SALIENT REGION DETECTION BY EXPLOITING BACKGROUND CUES

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Abstract- This paper proposesa method for detecting salient regions in given image. We take the information about the salient region by exploiting the background cues and to obtain a distinct foreground and a background. These salient regions can be used further for applications like adaptive image compression, content based image detection etc.

Keyword- Saliency, Region of Interest, Image Compression

I. INTRODUCTION

Saliency is the state or quality by which a part of image stands out relative to its neighbors. The ability of human visual system to detect visual saliency is extraordinarily fast and reliable. It is considered to be a key attentional mechanism that facilitates learning and survival by enabling organisms to focus their limited perceptual and cognitive resources on the most pertinent subset of the available sensory data.

The feature integration theory [1] of attention classifies the process of human perception of an image into two stages. The first stage of the feature integration theory is the pre-attentive stage. During this stage, the object is analyzed for details such as shape, color and orientation, with each aspect being processed in different areas of the brain. The second stage of the feature integration theory is the focused attention stage, where the individual features of an object combine in order to perceive the whole object. If the object is familiar, associations are made between the object and prior knowledge, which results in identification of that object.

Themethod proposed by Zhai et al. [2]uses point processing technique. Saliency value for each pixel is calculatedas weighted sum of all possible 256 grey levels. Contrast is considered as key to saliency. The points with maximum saliency value are chosen for salient region detection. Region growing technique proposed in this paper is, however, computationally expensive and sometimes the most salient points do not belong to the salient region.

Global contrast based saliency detection by Chen et al. [3] uses color statistics of the input image. To narrow down the possibilities of salient region/color the colorspace is sampled to only those colors which occur more frequently. Saliency cut method is used in last stage for determining salient regions.

The method proposed by Shuai et al. [4] is comparatively computationally much more feasible as this includes dividing the entire image into superpixels. Superpixels are the local regions having similar properties. A texture suppression algorithm is used to suppress small variances in textures. Background prior detected using mentioned method is not robust enough. Hence if salient object touches the boundary then this method fails to detect it.

The method proposed by Zhu et al. [5] provided a solution to the above problem. It assigns appropriate weights to the superpixels which touches the boundaries. It considers the perimeter and the area of the region/object touching image boundary. Depending upon the degree of closeness to the image boundary weight is assigned to that color intensity. But detecting the objects and their parameters like perimeter and area are difficult tasks to perform with a reasonable accuracy.

As we see that each of these methods has some other major drawbacks of its own which puts a severe restriction on applying the algorithm on a variety of image data sets, we propose an algorithm of our own to mitigate this issue and make the method as efficient and robust as possible.

II. PROPOSED METHOD

One of the important parameters of concern for computer vision tasks is computational complexity. Hence instead of determining pixel level saliency values, a different approach should be considered. Superpixel is one of the ways to reduce the number of computations as it segments the image into locally similar regions [6] which reduces the effective number of pixels. Considering the well-known fact that features remain more or less unchanged over its neighborhood, we divided image into 8*8 blocks after shifting to LAB colorspace.

It is observed that image boundaries are very much similar to the background of the image [4][5]. To detect the background cues, image boundaries are used. 2D images have 4 boundaries. Each boundary is analyzed as follows. Consider the right-most boundary. All the blocks touching the right-most boundary are considered for determination of background cue along that boundary. Say, there are N_1 number of blocks touching the right-most boundary. Calculate the summation of the Euclidean distance between every block with every other block in that boundary. A block which has the least Euclidean distance is the background cue from that boundary. This is because, for a block having the least Euclidean distance, the probability of occurrence of regions similar to that block is higher i.e. that block could be the part of background which occurs more frequently along the considered boundary.Then Euclidian distance is calculated as

$$\text{Dist}\ (j)=\sum_{i=1}^{N_1} |I_i - I_j| \qquad (1)$$

here I is the array of blocks touching rightmost boundary and i,j=1,2,…N_1.

Similarly find background cues for remaining 3 boundaries. The 4 blocks thus obtained are the part of prominent background in the image. Generally the background is not similar along all 4 boundaries. To determine the frequency or degree of appearance of the background cues calculate the Euclidian distance of these 4 blocks with all blocks touching the image boundaries. Higher the distance value lesser is the degree of appearance. The distance values obtained are named as $W_{bc}(i)$ where i=1,..4.

As mentioned above, we used LAB colorspace. The advantage of using this colorspace is that the luminance(L) and chrominance(A and B) information is available in different channels. This is used later to suppress the contribution of luminance to calculation of saliency value.

The saliency value of each 8*8 block is calculated using the equation (2). We calculate the weighted saliency value for each image block as follows

$$\text{sal}(i) = \sum_{i=1}^{n} \sum_{j=1}^{4} \frac{|I_i - I_{bcj}| * W_{lab}}{W_{bcj}} \qquad (2)$$

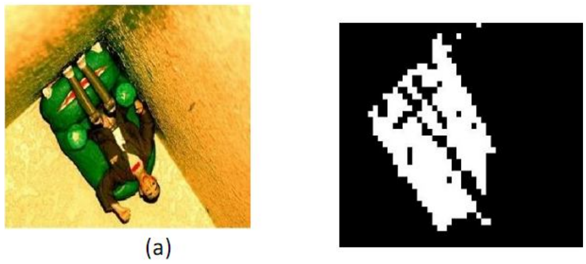
where n is the total number of 8*8 blocks in the image. W_{lab} = [0.115, 0.425, 0.425] used for suppressing the contribution of luminance to calculation of saliency value.

This is done so that in dark or over-lit regions of image the color contrast value dominates the saliency value calculation. This helps to overcome the undesired effects due to shadow regions or very bright regions. As a result, shadow or very bright types of regions are not highlighted to be salient in the final saliency map. The saliency map thus obtained is thresholded with an appropriate threshold value. For most of the images the threshold value lies in the range [90,130].

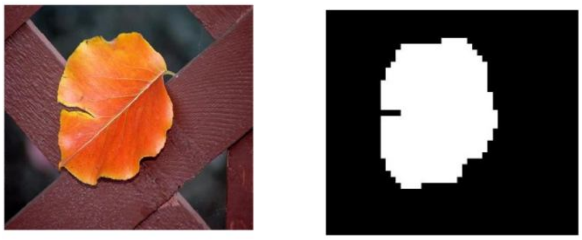
III. EXPERIMENTAL RESULTS

Following are the outputs obtained with our algorithm.

The algorithm worked for most of the images chosen from the data sets. However, in a few cases wherein there is not much intensity as well as chrominance difference, failed to provide good results. Fig (a),(b) and (c) show results close to ground truth. Fig (c) and (d) show a part of the cluttered background along with the salient object. The results are fair enough. Fig (e) shows a hockey stick and a shuttle cock. A part of the stick gets a part of the salient feature, which is not the case.

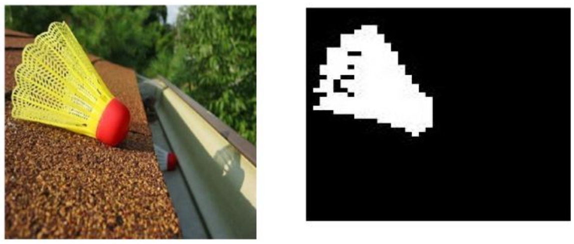


(a)



(b)

(c)



(d)

Fig1.Experiment results

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