Superpixels Based Interactive Image Segmentation Algorithm

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Abstract:

A superpixels based interactive image segmentation algorithm is proposed in this paper. Firstly the initial segmentation is obtained by MeanShift algorithm, and then a graph is built using pre-segmented regions as nodes, finally min-cut/max-flow algorithm is implemented for global solution. In this process, each region is represented by a color histogram and Bhattacharyya coefficient is chosen to calculate the similarity between any two regions. Extensive experiments are performed and the results show that the presented algorithm obtains much more satisfactory segmentation results with less user interaction and less comsuming time than MSRM algorithm.

Keywords: interactive image segmentation; graph cut; mean shift

1. Introduction

Image segmentation is a fundamental problem in image processing that its purpose is to extract the interesting object from the complex background for the following detection, tracking, recognition and scene analysis [1]. It has been widely used in the areas of pattern recognition and computer vision [1-14]. GraphCut interactive segmentation algorithm [6] has been widely researched recently because its robust, high efficiency, global optimization and outstanding performance in N-D image segmentation [6-11].

This paper presents an interactive image segmentation method based on MeanShift and GraghCut algorithm. The proposed model not only takes the similarities between regions into account, but also the relationships between regions and interactive information. Our method utilizes the color histograms to represent every region. It's an appropriate way to indicate the color distributions of the regions. As same as the MSRM algorithm, the Bhattacharyya coefficient is implemented to measure the similarity between regions, following min-cut/max-flow algorithm to produce a global result.

2. Proposed algorithm

MSRM algorithm uniformly quantize each color channel into 16 levels and then the histogram H_i of region *i* is calculated in the feature space of 16×16×16=4096 bins. The Bhattacharyya coefficient is chosen to measure the similarity between region *i* and *j*:

$$\rho(i,j)=\sum_{k=1}^{4096}\sqrt{H_i(k)\cdot H_j(k)} \qquad (1)$$

At the first, our algorithm obtains the pre-segmentation result from MeanShift, and then builds a weighted graph taking the pre-segmented regions as nodes. Bhattacharyya coefficient is employed to measure the similarity between regions. Min-cut/max-flow algorithm is implemented for a global segmentation.

As same as MSRM, our method utilizes color histogram to represent each region, histogram H_i corresponding to region *i*. Because the pre-segmentation from MeanShift algorithm resulted in relatively larger regions, compared with the mean value of color, color histogram is the better representation of a region. H^F and H^B are the histogram of user labeled region F and B respectively, and they are the color models of foreground and background at the same time. Bhattacharyya coefficient is chosen to measure the similarity $\rho(i,j)$ between region *i* and *j*, as formulation (1) shown.

Our method not only takes the similarity between regions into account, but also the relationship between regions and interactive information. So the energy function is defined as follow:

$$E(\iota)=\sum_{i\in V}R(\iota_i)+\sum_{(i,j)\in E}\left|\iota_i-\iota_j\right|\cdot B(\iota_i,\iota_j) \qquad (2)$$

The first item is region term, used for measuring how regions fit the interactive information, the second item is boundary term, defined for measuring the proximity between adjacent regions.

$$\begin{cases} R(\iota_i=1)= K & R(\iota_i=0)= 0 & \forall i\in F \\ R(\iota_i=1)= 0 & R(\iota_i=0)= K & \forall i\in B \\ R(\iota_i=1)=\rho(i,F) & R(\iota_i=0)=\rho(i,B) & \forall i\in U \end{cases} \qquad (3)$$

$$B(\iota_i,\iota_j)=\lambda\cdot\rho(i,j) \qquad (4)$$

Where K is a constant, N denotes the set of pairs of neighboring pixels, λ is the control parameter.

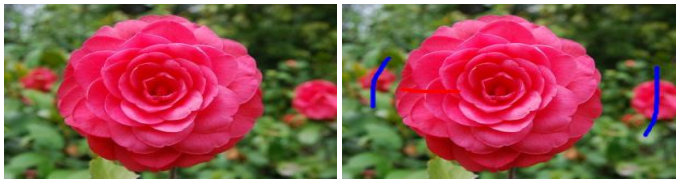
3. Results and Evaluation

Our experiment is implemented on a PC with AMD Athlon 7750 Dual-Core 2.70GHz CPU, 2G memory, VS2008 programming environment, using the C++ programming language. Fig.1 shows two color testing images.

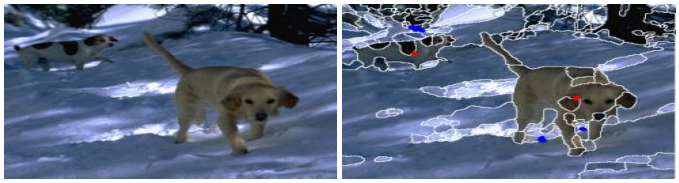
Fig.1 is the flower image with interactive information by user. Red strokes indicates a part of object, blue strokes labels a part of background. Fig.2-3 shows the segmentation results. According to the experiment results, MSRM method well done except the unsmooth boundary. Our method effectively addressed the problem of disappointing performance of edges and the result is more ideal. Fig 1 is the interactive information of animial image and the result is shown in Fig.3. Through the two methods have the same strokes initially, because of the underutilization of interactive information, MSRM leads to more mis-segmetation results. Our proposed method obtained desired solution relative to MSRM even in the condition of less strokes.

4. Conclusion

In this work, a super-pixels based interactive image segmentation algorithm is proposed. Firstly the initial segmentation is obtained by Mean Shift algorithm, and then a graph is built using the pre segmented regions as nodes, thus min-cut/ max-flow algorithm can be implemented more efficiently. In this process, each region is represented by a color histogram, which is a better way relative to mean value of the region. Pre-segmented regions also can give users guidance to simplify the processing, less strokes label more foreground/background regions.

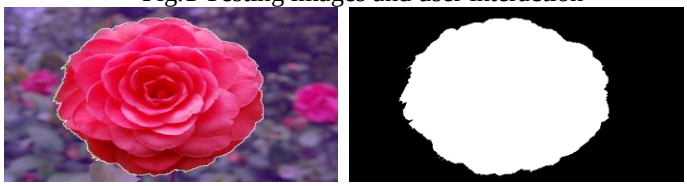


(a) Flower (b) User interaction



(c) Animal (d) User interaction

Fig.1 Testing images and user interaction



(a) MSRM algorithm

(b) Our algorithm

Fig.2 Segmentation results of Flower

(a) MSRM algorithm

(b) Our algorithm

Fig.3 Segmentation results of Animal

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