Improving Salient Object via Global Contrast Combined with Color Distribution

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Abstract. Salient object detection has many applications for computer vision field. In this paper, we have proposed a method for improving salient object detection which is a combination of global contrast and color distribution. The proposed method has three main steps: to reduce color space, to create salient map and to increase the object quality. The main problems of previous research consist of the consumption of time and the quality of salient map. The proposed method solves two above problems. We used a large dataset to test the proposed method. The proposed method's result is better than other methods in two points: the running time and the quality of salient map.

Keywords: Global contrast · Hard threshold · Saliency map · Derivative operator · Color distribution

1 Introduction

In real scenes, computer vision is useful in control roads, airports, offices, etc. Those tasks need to process inputted images in order to detect the contrasting areas, which contain interesting objects. Detecting and segmenting are the most important tasks in computer vision applications. In the past, many researches had to enhance the quality of objects. The previous methods show good results in many datasets but it still needs improving.

To extract an object in an image, the researchers usually use the salient map technique because it bases on the global contrast, which is easy to point out the region of salient object. In order to imply that technique, there is many an approach, which is global contrast, local contrast or blurring. Each of them has private advantages and disadvantages but global contrast has showed its benefits for instance, it is likely to easily identify the region of interesting object in images. Specifically, the global contrast approach needs to use a necessary component, the color reduction. One of the most recent researches applies the soft threshold implement.

In this paper, we have proposed a method for improving salient object detection using the combination of global contrast and color distribution, a variation of method

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which was published by Dat et al. [1]. To reduce color space, we used hard thresholds instead of soft thresholds. The main problems of our previous research [10] are the executing time and the complex structure of the first step (the reducing color space). We have focus to improve this structure. Our experiment used a public dataset from Cheng [11]. The result of proposed method is better than that of [1] in two points: the running time and the quality of salient map. The rest of the paper is organized as follows: in Sect. 2, we describe related works; details of the proposed method are given in Sect. 3; the results of the proposed method are presented in Sect. 4 and our conclusions are made in Sect. 5.

2 Related Works

Recently, many researches proposed the methods for contrast as deblurring method, combination between colors, edges and calculation. Their main purpose is to identify the interesting area but it takes so much time to solve an image. However, they have to focus on different aspects such as concentrating on key information, cutting-off unnecessary operators or creating a new computation model. Those methods are divided into two main groups: global approach and local direction. Each of them has advantageous and disadvantageous points.

The global contrast approach sets the salient value to a color basing on its distance and frequency to other colors in a specific image.

Achanta [3] used frequency of colors combined with color distance in order to measure the saliency value faster; however, there is still a large number of calculations because the possible color is 256^3. Paper [2, 3] gave an important upgrade to Achanta's method. Zhai [4] measured the saliency of each pixel, using its contrast to all other pixels. The advantage is the quality of salient map, yet main problems in which only the light dimension is used and its running time is so slow.

The local contrast aims to find out the salient value of a region by using its contrast and its salient value of neighbor areas. The quality of salient map in this method is better than the former instance because it carefully calculates the salient value for all regions. Rahtu [6] used conditional random field (CRF) to measure and to estimate the salient map. Walther [7] used attends to proto-object (APO), which would create the map. Murray [8] implied spatial pooling mechanism (SPM) in his research.

Most of them focus on color reduction by blurring the inputted image in hope of removing the small details and keeping the main features. Achanta [8] applied the color luminance measure (CLM) to all regions in the hope that we can generate a better salient picture. His research received good results but the remained problems such as: boundaries of interesting object are not well kept in all cases.

Other researchers combine some of these above methods. Tie [10] used center surround histogram (CSD) method combining global contrast and local contrast to use all advantages from both approaches. Additional, important ideas in [12, 13], analyzing the context and background, give us more solution to improve our method. Papers [14–16] suggest new approaches to us in order to reduce errors in current researches,

which are used to improve the quality of objects. All the above methods have their own advantages and disadvantages. However, the salient object detection must continuously be improved.

3 Salient Object Detection Based on Combination Global Contrast and Color Distribution

Salient object detection is a hard work. In this section, we present a method for salient object detection, a variation of method which was published by Dat et al. [1].

In this paper, we improve the algorithm in [1] in two steps: to reduce color space and to increase the object quality. The remaining steps are the algorithm which was presented in [1]. The steps of the proposed method are described below:

Firstly, all inputted images are going to be deducted its color space. We replace the soft threshold method in [1] by using hard threshold method. All inputted images will be moved to LAB color space, and then 256 color values in each dimension will be split into twelve-distinct hard thresholds. After that all remained colors should be compressed by replacing low frequency colors by high frequency colors. We use hard threshold technique instead of soft threshold method because of following reasons:

(i) Decrement of executing time. In the soft threshold, the minimum and maximum values must be extracted from each channel, we have three color channels so the total operations should be O(N), in which N is the total number of pixels in an image. Furthermore, the range between maximum and minimum value is going to be split into twelve parts. In fact, researchers usually use some detail methods to refine these values because they have to deal with special cases, for instance, the range has less than 24 values and we have to split them into 12 parts. That is the reason why researchers have to think over a solution for such cases. In contrast, our method automatically splits 256 values into hard twelve parts; its complexity is constant progress, O(1). As a result of this solution, we do not need to apply any refining method inside this stage.

(ii) All mediated results between steps are images so the better result of the former step is, the faster the latter step will be. It means the results of these steps are affected by its previous step.

(iii) We have chosen the best coefficient for the color-reduction step. That number must be adapted to two conditions: shortening the running time and retaining the image quality as much as possible.

The distinction between these methods is the distribution of values in a color channel. The dynamic thresholds, soft thresholds are based on the maximum and minimum values in each dimension of a specific image while the hard thresholds do not care about this trouble so it eliminates time from spending for this stage.

Secondly, salient map will be created. This step includes three small parts such as to evaluate salient value of each color, to smooth the salient value of neighboring colors and lastly, a salient map for respective images will be generated.

To get the interesting object, we extract the main object in the highest contrast area. Following it, the images are going to be wiped out all wrong pixels which belong to the background or their colors are similar to the environment. After that, we reuse the HC-map algorithm and then apply the derivative operator on the distances between colors in order to remove failed pixels as [1].

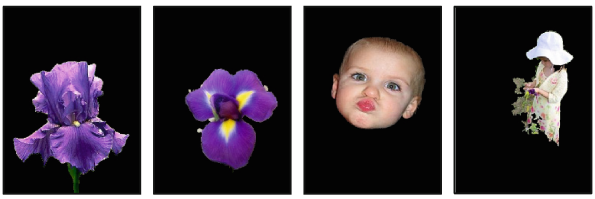
Finally, increase the object quality by sharpening without the median filter as in [1]. The object will be improved its quality by the sharpening method. We choose that method because one of the criteria for evaluating the quality of an image is sharpness.

One additional improvement in this paper is to enhance the quality of extracted objects. This time, we choose sharpening technique because it satisfies conditions:

– To rise up the quality of object.
– To limit noisy troubles.

In fact, there still exist noisy pixels. The extracted objects need to be improved not only sharpen, color contrast but also eliminate small blurring areas. We have decided to use the sharpening algorithm in order to solve those problems because sharpness is one of main conditions for evaluating the good quality of images. The Fig. 1 shows some outputs of this stage.

(a) Original image



(b) Sharpening object of proposed method

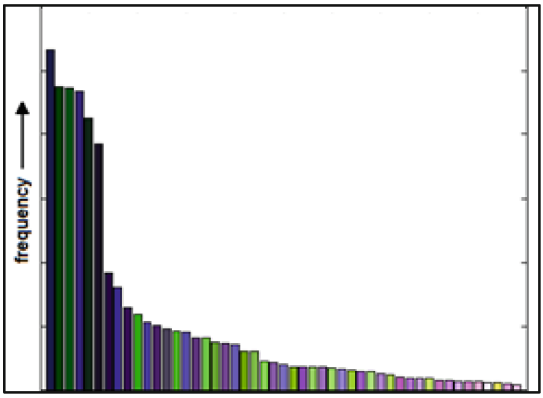
Fig. 1. Result of enhancing object quality by filter.

4 Experimental Results

In this section, we have applied the procedure described in Sect. 3 and achieved superior performance in our experiments as demonstrated in this section. We evaluate the results on the public available MSRA10K database [11]. This dataset has more than 10,000 images. Our Matlab program will be executed on this dataset.

Figure 2 presents colors in a reduced image. In Fig. 2, the deduced photo remains 58 colors at the top right corner and the bar chart presents the frequency of being kept ones at the bottom. The total colors have been reduced, which is an important condition for continuing steps. For instance, the generating salient map, this stage receives the most benefits from the former step because its calculation is based on the number of colors and the quality of image. In all cases, the color range in hard threshold method is always equal or bigger than the color range in soft threshold method so that it is surely to keep high frequent colors and widen the distances between distinct colors. These are the reasons why the salient map creates better in common images. Other continuing steps are similar to our previous research. Visually, the reduced image and the original image changed only a little, presented in Fig. 2a and b. The soft threshold method takes about 0.5459 s to reduce total colors in an image while the hard threshold method costs 0.1465 s for the same task.

(a) (b)

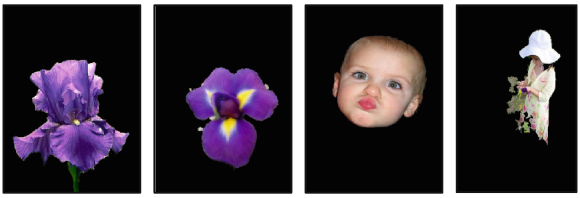


(c)

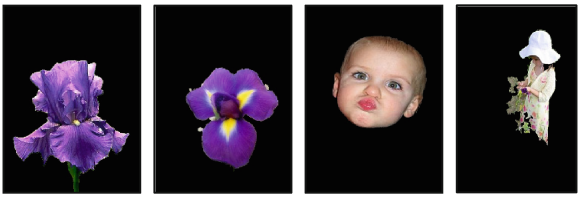
Fig. 2. Colors in a reduced image. (a) Original image, (b) Reduced image, (c) Frequency of remained colors

The Fig. 3 shows some outputs of enhancing object quality by filter in [1] and the proposed method. In Fig. 3, we see that: the result of sharpening object of the proposed method is better than that of [1].

(a) Original image



(b) Median filter of [1]



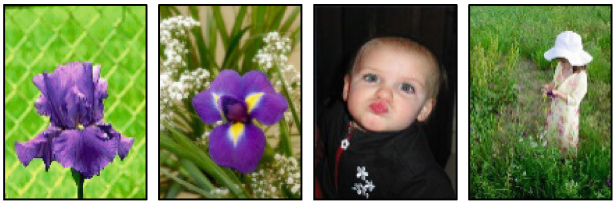
(c) Sharpening object of the proposed method.

Fig. 3. Result of enhancing object quality by filter.

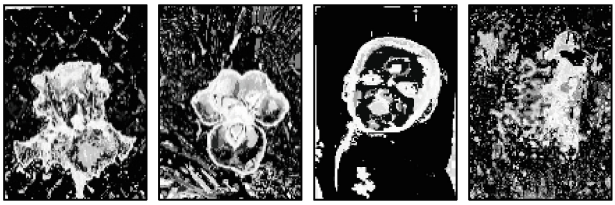
Now, we compare the proposed method results with the method in [1]. These methods will be compared in the executing time and the quality of saliency maps. They are computed in 20 % of images in dataset which fit our requirements.

In Fig. 4, we can visually see that the results of the proposed method which have a rather better quality of salient map than that of [1]. The difference is at the top-line pictures, the purple areas have the same contrast value in our approach while the method in [1] does not solve this problem as well as the latter method. The experiment has pointed out the advantages in the current method. Our current method needs requirements:

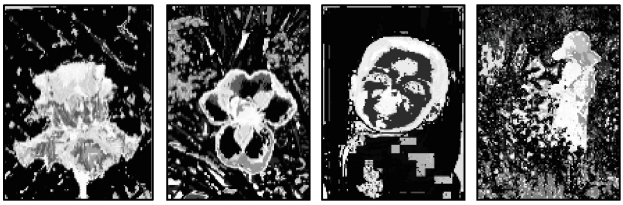
- Using global contrast technique.
- Background has similar colors.
- Object and background colors must be high contrast colors.
- Clear contours surround the interesting object.



(a) Original image



(b) The result of method in [1]



(c) The result of the proposed method

Fig. 4. Salient maps.

Results are displayed in Table 1 and Table 2. This table shows the running time of all recommended methods in this paper. These algorithms are executed in Matlab 2013a environment. The hardware is Core i5-4200U 1.6 GHz (4 CPUs), 4 GB RAM, 500 HDD drive.

Table 1. The running time belongs to color-reduction stage in those methods.

Experimental	The time of method in [1] (s)	The time of the proposed method (s)
1	0.5459	0.1466
2	0.5461	0.1472
3	0.5467	0.1485
4	0.5439	0.1442
5	0.5467	0.1458
Average	0.5459	0.1465

Table 2. The running time of other stages in those methods.

Experimental	The time of method in [1] (s)	The time of the proposed method (s)
1	3.7277	2.9531
2	3.7237	2.9571
3	3.7273	2.9770
4	3.7128	2.9169
5	3.7242	2.9462
Average	3.7231	2.9500

In Table 1, the running time is measured by second and the improvement uses percentage unit. It has showed a big increase, furthermore, the color-reduction step is also increased the performance of other steps, which are presented in Table 2.

Table 2 gives us a detailed look at the effect of the development in stage one on following stages. The inputted results are better but its effect is beyond the expected, 20.76 %. To sum up, the total time of the proposed method is faster than the method in [1] by 27.4671 %, which is a good number for an improvement in the color reduction step.

5 Conclusions

Saliency has been an important problem in neuroscience, neural systems, computer vision, etc. Salient object detection is a hard task. In this paper, we have proposed a method for salient object detection using the combination of global contrast and color distribution, a variation of method which was published by Dat et al. [1]. We have successfully improved method [1] in two main points: the running time and the quality of extracted objects. Especially, time in step one is the most significant point. It has improved the efficiency of algorithm and cut off the redundant time. The usage of hard threshold has removed unnecessary operators in order to boost up the speed and results of the proposed method.

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