Automatic Method for Salient Region Detection

Muhammad Awais Niaz✉*, Ahmed Saeed, and Husnain Ahmed*

Department of Computer Sciences
University of Wah,Wah Cantt

ABSTRACT

Automatic salient object detection is the process of segment the sali-ent object or useful information from input images without any pre-vious knowledge and assumption of the content of the corresponding images scene. It is used in many computer vision and computer graphics application. Detecting salient object with complex back-ground and biased dataset is difficult and challenging problem. In this manuscript, we proposed an effective and efficient supervised method based on graph cuts to detect the salient object. The pro-posed method performs the segmentation process directly on the in-put image without first converting it into binary form. Therefore, the segmented salient object contains the same color space as the origi-nal input image. The proposed method is tested on MSRA and DUT-OMRON benchmark datasets and it performs better compared to existing methods.

Keywords: *Salient object, automated detection, background removal, graph cut.*

1. INTRODUCTION

Salient object detection (SOD) has its importance in image analysis and understanding. It is used to identify remarkable regions in an image where the spotted part would draw human consideration. Salient region detection is very useful and it has been studied and applied to many applications including segmentation [1], retargeting of image [2] recognition of object [3] assessment of image quality [4], photo rearrangement [5], image thumb nailing [6], and video compression [7]. The progression of this program is actually the inspiration from the concepts of “human visual perception”. One significant step is how to separate the salient region [8] with the other parts in an image.

Many salient region detection techniques are proposed based upon the different color detection because a color is an important optic key to human. In this paper, automated method for salient region detection is introduced. Detecting a salient object from complex background and duplicate or biased dataset is a challenging problem. Separating foreground from background when both having same similar colors is complex task. Object detection becomes challenging with low quality input images. The proposed method overcomes the shortcoming of the existing methods such as detection of object from same background or complex pattern.

✉ javeriacomsat@gmail.com

The proposed method is robust and offers improvements in (i) image segmentation in Computer Vision, (ii) object extraction from complex background, (iii) object extraction from same background color as foreground color, (iv) object detection from biased dataset. This paper contains four sections. Section II presents related work for the detection of salient object in an image. The proposed method is described in Section III and performance comparison is carried out in Section IV.

2. RELATED WORK

In computer vision, SOD is an interesting research area. Although different methods have been reported in the literature for the SOD in an arbitrary image [28]. There is still a problem plagued in case of scattered objects and complex backgrounds. Many efficient automatic methods have been proposed for the detection of salient object in complex background [29-30]. Some methods are described in this section.

Bottom-up hierarchical clustering method is proposed for the detection of salient object in an image [9]. Salient region has been segmented using hierarchical saliency function [10]. A novel method is proposed based on the learning graph affinities for SOD [11]. Yang et al. proposed a novel edge guided SOD tech-nique that employed segmentation to derive the two scales nested superpixels. The coarse saliency map is estimated using spatial prior, boundary prior and color contrast. Background prior is calculated using the geodesic distance between the superpixels. Saliency map is computed using background prior, coarse sali-ency and inter-scale consistency [12]. Aksac et al. proposed an efficient method for SOD. The compact regions are generated using image decomposition via utilizing the segmentation of superpixels. The saliency map is obtained using color, histogram, area and location features [13]. Peng et al. proposed a novel structured matrix decomposition method for SOD [14]. Singh et al. used Davies-Bouldin index method to segment the salient region and then Gaussian mixture model to find the segmented pixels. The saliency map is computed using spatial saliency and position prior pixels [15].

Frequency domain method incorporates both global and local features using fast Walsh-Hadamard transform for SOD [16]. Salient region has been segmented using bipartite graph partitioning and hyper complex Fourier transform (HFT) method. The saliency map is computed by taking the average HFT coef-ficients of each segmented region and threshold method to separate salient region from the background [17]. Rough salient region is segmented using distance weighting, morphological closing and adaptive binarization. Refine salient region is obtained using Bayesian decision method [18]. Cognitive visual attention model is used for SOD. It computes and fuses all the feature channels to a saliency map [19]. Zhang et al. proposed a novel graph-based op-timization for SOD that uses multiple graphs for describing the natural scene image in better way SOD [20].

3. PROPOSED WORK

Graph cut algorithm is employed for image smoothing, segmentation, and restoration. In our proposed method, we use graph cut to segment the foreground object. The segmentation results are evaluated with ground truth annotations in term of foreground, background precision, error rate, sensitivity, accuracy and unknown rate. The block diagram of the proposed method is shown in Fig. 1.

Graph cut is the process of partitioning the direct or indirect graph into disjoint set. Graph cut algorithm takes an image as graph and initializes the source and sink node. It calculates the distance and intensity of each pixel from source and sink node and declare the pixel as foreground or background. Sink node is use for background pixel and source node is use for foreground pixel of an image. If the pixel distance and intensity value is same with source and sink then it uses energy function for declaration of pixel as back-ground or foreground.

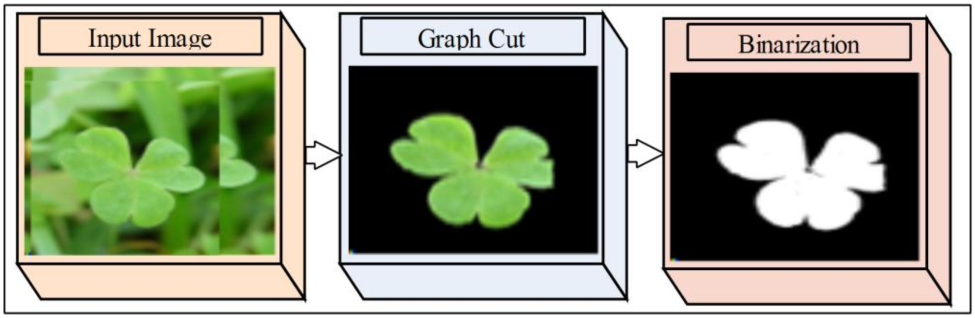

Fig. 1. Block diagram of the proposed automatic salient region detection system

3.1 Algorithm of Proposed Technique

The followings steps formulate the whole system.
Step 1: START
Step2: Choose Input Image
Step3: Choose Ground Truth
Step4: Start Graph cut

- Calculate the weight of each vertices.
- Define the seed and sink node
- Calculate the distance from seed and sink node
- Assign a label to nearest node sink or seed
- Segment the foreground from background.

Step 5: Compare the segment image and ground Truth Image
Step 6: Calculate the Foreground Precision
Step 7: Calculate the Background Precision
Step 8: Calculate the Unknown Region

Step 9: Calculate the Error
Step 10: Show Result
Step11: END

4. EXPERIMENTS

The performance of the proposed method is evaluated in term of MSRA10K and DUT-OMRON benchmark datasets. In MSRA dataset contain 10,000 images with pixel level saliency labeling [21].

DUT-OMRON consists of 5168 images that are selected manually from more than 140000 images. All images having more than one salient objects with complex background [22].

4.1 Performance Evaluation

The detection capability of the proposed system is evaluated on the basis of accuracy and sensitivity. It is characterized as the proportion of the quantity of ground-truth pixels recovered as a salient region to the aggregate number of proposed segmented pixels recovered as the salient region. The second assessment record is the sensitivity.

We utilized classification method to classify either super pixel belongs to foreground region or background region. Table I-II demonstrates performance of the proposed method in terms of Background. Precision (BP), Foreground Precision (FP), error rate (ER) are described in Eq 1-3, in which$|.|$ indicates the quantity of pixels, BC and FC signify the background/foreground, BGT and FGT represent explanations of ground-truth closer background/foreground, correspondingly, and it signifies the entire picture. The error rate (ER) indicates the degree of the range of misclassified areas to the picture size, and the unknown rate is the proportion of the zone of the regions classified as unknown to the picture size.

We utilized the idea of graph cut at the early saliency estimation step. We fixed the comparatively consistent regions of salient and non-salient regions to foreground or background correspondingly, and consider the unclear regions as unknown. Related to the binary maps without unknown regions, we find that classifying unclear regions as unknown regions which can benefit to get more consistent locations of salient regions. Foreground Precision (FP); background Precision (BP), error rate (ER) and unknown rate.

We decided whether every super pixel fits to foreground candidate (f), background nominee, or unknown regions utilizing the response value extracted from the classifier. In our research, we utilized threshold values $T_{f=}255 * 0.95$ and $T_{back} = 255 * 0.05$. If superpixels response value goes above T_f are, then it considered to the foreground; though, if the value is lesser than T_{back}, then it considered to the background; otherwise, it is considered as unknown. The proposed segmentation results are mention in Fig. 2.

$$F_p = \frac{|\{F_C\} \cap \{F_{GT}\}|}{|\{F_C\}|} \quad (1)$$

$$B_p = \frac{|\{B_C\} \cap \{B_{GT}\}|}{|\{B_C\}|} \quad (2)$$

$$E_R = \frac{|(\{F_C\} \cap \{F_{GT}\} \cap \{B_C\} \cap \{B_{GT}\})|}{I} \quad (3)$$

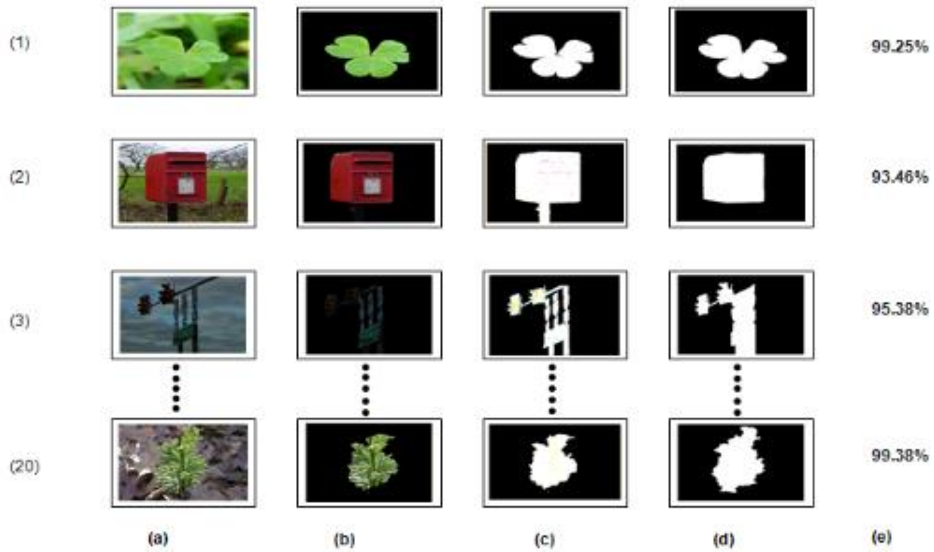

Fig. 2. Proposed Segmentation Results (a) Original image, (b) segmentation (c) binarization and (d) ground truth annotation

Table 1. Proposed Method Results

Calculation Matrix	**MSRA Dataset**	**DUT-OMRON Dataset**
Foreground Precision	0.960564	0.966351
Background Precision	0.758756	0.782253
Error Rate	0.064782	0.032726
Unknown Region	0.004600	0.526239
Accuracy	0.960564	0.956321
Sensitivity	0.810564	0.816351

Table 2. Comparison Table

Method	**Regression based[26]**	**Classification[27]**	**Proposed method**
Foreground Precision	0.789	0.875	0.960564
Background Precision	0.980	0.983	0.758756
Unknown Rate	0.423	0.308	0.064782
Error Rate	0.032	0.019	0.064782

5. CONCLUSION

There are many existing salient object detection system but they have some issues. They do not detect the object from image where foreground and background have same color or image having complex background pattern. Our system goal is to resolve these segmentation problems in image processing and computer vision. This system resolves these issues that exist in previous systems. The main advantage of our proposed method is that accurately segment the foreground region even when both foreground and background color is same in an image. The proposed method achieves 0.96 Fg. Precision, on MSRA and DUT-OMRON Datasets.

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