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A novel approach to deal with Salient Region Detection Problem

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ABSTRACT
While considering the image processing operation estimation of Saliency become important parameter. Now a day several methods are exist for the Saliency estimation but no single method can achieve full accuracy or performance. In this Paperbased on reconsideration about existing methoda clear algorithm is proposed for saliency detection.

The phases of algorithm comprises of Decomposition of image into compact and homogeneous elements which possess some spatial relationship corresponding to each other. Then compute the two parameter Uniqueness and Color Spatial Distribution. The parameter allows to preparation of Saliency map which capture the overall area of the Salient Object.

In the detail experimental evaluation analysis of the all possible feature done and state out that the proposed method performs well on the all available method.

General Terms
Image Processing, Computer Vision, Image Retrieval etc.

Keywords
Gaussian Filter; Visual Saliency; Saliency Map; Gaussian weight; Mean Absolute Error etc.

1. INTRODUCTION
When human capture images he always emphasis on some particular object. These objects are termed as Salient object where human put its most attraction. Computationally detecting these objects in image makes use of computational resources following particular sequence. The extracted object have wide variety of importance in many areas like computer vision, image processing, object recognition and image retrieval.

Now the question arises how one can point that the object is Salient. Perhaps the answer for this question is Rarity or Surprisingly. When one called an object is unique than it has some unique feature like texture, color,boundary and edges etc. The field of Visual Saliency closely related to field of cognitive psychology, neurobiology. Based on the theoretical study of Koch and Ullman and subsequent theories suggest the two possible categories of the visual attention: First Bottom Up approach and Second is Top down Approach.

Result from the previous experiment show that the important feature in visual saliency is contrast. So in proposed approach Contrast has takeninto consideration as major factor. The first stage image decomposition subsequently followed by the Contrast measurement for object comparison. This result in the Saliency Map which direct towards the clear image of the Salient Object. As demonstrated each module of given work closer to the existing approach and give resulting solution which possess better ranking on the publically benchmark available .

2. RELATED WORK
As the bottom up approach is going to follow so first it become necessary to discuss the categories of the same. The bottom up approach classified into two categories as biologically inspired method and computationally oriented approach. The implementation of Koch and Ullman [1] supported by the first type of category. In such implementation major focus is on the low level feature of image like color, edges, boundary and orientation of edges. Itti et al [2] also provide an implementation in same category but they make use of Gaussian filter for the high quality estimation of values. But after some time it observed by the researcher Cheng et al [3] that the saliency map obtained by the previous methods looks like blurry and they emphasis on the small features so these problems makes it failure for most of the application.

One of the alternatives for the above problem is Frequency Space method [2] which compute the Fourier transformation of image and compute the saliency based on the amplitude and phase spectrum [4]. The resulting saliency maps possess high contrast and less blurry image. One can also think about the color space techniques. The local and Global analyses are the two varieties available for this. In Local approach comparison of the image pixel with respect to its neighborhood pixels done. However the resultant picture possess less blurry but still they didn't preserve the global structure.. They are also sensitive to the image edges and noise.

On the other hand the global method takes into consideration the contrast feature over the whole image. The path based approach [5] work in the similar manner. They are good in term of sensitivity but at the same time they suffer from the complexity issues so they can be only applicable on the images having low resolution feature [6]. Or it may be possible as they have to operate in the small area means with fewer dimensions [7]. Further Achanta et al provide a solution which achieves the globally consistent result. They use the Gaussian blur to reduce the noise effect in the image [8].

Liu et alsuggest the combination of the multi scale contrast and color spatial distribution to generate the conditional random field [CRF] for saliency estimation [6].

Subsequently the Ren et al and Cheng et al make use of segmentation for saliency detection [9]. Cheng et al worked on the histogram of the object and find the dissimilarities between the bins [3].

By looking at the all existing approaches it has found that the detection of Saliency becomes an important area with the

reduced complexity and less feature availability. The work is highly influenced by the contrast measure and Color spatial distribution concept to achieve the pixel accurate saliency map.

3. OVERVIEW

As discussed earlier the algorithm first decompose the image into pixels which bears the sufficient featured information like measure of contrast which is useful for the per pixel saliency calculation. The phases of our algorithm discussed below.

3.1 Abstraction

By means of the Abstraction process the main aim is to decompose the image into number of pixels which possess the relevant structure and abstract out unnecessary details. These pixels then further grouped with the other pixel having same spatial relationship and make the perceptually homogeneous regions. To differentiate one image region to other the edges or some boundary related features maintained between them. The method also imposes some size related restriction on these elements.

One approach to achieve the decomposition is through edge preserving localized over segmentation method.The quality of the saliency map extremely robust corresponding to the elements. Now the two measures for contrast computation discussed below.

3.2 Uniqueness of element

The first factor for contrast measure is uniqueness. It indicates those image regions which catch user's attentions towards them. One can call them unique region because of some difference in some feature like size, orientation, brightness etc. corresponding to other region. This assumption is the basis for the most of saliency detection algorithms like contrast based saliency.

3.3 Element Distribution

While the Saliency implies uniqueness the opposite might not always true [3].The concept state that each object which is unique doesn't hold good choice for Saliency always. While on the other side the Saliency objects always unique in its domain. If sometimes one think about the size of the salient object then it may or may not be a good choice because not always the salient object is largest among all object. While sometimes it becomes true. The background of the image has wide area compare to the other object but still it does not fit in the Saliency requirement.

Theother factor for element distribution is the case where the object element does not cover the whole image area while they are distributed over small locations. Large Scale image segmentation techniques loss this type of information.

3.4 Saliency Assignment

The two measure of contrast discuss in the previous phase are calculated over the all image pixels. In the final step we assign the saliency value to the all pixel regions. The presented work inspired by the mechanism of this step as it allow the assignment of saliency value to those pixel also for which sufficient pixel accurate information is not available at this stage because of the abstraction phase of the process.

a) Source Image

b)Abstraction

c) Uniqueness

d) Distribution

e) Saliency Achieved

f) Ground Truth

Fig 1: Various Steps of Algorithm

4. ALGORITHM

In this section the major consideration is on discussion of algorithm concept with the contrast feature and Saliency value assignment Stages.

4.1 Abstraction

The work presented here based on Super pixel approach to decompose the image into large number of the pixel which abstracts out unnecessary details but at same time preserve the relevant structure. It makes use of the K means Clustering algorithm for decomposition. We can use the K means clustering in RGB space. The work also based on the CIE color space.

4.2 Element Uniqueness

The element uniqueness is generally defined based on the rarity of segment i, its position pi and color Ci. It can be given as follow

$$U_i = \sum_{j=1}^{N} \left|\left|ci - cj\right|\right|^2 . w(p_i, p_j)$$

The value of W_{ij} allows one to effectively combine the feature of global and local contrast estimations. If W_{ij}=1 then it yield a Global Contrast value instead of local contrast. The estimation of the above equation takes $O(N^2)$ operation where N is the number of Segments. Cheng et al [7] calculate the value of above equation using histogram bin. To reduce the complexity of above function use of the Gaussian weight done in this work. It has been observed that the complexity is reduced by the O(N) time by the above changes. By introducing the Gaussian weight in the above function one can define the uniqueness in following way-

$$U_i = \sum_{j=1}^{N} ||ci - cj||^2 . w_{ij}^{(p)}$$

$$U_i = c_i^2 \sum_{j=1}^{N} w_{ij}^{(p)} - 2c_i \sum_{j=1}^{N} c_j w_{ij}^{(p)} + \sum_{j=1}^{N} c_j^2 w_{ij}^{(p)}$$

Here the both summation term can be evaluate by the Gaussian blurring color cj and the squared color cj^2. Parameter σ_p was set to the value 0.25 in the all experimental work so that it achieves the proper balancing between the local and global effect.

4.3 Element Distribution

The spatial variance Di of the color c_i is the main factor to decide the element distribution measure for the segment i. As one knows that the low variance value is the indication of the fact that the two segments are closely related to each other so at this stage it becomes necessary to compute the Relative Spatial Variance value which is given as below

$$D_i = \sum_{j=1}^{N} ||P_j - \square_i||^2 w(c_i, c_j)$$

Where W_{ij} indicate the similarity between the color c_i and c_j of the corresponding segment i and j. P_j is the position for the segment j.

Here again the above function gives the quadratic running time complexity. But one can resolve the problem and perform the overall operation in linear time by taking the Gaussian weight. The calculation of the linear time complexity is given as follow

$$D_i = \sum_{j=1}^{N} ||p_j - \square_j||^2 w_{ij}^{(c)}$$

$$D_i = \sum_{j=1}^{N} p_j^2 w_{ij}^{(c)} - 2w_i \sum_{j=1}^{N} p_j w_{ij}^{(c)} + \square_i^2 \sum_{j=1}^{N} w_{ij}^{(c)}$$

$$D_i = \sum_{j=1}^{N} p_j^2 w_{ij}^{(c)} - \square_i^2$$

One can introduce the factor σ_c for controlling the color sensitivity and from experimental point of view its value is taken as 20.

In summary part it has been shown that by introducing the filtering color values in the image one can compute the uniqueness and by filtering the position one can compute the element distribution. In the next phase process of combining the two given feature to obtain the Resultant Saliency Map discussed.

4.4 Saliency Assignment

The first step towards the Saliency assignment is to normalize the value of the both uniqueness U_i and distribution D_i in the range 0…1. If one thinks that both measure as independent so one can combine both measure in the following manner for saliency computation of Segment Si.

$$S_i = U_i . \exp(-k . D_i)$$

As in the practical scenario one can find that the distribution of element is much more significance than the Uniqueness of element. So to put higher emphasis on this factor one can introduce the exponentiation function with this. Throughout the experiment the value of k is taken as 6 to scale up the value of exponent.

In final step it is necessary to assign the final saliency value to the each image pixel. To differentiate this from the previous work one can think it as the up sampling of the pre element saliency S_i. One can define this saliency in the following manner-

$$\sim S_i = \sum_{j=1}^{N} w_{ij} S_j$$

Here $\sim S_i$ is the weighted linear combination of the all Saliency S_j which are surrounded by it. Again here one can prefer the Gaussian weight over the simple weight to achieve the better complexity. As the work introduce the Gaussian concept in many phases so they all can be perform on the same filtering framework. The saliency values of each component is embedded in the five dimensional space using the corresponding position p_i and color value c_i in RGB color space.

Fig 2: Input Image and corresponding Result obtained by the proposed method

The Saliency maps obtain in the final stage having different scale up. One can rescale the saliency map in the range 0..1 further.

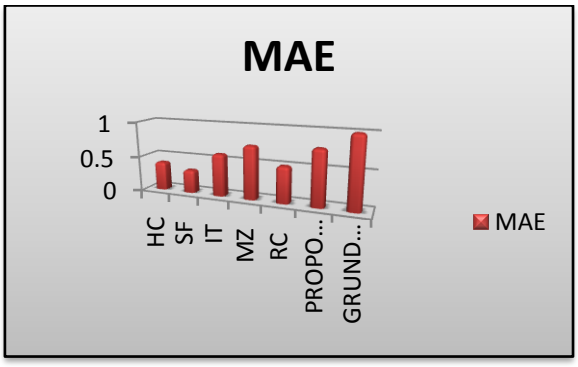

Fig 3: Analysis of the proposed method with respect to other method on Mean Absolute Error

5. RESULT

The Experimental result shows that the method achieves better performance compare to the available method. Previously the best available method achieve the efficiency near about 75% i.e. mean absolute error (MAE) was 25%. We successfully step down the MAE by 23%.

6. CONCLUSION

The work presented the Saliency filter approach for the saliency detection based on the image abstraction in homogeneous elements. The method out perform well on the most of the available datasets of the images and provide the solution somehow near to the state of art.

From future point of view one can believe that the method will be helpful for the most of the areas of real life where the saliency has its importance. However there are some limitations because of which one can't achieve the full efficiency in the detection of the region. But still in the modification of the Abstraction approach like patch based image segmentation can lead to better result in detection.

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