algorithm based on Gaussian mixture model and adaptive MS algorithm. The MS algorithm was used to decide the number of Gaussian components. Another hybrid algorithm by Liu et al. [20] incorporated MS and ant clustering technique for efficient image segmentation. A deterministic searching method was developed by incorporating the multiple cues into MS algorithm and was applied on human tracking in color videos [21]. Ai et al. [22] examined incorporating the temporal characteristics of acquired functional magnetic resonance imaging data with mean shift clustering for functional magnetic resonance imaging analysis to enhance activation detections. Lai et al. [23] used MS for histogram equalization and determined a set of textured regions by using the density of edge concentration by using the MS abased approach. Ozden et al. [24] proposed an approach using low-level features incorporating color, spatial information and texture features in MS algorithm for segmentation.

Although MS algorithm is quite successful in image segmentation, it is necessary to determine a proper bandwidth value for the input image. This situation creates two different categories of MS based image segmentation approaches. In the first category, researchers use the MS method to initially partition images and then another segmentation scheme is produced based on some other methods such as graph cuts or clustering methods. In the second category, researchers investigate to improve the MS segmentation based on some adaptive MS methods. Therefore, in this paper, we introduce the neutrosophic set (NS) theory to MS algorithm to develop an adaptive MS clustering algorithm for color image segmentation. In the proposed method, we employ an improved NS based filter. Previous filters in NS domain, such as alpha-mean filter, make edge blur, and cause erroneous boundary segmentation. Moreover, the local spatial feature was not considered with the global features. To alleviate these drawbacks, we present an efficient segmentation algorithm based on neutrosophic adaptive mean shift clustering (NAMS) for color images. Each color channel of image is transformed in neutrosophic set and interpreted using three membership subsets: true, indeterminate and false memberships. An indeterminacy filter implemented using indeterminacy memberships and neighbor features is utilized to alleviate the indeterminacy in the spatial domain. A new adaptive mean shift clustering is improved by determining the bandwidth using the indeterminacy values adaptively, and employed to identify the pixels into non-overlap groups.

The remained paper is organized as: Section 2 describes the proposed approach. Section 3 discusses experiments and results. The conclusions are conducted in Section 4.

**Fig. 1.** The flowchart of the proposed method.

2. Proposed method

2.1. Indeterminacy filter

In this section, an indeterminacy filter is implemented to alleviate the disadvantages of traditional neutrosophic filter operations. Each color channel of an image is transformed in neutrosophic set, and a subset I_s interprets each channel's indeterminate information on spatial domain. A filter named indeterminacy filter is constructed using I_s to alleviate the indeterminacy of spatial information.

Download English Version:

<https://daneshyari.com/en/article/7121467>

Download Persian Version:

<https://daneshyari.com/article/7121467>

[Daneshyari.com](https://daneshyari.com)