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A FUSION OF LOCAL AND GLOBAL SALIENCIES FOR DETECTING IMAGE SALIENT REGION

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ABSTRACT
Visual saliency is an important quality that makes an object, person, or pixel that relative to its neighbors and thus captures humans attention. Detecting and segmenting salient objects in natural imageries, also known as salient object detection, has attracted a lot of research focused on computer vision and has resulted in many applications. However, while many such models exist. Saliency detection has gained a lot of attention in image processing. In past few years many saliency detection methods have been proposed. This paper presents various saliency detection methods.

KEYWORDS: Saliency detection, Visual attention, Human Visual System.

I. INTRODUCTION
Visual attention is an important characteristic in the human visual system (HVS), through which a person can easily identify the interesting parts of a scene, i.e., visual saliency. Thus visual saliency has applied to a variety of application areas, e.g., object recognition, image/video compression, image cropping/ retargeting, human gaze and actions, image retrieval . A number of saliency models have been proposed in the past decades, which include the local and global features ,to estimate the image saliency. The local feature-based approaches extract the visual features from pixels in an image, the global feature- based approaches, estimate the visual saliency from the whole image. The saliency detection performance has been improved with the emerging saliency models. Nevertheless, saliency models based on either local features or global features alone are still insufficient to effectively handle the images. To improve the overall saliency detection performance, taking effective local and global features and combination model. Accordingly, we shall choose and extract the corresponding features for saliency detection. Consequently two kinds of features: 1) local features and 2) global features. Specifically, the local features consist of local region-based color feature, and local region-based texture feature where the orientation information can be found as well, while the global features comprise: 1) global color feature that describes the color distribution in the whole image, and 2) global edge feature that is extracted in the frequency domain after smoothing, which can suppress the repeated patterns and preserve the edges. Hereinafter, the saliencies obtained using local region-based color feature, local region-based texture feature, global color feature, and global edge feature individually are named as local color saliency, local textural saliency, global color saliency, and global edge saliency ,respectively. Further, he first two are simply called local saliency; the latter two are called global saliency.

In summary, the contribution of this paper is mainly twofold:

1. A smoothing scheme for the local color saliency detection and multiple edge saliency is proposed. Compared with the existing models, this method can provide better saliency, and can work well even in the low-resolution or noisy images.
2. The combination of the local and global saliency scheme which employs different visual cues can make fully use of their individual merits to achieve improved performance.

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II. LITERATURE SURVEY

A lot of work has been done and various methods have been proposed to detect image saliency .This section discuss some of those methods.

A. Frequency-tuned Salient Region Detection

Achanta *et al*.[1] suggest that visual salient image region detection is useful for a large number of applications such as object segmentation, adaptive compression, and object recognition. In this method introduces a method for salient region detection whose output is full resolution saliency maps. These maps also define boundaries of salient objects. Boundary preservation is done by retaining substantially more frequency content from the original image than other techniques. These methods make use of color and luminance for preserving the boundaries by obtaining more frequency content from the original image than the previous methods. This method is mainly divided into 5 stages:

1. In whole Image focus on largest salient objects.
2. Highlight whole salient regions uniformly.
3. Salient objects are preserved with their well defined boundaries.
4. Eliminate the high frequencies occurring from texture, noise as well as from blocking artifacts.
5. Final output full resolution saliency map with well defined boundaries.

This method highlights the whole salient objects, by establishing the well-defined borders of salient objects, and eliminating high frequencies arising from noise in it.

B. Graph-Based Visual Saliency (GBVS)

Harel *et al*.[2] proposed that generally visual saliency models are divided into three different stages that are as follows:

1. Extraction**:** In this step feature vectors are extracted from different location over the image plane.
2. Activation**:** Use the feature vectors from previous stage to create activation map.
3. Normalization**:** Perform the normalization over activation map by combining one or more activation maps into single map.

In this graph based visual saliency model unified approach is used for step 2 and step 3 that is nothing but Markov chains are interpreted using dissimilarity and saliency to define edge weights on graphs and treat the equilibrium distribution over map locations as activation and saliency values.

C. Saliency Detection: A Spectral Residual Approach

Hou *et al*.[3] suggested the ability of human visual system to detect salient regions is very fast and reliable. It presents a simple method for the visual saliency detection. This model is independent of features, categories, or other forms of prior knowledge of the objects. Extract the spectral residual of an image in spectral domain by analyzing the log-spectrum of an input image. This is a fast method to construct the respective saliency map in spatial domain. Generality is main advantage of the spectral residual approach. Other methods require the prior knowledge for saliency detection which is not required in this system.

D. Global Contrast based Salient Region Detection

Cheng *et al*.[4] uses a regional contrast based saliency extraction algorithm. This algorithm evaluates global contrast differences and spatial coherence. The algorithm is simple, efficient as well as yields saliency maps with full resolution. The region based contrast method first divides the input image into regions then computes the saliency of each region by calculating weighted sum of that region’s contrast to other image regions. It is global contrast based method which considers motion contrast between images and can be calculated by considering planar motions between images. Color histogram is used in this method to compute pixel level saliency maps which is combined with spatial attention model providing interesting regions as well as objects and finally this dynamic fusion framework is provided which can be apply on several video sequences and various images to detect the interesting objects and motions that are present in sequences with high user satisfactory rate.

E. Saliency Detection: A Boolean Map Approach

Zhang *et al*.[5] suggested that an image is characterized by a set of binary images, those are generated by randomly thresholding the image’s color channels. Computes saliency maps by analyzing the topological structure of Boolean maps which is based on a Gestalt principle of figure-ground segregation. Implementation of this method is simple also it runs very efficiently.

F. Salient region detection and segmentation

Achanta *et al*.[6] says that detection of salient image regions is useful for applications like image segmentation, adaptive compression, and region-based image retrieval. In this method that determines salient regions in images with the help of low-level features of luminance and color. The key points of this method are fast, implementation is easy and generation of high quality saliency maps whose size and resolution is as same as the input image.

G. A framework for visual saliency detection with applications to image thumbnailing

Luca *et al*.[7] it uses a novel framework for visual saliency detection which based on a simple principle that images sharing their global visual appearances shares their similar salience . First retrieves the images more similar to the target image then built a simple classifier and then generate saliency maps by using created classifier. Finally, extract thumbnails by refining maps. "Isocentric Color Saliency in Images", in this method here suggest a computational method to detect visual saliency in images. This method suggests that salient object must have characteristics that are different than the remaining of the scene, being edges, color or shape . This approach is fast as well as runs without any learning.

H. Context-Aware Saliency Detection

Goferman *et al*.[8] proposed that aim of this method is to at detect region in the image that represent the scene. The regions are salient if they draw the attention, sometimes background of object also contains important context which is useful for clear understanding of object so the proposed method detects the salient object with its surrounding. Which aims at detecting the image regions that represent the scene. This saliency is based on four principles :local low-level considerations, global considerations, visual organizational rules, and high-level factors. This saliency detection method is different from other whose goal is to either identify fixation points or detect the dominant object. This method is beneficial in applications where image context of the dominant objects is as essential as the objects. The proposed method is useful in image retargeting and summarization.

I. Saliency Detection Based On Frequency and Spatial Domain Analysis

Levine *et al*.[9] proposed a method that combines global information from frequency domain analysis and local information from spatial domain analysis. Frequency domain analysis-model non-salient region using global information. Spatial domain analysis-enhance region that are more informative by using center surrounded mechanism. Output from the two analysis used for creation of final saliency map.

J. A model of saliency-based visual attention for rapid scene analysis

Itti *et al*.[10] proposed a local contrast based model in which multiscale image features such as colour, intensity and orientation information from images are combined into a single topographical saliency map. It makes use of Gaussian based approach to develop model called as dynamic routing model which is used to define saliency by calculating center surround differences in which information from only small region of visual field can progress through the cortical visual hierarchy. So this framework is important for fast selection of small number of interesting image locations which also extends the framework by including guided search which is used to weight the importance of various features so only those processes which have higher value of weight can proceed to the next level and reduce the time for object recognition.

K. Salient region detection by modeling distributions of color and orientation

Gopalakrishnan *et al*[11] presents a saliency region detection method by considering color and orientation which are two important cues of image. It provides integrated approach in which output of color saliency framework and orientation saliency framework are combined together. It considers that low level features at the background have more spread over the entire image than the salient regions. The color saliency model can be obtained by calculating distribution of component colors over entire image space as well as considering their remoteness. And Orientation saliency framework considers the local and global orientations in the image that uses the method of Fourier transform to highlight local patches and finally either color or orientation framework is selected to provide final saliency map based on the correctness of the framework to find out the salient region.

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L. Saliency filters: Contrast based filtering for salient region detection

Perazzi *et al.*[12] introduces a compactness based method for detecting salient region in image As previous contrast based methods generates saliency maps which are generally blurry, and often overemphasize small, purely local features. So given algorithm consists of four basic steps. Firstly this method decomposes given images into homogenous elements that eliminate the parts which are not important and have less chance to be part of salient region and cluster the pixels which have similar properties into one group. After this abstraction element uniqueness and distribution is considered to compute final saliency map. Element uniqueness considers that image

region that stands out different from other portion of image and catches attention can be labeled as to be more salient so in this part it is discovered that how an each element of the image is different from other element or other part of image.

M. A Hybrid of Local and Global Saliencies for Detecting Image Salient Region and Appearance

Qinmu *et al*.[13] presents a visual saliency detection approach, which is a hybrid of local feature-based saliency and global feature-based saliency (simply called local saliency and global saliency, respectively, for short).First, use an automatic selection of smoothing parameter scheme to make the foreground and background of an input image more homogeneous. Then, partition the smoothed image into a set of regions and compute the local saliency by measuring the color and texture dissimilarity in the smoothed regions and the original regions, respectively. Furthermore, we utilize the global color distribution model embedded with color coherence, together with the multiple edge saliency, to yield the global saliency. Finally, combine the local and global saliencies, and utilize the composition information to obtain the final saliency.

III. SYSTEM MODEL

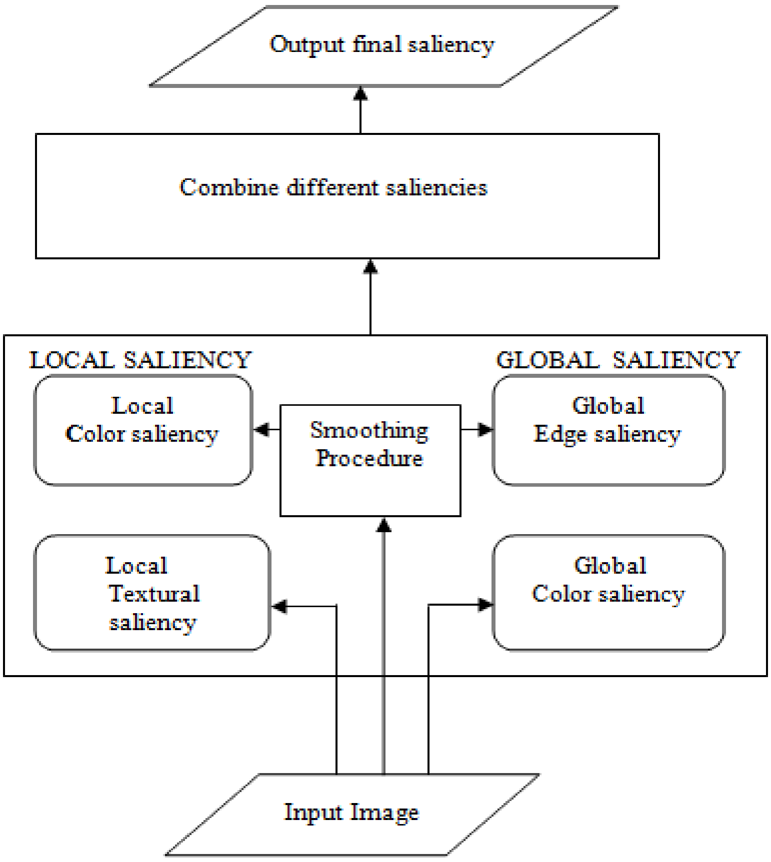

Fig1 .Hybrid of local and global saliencies

The system architecture consist of two phases as shown in Fig.1 .In the first phase input an image and the smoothing is performed for extracting local color saliency and global edge saliency. Then extract local and

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global features for detecting salient region .After that obtain corresponding saliencies. The second phase combines different saliencies and obtain the final saliency. In the following sections present in detail about all the phases.

1. Image Preprocessing

In this section we use an efficient smoothing method based on the mechanism of counting spatial changes. After smoothing foreground is emphasized and background is more homogeneous. Use L_0gradient minimization[14] as smoothing scheme, in this scheme smooth parameter should be pre assigned .

$$min\{\sum_{(x,y)}(I(x,y) - \mathrm{I}(x,y))^2 + \lambda C(I)\} \qquad (1)$$

where $I(x,y)$ denotes image after smoothing on (x,y),whereas $\mathrm{I}(x,y)$ is the original image. Furthermore, $C(I)$.counts the number of pixels, whose gradient magnitude is not zero in I . The smoothing parameter λ is a weight directly controlling the significance of $C(I)$.

First, we convert an RGB image to YUV color space. The Y channel image (brightness) is then split into the blocks of 8×8 pixels. Then discrete cosine transform (DCT) is performed. A quantization matrix is used. Restore the image by the inverse DCT transformation.

2. Detecting Local Saliency

In this section we find out local saliency by using color and texture features.

i. Local Color Saliency

Smooth the image using the first part. Then by utilizing mean shift algorithm [15] we partitioned it into regions r_0,r_1,……..r_k and k is the total regions. Two factors are considered to evaluate saliency locally 1) dissimilarity in image regions 2) spatial distance. We measure the color saliency in RGB color space.$D(r_k,r_i)$ Specifies the difference of region r_k,r_i and it is computed as given below:

$$D(r_k,r_i) = R(r_i)|\overline{u_k - u_\imath}| \qquad (2)$$

where $R(r_i)$ is the ratio between the area of region r_i and the

whole image, u_k and u_i are the mean color in region and (r_k,r_i) respectively. The local color saliency for the region r_k is given as:

$$\mathrm{S}l_c(r_k)=v_1 \,.\sum_{i\neq k} v_2 \,.\, D(r_k,r_i)$$

Where $v_1 = \exp(-\sigma_1 \,.\, \mathrm{Dist}(r_k, I_C))$ (3)

$$v_2 = \exp(-\sigma_2 \,.\, \mathrm{Dist}(r_k, r_i)) \qquad (4)$$

Where v_1 and v_2 are the two weight vectors . I_C is the image centre , and $\mathrm{Dist}(r_k, I_C)$ is spatial distance between r_k and I_C and σ_1=σ_2=0.05. A snapshot of the image saliency result using the proposed local color saliency is illustrated in Fig. 2.

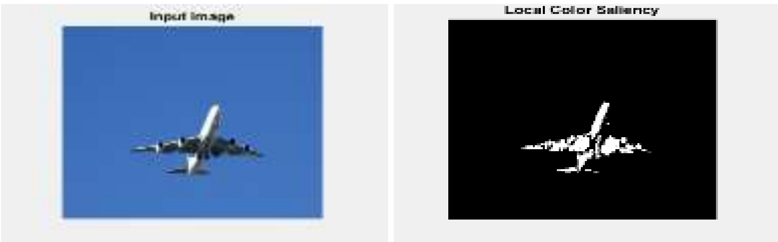

Fig. 2.Local Color Saliency

ii. Local Textural Saliency

As per the theory of HVS(Human Visual System) visual attention is closely related to the arch, corner, and circle .The LBP(Local Binary Pattern)[16] is the most useful texture feature descriptor.LBP is defined as below:

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$$\text{LBP} = \sum_{n=0}^{7} 2^n \cdot \phi(i_n - i_c)$$

Where n runs over the eight neighbors of the center pixel c,i_n and i_c are the gray value , and $\emptyset(\mu)$ is 1 if $\mu \geq 0$ and 0 else. Example of calculating LBP is shown in Fig. 3

example

14	13	12
15	14	11
16	17	18

threshold

1	0	0
1		0
1	1	1

weights

1	2	4
128		8
64	32	16

Patten = 10001111
LBP = 1+16+32+64+128 = 241

Fig. 3 LBP

The image is partitioned into the different regions for the local color saliency detection. The texture dissimilarity is also computed on the regions. Accordingly, the LBP is calculated for pixels in the image (excluding the border pixels). Then, we compute the histograms for the SLBP within each region, i.e., counting the number of each type of SLBP within a region. The local textural saliency is calculated as:

$$Sl_t(r_k)=v_1 \ .\textstyle\sum_{i\neq k} v_2 \ . D(r_k, r_i) \qquad (5)$$

Where v_1 and v_2 are same as in (3), and also $\sigma_1 = \sigma_2$ =0.05. . A snapshot of the image saliency result using the proposed local textural saliency is illustrated in Fig. 4.

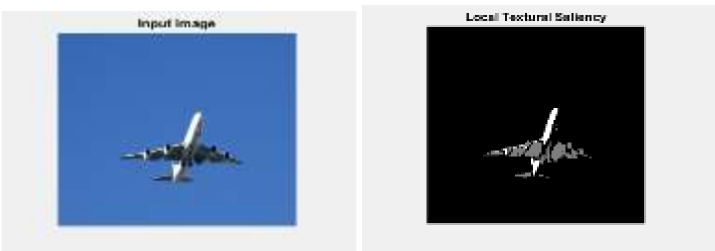

Fig. 4 Local Textural Saliency

3. Detecting Global Saliency

Global saliency find out using color and edge feature.

- ***Global Color Saliency***

Here uses color spatial distribution and color coherence ,it measures color similarity in each blocks. To evaluate it the variance in the two are measured. For that we measure the horizontal and vertical variance .Horizontal variance is given as:

$$V_h(c) = \frac{1}{\Sigma_x p(c|I_x)} \Sigma_x p(c|I_x) \cdot \|x_h - M_h(c)\|^2 \qquad (6)$$

$$M_h(c) = \frac{1}{\Sigma_x p(c|I_x)} \Sigma_x p(c|I_x) \cdot x_h \qquad (7)$$

Where x_h is the *x*-coordinate of pixel *x*. The spatial variance of component *c* is

$$V(c) = V_h(c) + V_v(c) \tag{8}$$

Where V_h(c) is the horizontal variance and V_v(c) is the vertical variance . Then, we normalize *V(c)* to [0, 1]. *H(c)* as the color distribution difference, we define the color coherence as 1−*H(c)*, and *H(c)* is calculated by the following expression:

$$H(c) = \frac{1}{\Sigma_x p(c|I_x)} \Sigma_x p(c|I_x) \nabla (P_{N_x}) \tag{9}$$

where N_x denotes the 8-point neighborhood set of the pixel *x*. The global color saliency S_{gc} is defined as:

$$S_{gc} = \sum_c (1 - V(c))(1 - H(c))\mathcal{D}(c)p(c|I_x) \tag{10}$$

A snapshot of the image saliency result using the proposed global color saliency is illustrated in Fig. 5

Fig. 5 Global Color Saliency

- ***Global Edge Saliency***

Edge is another important visual cue for the image saliency, which has been utilized in the object detection .For finding edge saliency we implement a multilevel smoothing procedure on the image and extract visual edges in the frequency domain. This procedure incorporates the edge cues from the different smooth levels of the image to generate salient edge maps. It is expected that the combination of different edge maps from multiple images at different smoothing levels can alleviate the impact of false saliency caused by noise, and highlight the true saliency existing at each level. Specifically, suppose the images obtained at *m* different levels of smoothing are denoted as $I_1 \ldots\ldots I_m$ where I_m is the smoothest image.

The edge saliency map of image I_i is given as :

$$S(\mathcal{I}_i) = \left| F^{-1}\left\{ A(u,v) \cdot e^{iP(u,v)} \right\} \right|^2 \tag{11}$$

Where $A(u,v) = |F\{\mathcal{I}_i(x,y)\}| * g_1$ is the smoothed amplitude spectrum of *Ii* using a Gaussian filter *g*1 = exp*(*−*(u*2 + *v*2*)/σ* 2*)*, with *σ*2 = 0.05. *P(u, v)* is the phase spectrum of the original image, *F*{·} is the Fourier transform, and *F*−1{·} is the inverse Fourier transform.

The saliency edges obtained from the different smoothing parameters are combined by:

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$$S_{\text{multi}} = \left\{ \frac{1}{m} \sum_{i=1}^{m} \frac{1}{S(\mathcal{I}_i)} \right\}^{-1} \qquad (12)$$

where *S*multi is the merged saliency edge, which provides more robust edge saliency using the multiple smoothing schemes.

A snapshot of the image saliency result using the proposed global edge saliency is illustrated in Fig. 6

Fig. 6 Global Edge Saliency

4. Combination of Different Saliencies

The combination of the saliency map *S*all is expressed as:

$$S_{\text{all}} = \sum_{i=1}^{4} \tilde{w}_i \cdot S_i. \qquad (13)$$

Where $\widetilde{w_i}$ is the weight vector we assigned and *i*

Denotes the four saliencies respectively.

A snapshot of the image saliency result using the proposed final saliency is illustrated in Fig. 7

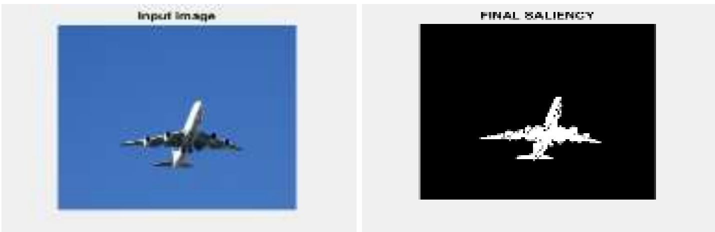

Fig. 7 Final Saliency

IV. RESULTS AND DISCUSSION

Datasets

Dataset is ECSSD, it consist of about 200 images, we perform testing on it.

In this experiment, we performed the saliency detection on the ECSSD dataset .The Precision–Recall curves are plotted in Fig. 8, which shows the results of saliency detection by these different methods.

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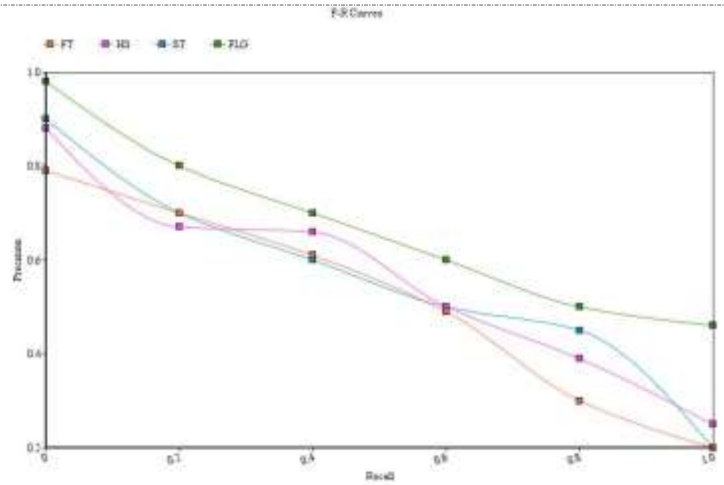

Fig .8 Precision-Recall curve

From this figure, we can see that the proposed method give better performance. Where FT[1],HS[13],ST[5] gives less than that of our FTG method.

Also, Fig. 9 shows the comparison results in terms of Precision, Recall, MAE, and *F*-measure for each method. Actually, it is more difficult to maintain a high *F*-measure on the ECSSD dataset because the images in this dataset are usually with more complicated background that makes the segmentation more challenging

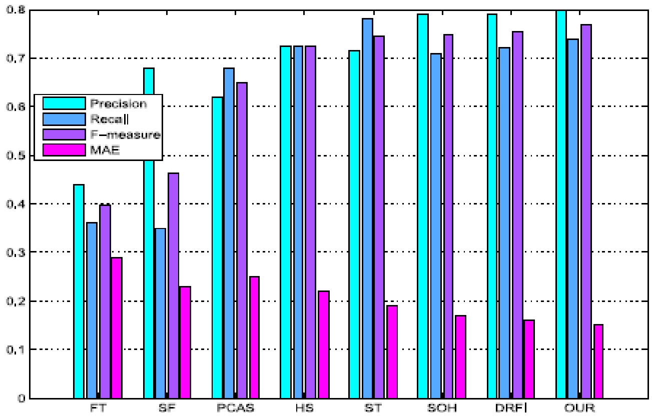

Fig.9 Comparison Results

V. CONCLUSION

In this paper, we have proposed a novel method to detect image saliency by utilizing local and global features. First of all, proposed smooth scheme based on the minimization algorithm to smooth the image, featuring the automatic selection of smoothing parameter. After partitioning image into a set of regions, we compute the local color saliency in the segmented regions, and then estimate the local textural saliency. Furthermore, we have adopted the global color distribution embedded with color coherence, and utilized the multiple salient edge to calculate the global saliency. Subsequently, we combine the local and global saliency, and utilize the composition information to performed so that the final saliency is obtained .According to the performance part we obtain a better saliency result than the previous methods. Also we done our method for saliency detection on video

VI. REFERENCES

[1] R. Achanta, S. Hemami, F. Estrada, and S. Susstrunk. "Frequency-tuned salient region detection". In CVPR, pages 1597–1604, 2009.

[2] J. Harel, C. Koch, and P. Perona. "Graph-based visual Saliency", Advances in neural information processing systems, 19:545, 2007.

[3] X. Hou and L. Zhang. "Saliency detection: A spectral residual Approach", In CVPR, pages 1–8, 2007.

[4] M. M. Cheng, G. X. Zhang, N. J. Mitra, X. L. Huang, and S. M. Hu,"Global contrast based salient region detection," in Proc. IEEE Conf. Comput. Vis. Pattern Recognit., Dec. 2011, pp. 409– 416.

[5] Jianming Zhang, Stan Sclaroff "Saliency detection: a boolean map approach", in Proc. of the IEEE International Conference on Computer Vision (ICCV), 2013.

[6] R. Achanta, F. Estrada, P. Wils, and S. Susstrunk. "Salient region detection and segmentation", In ICVS, pages 66–75. Springer, 2008.

[7] Luca Marchesotti, Claudio Cifarelli and Gabriela Csurka, "A framework for visual saliency detection with applications to image Thumbnailing", IEEE 12th International Conference on Computer Vision (ICCV),2009.

[8] S. Goferman, L. Zelnik-Manor, and A. Tal, "Context-aware saliency detection", In CVPR, pages 2376–2383, 2010.

[9] J. Li, M. D. Levine, X. An, and H. He, "Saliency detection based on frequency and spatial domain analysis," in Proc. Brit. Mach. Vis. Conf., Dundee, U.K., 2011, pp. 1–11.

[10] L. Itti, C. Koch, and E. Niebur, "A model of saliency-based visual attention for rapid scene analysis," IEEE Trans. Pattern Anal. Mach. Intell., vol. 20, no. 11, pp. 1254–1259, Nov. 1998.

[11] V. Gopalakrishnan, Y. Hu, and D. Rajan, "Salient region detection by modeling distributions of color and orientation," IEEE Trans. Multimedia, vol. 11, no. 5, pp. 892–905, Aug. 2009

[12] F. Perazzi, P. Krähenbühl, Y. Pritch, and A. Hornung, "Saliency Filters: Contrast based filtering for salient region detection," in Proc IEEE Conf.Comput. Vis. Pattern Recognit. (CVPR), Providence, RI, USA, 2012,pp.733–740.

[13] Qinmu Peng, Yiu-ming Cheung, , Xinge You, , and Yuan Yan Tang, "A Hybrid of Local and Global Saliencies for Detecting Image Salient Region and Appearance", IEEE Trans.on Systems, Man, and Cybernetics: Systems 2016

[14] L. Xu, C. Lu, Y. Xu, and J. Jia, "Image smoothing via L0 gradient Minimization," ACM Trans. Graph., vol. 30, no. 6, pp. 1–11, 2011.

[15] D. Comaniciu and P. Meer, "Mean shift: A robust approach toward Feature space analysis," IEEE Trans. Pattern Anal. Mach. Intell., vol. 24, no. 5, pp. 603–619, May 2002.

[16] R. Lopes et al. ,"Local fractal and multifractal features for volumic texture characterization," Pattern Recognit., vol. 44, no. 8, pp. 1690–1697, 2011

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