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IJSRNSC

Volume-5, Issue-3, June 2017
Research Paper

Int. J. Sc. Res. in Network Security and Communication

ISSN: 2321-3256

Accelerate Image Reconstruction Using GPU

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Received 18th May 2017, Revised 30th May 2017, Accepted 26th Jun 2017, Online 30th Jun 2017

***Abstract*—** The Region-of-Interest approaches of image processing attempt to assign more bits to ROI's and fewer bits to other regions. The perceptual quality of image degrades as the background image gets distorted. To address the issue, the system generate as hierarchical framework of 3 layers i.e. image search, patch matching and image synthesis (image reconstruction). Compared with existing techniques i.e. ROI, the proposed system achieve better results in terms of Time, Recall, Precision and Fmeasure (Accuracy). The proposed system enhances the speed of reconstruction of reconstruction of image by 5-6% and also increases the accuracy by 8% to 10% than existing approach.

***Keywords*—**Salient Object Detection, Dynamic Region Merging, Image synthesis, Image processing.

I. INTRODUCTION

Importance and necessity of image processing stems from two principal application areas: the first being the Improvement of pictorial information for human interpretation and the second being the processing of a scene data for an autonomous machine perception. The ROI(Region-of-interest) based image coding approaches are used for detection of salient objects in the images which assigns more bits to the ROI and fewer bits to the other regions of the image. The Characteristics of human visual structure (HVS)[1] and the principal of visual attention [2] have been inspired the advances in the field of image processing to achieve pictures perceptual quality. Since ROI approaches focuses on ROI bits, the background images remains blur on performing some operations. To recover the object, the prior techniques used the HEMS approaches to reconstruct the image from blurness. Envlienced by this, in past decade the foevation based picture coding strategy [3] and modified foevation based methodologies [4] and ROI approaches uses JPEG2000 have been proposed to encode pictures to upgrade subjective quality of an image.

To perceive the amazing challenge regions more precisely, the saliency recognition issue has pulled in various investigators for a variety of employments. These models can be associated with gage astounding zones thus for better ROI-based picture coding ready to do finishing more Piece speculation stores than non-ROI-based strategies. Therefore, the striking article careful ROI ID and twisting overhauled bit-portion arranges incite to more profitable picture coding for lower bit-rate cost and upgraded nature of experience. Saliency or ROI-based image coding[5], and progressed piece parcel approaches[7] every now and again result in better visual quality on striking areas while surrendering the quality of establishment ranges in darkening the collectibles.

The main focus of the viewers is assumed to be on object centered image i.e. the focus is on salient object of an image. Hence the issue generated in prior work is the distortion of the background image. The need is to update
The standards of ROI have and recover the image. To reconstruct the image the system refines salient regions along with their background features. On the other hand, we need to give state of focus on the background of the image. To achieve the perceptual quality of an image, the focus should be given to background of image instead of foreground of an image. To make it computationally sensible, system have an inclination to propose a structure that contains of 3 layers, i.e., search relevant image from database, extract similar patches from the image, and distortion optimized image synthesis makes it possible to reconstruct the image. The main contributions of this paper are summarized as follows.

[1] To encode the salient object and quantized background features in the image.

[2] To propose a hierarchical framework; which reconstructs the background image.
[3] To work on parameters like Time, Recall, Precision, Fmeasure (Accuracy).

In this work the main focus is on reconstructing the distorted background of the image. The prior used technique i.e. JPEG2000 utilizes wavelet based coding framework based mostly on implanted square based coding with streamlined truncation. The reconstruction of the background image is done by: Salient Object Detection, Dynamic Region Merging (DRM) and Fusion Algorithm. The Salient Object Detection process will be carried out to detect the Salient object of the image. After detection of the Salient object the Dynamic Region Merging (DRM) process will classify the pixels of image into different cluster which have similar feature and will reconstruct the background image. The similar features of the image are calculated by Nearest Neighbour Graph Algorithm. After the extraction of similar features, the merging of image is done by Average Mean Method.

The remaining parts of the are structured as follows. In Section II, we summarized the related approaches and are shortly described for image coding in Section III. In Section IV, the dataset and the parameters used for the evaluation of results are described. The experimental results are shown in the form of graph and table. Section V concludes the paper.

II. LITERATURE SURVEY

A model of visual attention is proposed based on the concept of selective tuning [1]. It provides solution to the problem of selection of image. Its centred thesis was to optimize the search procedure which was used to optimize the search. But the concept of selective tuning was not feasible. This approach used to take long time for selecting particular image [2].

The algorithm proposed in [3], can detect the objects through the foveation points. It can be done in two ways either by automatic method or by determining foveation points and the question was how to determine the foveation points. But it was difficult to determine the depth of foveation points and hence it lead to congestion situation and the delay. As per research done in [4], the paper represents the biologically motivated algorithm, to select the salient regions of the image. The shortcoming of this method was that the bits required for calculation of salient object are more than the saliency detection algorithm and it is an time consuming process.

The Algorithm JPEG2000 represented in [5] was used to make the mask of the objects. Simple method for generation mask was using rectangular shape mask. But the shortcoming was that the image was not able to mask the object, which left some of the pixels empty by not recovering the image pixels.

The method partial significant bit planed in [6], was used to recover the disturbed image and recovering the saient object of the image. But it lead to some disadvantage that it leaves the background image blur as well as disturbed.

The proposed technology or method as MAXSHIFT method in [7], is based on rearrangement of packet in code stream to place region of interest before background coefficient. It was noticed that during this transmission of packets some of the packets were lost and hence the image left uncovered. The method called as Principal component analysis (PCA), or computing the distinctness between the patches that is to be replaced during construction of image. But this algorithm is not useful in high level synthesis such as face detection and object recognition. Hence it lead to drawback and was not user friendly [9, 10].

The non-metric method for texture synthesis in [11], used to recover the image, but as one pixel at a time only. But the drawback of this method or the disadvantage of this method is that the background image is not reconstructed and hence left the image blurred.

The graph-cut algorithm was applied to image and video synthesis by irregularly copying patches into the output image in [12]. The portion of the patch to copy is decided by graph-cut algorithm with energy minimization. Similar ideas can be applied in the image in painting problem by exploiting the available texture samples within the source image, or from a collection of similar images.

In our work, the background images can reconstructed without any loss of data. These methods can be applied to textures with regular patterns, such as sea textures cropped from photos or videos. In this work, background cannot be recovered with strict fidelity. Using the texture synthesis approach, the aim is exploiting the available prior images and gets a synthetic background for better visual quality.

A framework was proposed in [14] for image compression so that particular or salient object can be constructed, but this was not user friendly. The assistant information as well as selected exemplar can be described and compressed into bit stream in more compact fashion.

In [15] have addressed emerging video compression approaches based on image analysis and compression. But these video compression techniques was not robust and did not reduce the complexity of the algorithm and hence did not provide better perceptual quality. The [16][17]

Describes the technique of Salient Object Detection(SOD), Dynamic Region Merging(DRM) and fusion Method. [18][19]Proposed an approach for image sear for multi model interactive search which will search images on the systems an on mobile devices. It proposed and object recognition model as scalable recognition with vocabulary tree. But in this paper there is no visual structure within the exemplar whereas usability of a system is not improved and object was unable to recognize.[20]Proposed a framework as vocabulary decomposition to reduce the transmission overhead the overhead in the transmission was generally reduced but at very slow rate.

III. THE PROPOSED FRAMEWORK

In this section, the framework of proposed approach is introduced. The proposed approach focus on encoding of salient object and quantized the background features, utilizing hierarchical framework structure to reconstruct the background image from database in a question mindful way. The proposed system focuses on 3 layers: Salient Object Detection, Relevant Image Search from Database and Reconstruction of background image. Let's understand the flow of the system by the block diagram of the system.

The block diagram of the system is given in fig 1. In the proposed framework we focus to encode the Salient object and quantized background features utilizing the hierarchical exemplar-based matching-synthesis (HEMS) system to remake the picture from an outer database in a question mindful way. The object is detected using Saliency Object Detection (SOD) Algorithm [16]. Salient Object is basically

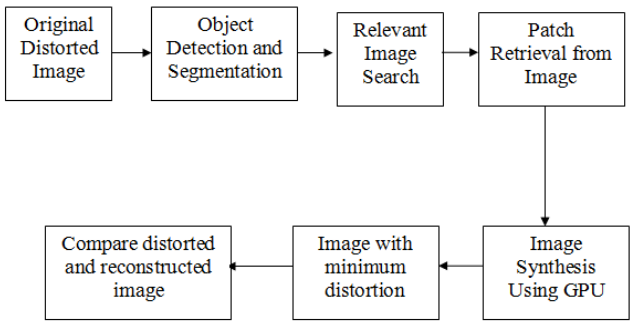

Figure 1. Block Diagram of Proposed System

Image Segmentation partitions a digital image into multiple segments to reveal the similar features among the adjacent areas. By utilizing Saliency Object Detection, the object is distinguished and recreated if the background image is obscure or blur. To address this issue, the proposed system works on background image. A Description is compared with the description of adjacent region, if both are similar, merge them into bigger framework. Otherwise regions are denoted as dissimilar object. Once the division is done, the background is to recover pertinent or relevant picture from the database. The background of the picture which is to be remade is contrasted with every one of the pictures applicable with it. HEMS are utilized to reproduce the background picture. This capacities or the procedure is completed in a parallel fashion in order to minimize the time required for execution. Consequently we get the outcome with least twisting. We can then look at the first distorted picture and the reconstructed picture. The Algorithms utilized are Salient Objects Detection (SOD) Algorithm and Dynamic Region Merging (DRM) Algorithm and Average Fusion Method .In the third layer, we will choose the surface patches for the reconstruct the background of the pictures and last protest is finished. Here we select the most ideal fix surface which will give the best nature of the reproduced picture

A. Salient Objects Detection (SOD)

1) Region Based Contrast (RC): The Humans are very expert at identifying the most visually noticeable or familiar with the foreground objects in the images which are Salient Objects. Salient objects are nothing but the notifiable objects in the images. Except this the main challenging part comes in detecting the image in the background. Salient Object Detection model separates the foreground image from the background image rather than partitioning it into the regions. It is applicable in many fields such as image segmentation, object recognition, image compression and image retrieval.

The regional contrast based salient object extraction algorithm, evaluates international distinction variations and spatial weighted coherence scores. Automatic estimation of salient object regions across pictures, with none previous or knowledge of the contents of the corresponding scenes enhances many computer vision and computer graphics applications [16]. A contrast based method, which separates a large- scale object from its surroundings, is desirable over local contrast based methods producing high saliency values at or near object boundaries [17]. Saliency of a region primarily depends on the contrast of the region with respect to its close regions, while contrasts to distant regions square measure shorter. Region Based Contrast (RC) technique segments the input image into regions and assign saliency value to them. The Saliency value is calculated using contrast score of the image.

This approach acknowledges the relation between image segmentation and saliency detection. It detects the energy of the image or high energy concentrated portion is detected for saliency mapping. In manmade photos, objects are often concentrated towards the inner regions of the

images away from image boundaries. Human pay more attention to image regions with high contrast to surroundings. High contrast to surrounding region is usually stronger evidence to saliency of a region. Firstly the input image is segmented into regions using a graph-based image segmentation method. Then the color histogram for each region is build. For a region r k, the saliency value is calculated by measuring its color contrast to all other regions in the image.

$$S_{rk} = \sum_{rk \neq ri} W_r D_r (r_k, r_i) \quad (1)$$

where $w(r_i)$ is the weight of region r_i and $D_r(:; :)$ is the color distance metric between the two regions. The weight of distances is calculated by the number of pixels in r_i as $w(r_i)$ to emphasize color contrast to bigger regions. The color distance between two regions r_1 and r_2 is,

$$D_{r(r1,r2)} = \sum_{i=1}^{n_1} \sum_{j=1}^{n_2} f(C_1, i)\, f(C_2, j)\, D(c_1 i, c_2 j) \quad (2)$$

where $f(c_k, i)$ is the probability of the i^{th} color c_k ,i among all n_k colors in the k^{th} region $r_{k,k} = \{1, 2\}$. Note that we use the probability of a color in the probability density function (i.e., normalized color histogram) of the region as the weight for this color to further emphasize the color differences between dominant colors.

B. Dynamic Region Merging (DRM)

Image segmentation may be a basic nonetheless still difficult downside in computer vision and image process. In specific, it's an important method for several applications object recognition, target tracking, content-based image retrieval and medical image processing, etc. Typically speaking, the goal of image segmentation is to partition a picture into a particular variety of items that have coherent options (color, texture, etc.) and within the in the meantime to cluster the items along for the convenience of perceiving. In several sensible applications, as an out-sized variety of pictures area unit required to be handled, human interactions concerned within the segmentation method ought to be as less as potential. This makes automatic image segmentation techniques additional appealing. Moreover, the success of the many high-level segmentation techniques (e.g. class-based object segmentation) additionally demands refined automatic segmentation techniques.

There are completely different algorithms to merge the information. DRM is use to finally merge the info because it offers automatic and fine segmentation. A region description is compared with the outline of adjacent region; if both are similar; merge them into a larger region. Otherwise regions are denoted as dissimilar regions. Such regions don't seem to be combining. Merging of adjacent regions can method for all combos of neighboring regions[17]. If a region cannot be merged with any of its neighbors, it is marked final and the merging process stops when all image regions are so marked. This is the last process to merge the above mention regions. This algorithm is conducted like discrete system.

1) Nearest Neighbor Graph (NNG): The Dynamic Region Merging process depends on the adjacency relationship between regions. At each merging step, the edge with minimal weight is required. The edge weights and nodes of Region Adjacency Graph(RAG) are calculated and stored for each layer. Since positions are unknown, the linear search of these nodes and require O(E) time. After each merging at least one of the edges must be removed from RAG, the positions and edges weights are updated. If number of regions to be merged is very large, the total computational cost in DRM Algorithm will be high.

Based on the observation that only a small portion of RAG edges counts for the merging process, we can find an algorithm for accelerating the region merging process. The implementation of the algorithm relies on the structure of nearest neighbor graph (NNG), which is defined as follows: For a given RAG, where G = {V,E }, the NNG is a directed graph $G_m = \{V_m, E_m\}$, where $V_m = V$. If we define a symmetric dissimilarity function S to measure the edge weights, the directed edge is defined as:

$$Em=(V_i, V_j \mid W(V_i, Vj))=min\, S(V_i, V_k)\, (V_j, V_k) \in E \quad (3)$$

C. Fusion Method

Image fusion is the way toward joining applicable data from at least two pictures into a solitary picture. The subsequent picture will be more instructive than any of the information pictures. In remote detecting applications, the expanding accessibility of space borne sensors gives an inspiration for various picture combination calculations. A few circumstances in picture preparing require high spatial and high unearthly determination in a solitary picture. The vast majority of the accessible hardware is not fit for giving such information convincingly. Image fusion systems permit the reconciliation of various data sources. The combined picture can have corresponding spatial and ghostly determination attributes. In any case, the standard picture combination strategies can mutilate the unearthly data of the multi-spectral information while consolidating. In satellite imaging, two sorts of pictures are accessible. The panchromatic picture procured by satellites is transmitted with the most extreme determination accessible and the multi-spectral information are transmitted with coarser determination. This will ordinarily be two or four circumstances lower. At the beneficiary station, the

panchromatic picture is converged with the multi-spectral information to pass on more data.

1) Average Method: In this strategy, the resultant picture is gotten by averaging each comparing pixel inside the information pictures. It's one among the main strategy and direct to know and execute. It functions admirably once pictures to be joined from same kind of gadget and contain added substance commotion. This system is to a great degree keen beyond any doubt enough express cases wherever in the info pictures have Associate in Nursing general high shine and high refinement. However it leads to undesirable aspect impact like reduced distinction and a few noise will simply introduced into the united image, which can cut back the resultant image quality subsequently. The normal esteem is doled out to the comparing pixel of the yield picture which is given in beneath condition.

$$P(i,j)=\{A(i,j) + B(i,j)\} / 2 \quad (4)$$

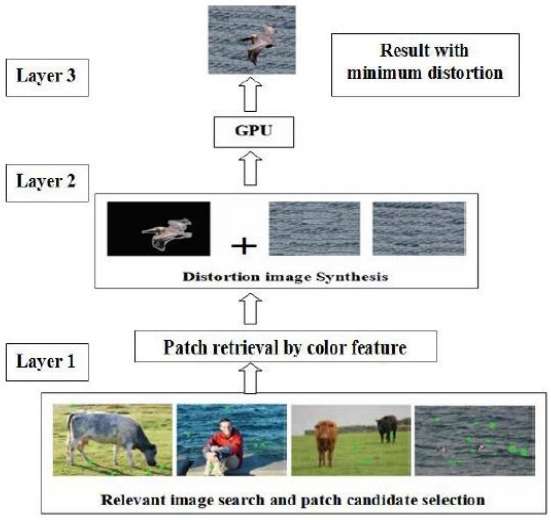

Figure 2 Example of Proposed System

The flow of the system in an example is as shown in fig 1. The first layer of the system has relevancy image seek for the reconstruction of image. Image retrieval has been studied from last twenty years severally[17]. Prior techniques uses code book for each feature descriptor[18]. Theres a code book to each feature descriptor, in order that pictures. The pictures from the databases will be regenerate into the question images. Once the relevant image is searched the patches relevant to the distorted pictures area unit searched. After the search of the images, we tend to then seek for the relevant patches from the information pictures. The images are selected by matching color histogram between the background and candidates patches. Patches are then matched by the colour features to pick out the acceptable candidates. The goal of the second layer is to seek out the foremost similar patches in terms of the minimum color distinction. the color distinction of the purpose *p* of a picture ought to be minimum with the purpose *q*. we'll get some matched patches with the minimum distance because the input to the third layer.

In the third layer, we will select the texture patches for the texture background of the images and final object is done. Here we select the best possible patch texture which will give the best quality of the reconstructed image. So we calculated the minimum distance to find similar patches within the returned images.

D. Mathematical Model

The System can be mathematically defined as a collection of three tuples. S can be written as :

S ={I, O, A}

where
I= Input(set of distorted images).
O= Output(set of Reconstructed images).
A= set of Procedures(SOD, DRM, Fusion method).
where

SOD = Salient Object Detection.
DRM = Dynamic Region Merging.

Input :
X= Get the distorted image $\{x_1, x_2, x_3, \text{———}, x_n\}$

Output :
Y= Get the recovered image $\{y_1, y_2, y_3, \text{———}, y_n\}$

Set of Procedure:

i = set of input images.
S_k = Saliency value.
D_r = Color distance between two regions.
r_1 = region$_1$:
r_2 = region$_2$:

```
SOD()
{
        initialize i;
        do
        S_rk = ∑_{rk ≠ ri} W_r D_r (r_k , r_i)
        while(i >0)
```


calculate color distance between region r_1 & r_2;

$$D_{r(r1,r2)} = \sum_{i=1}^{n1} \sum_{j=1}^{n2} f(C_1, i)\, f(C_2, j)\, D(c_1 i , c_2 j)$$

if($D_r(r_1, r_2)$==min)
generate the boundary of salient object;
}

2. DRM(Dynamic Region Merging)

Input S_i = Segmented Image.
Output = Merged image.

DRM()
{
initialize i;
Set i=0;
For each region in segmentation S_i , calculate the values of neighboring pixels.
Merge the pairs of neighboring regions whose pixel value are minimum, such that segmentation S_{i+1} is constructed.
Go back to step2 until $S_{i+1} = S_i$.
Return S_i .
}

3. Fusion method(Average method)
Input S_i = Distorted image.
Output = Reconstructed image.
S = sum.
P = Merged image.
Average()
{
initialize p;
Consider pixel p=(i,j);
Calculate sum S of all pixels;
$P(i,j)=\{A(i,j) + B(i,j)\} / 2$
}

IV. METHODOLOGY OF EVALUATION

To evaluate the effectiveness of proposed approach the experiments conducted are applied to images for salient object detection, segmentation and image reconstruction of image. In our task we mainly concentrate on Salient object images to reconstruct the background while maintaining the good quality of image. We chose Region Based Contrast and Dynamic Region Merging as baseline algorithm integrated and compared the approaches in serial and parallel.

A. Dataset

A portion of dataset used in the proposed approach was collected from Berkeley.edu dataset for the purpose of Salient Object Detection and Segmentation for high quality output. We further collected dataset from VOC 2007 dataset for the purpose of image reconstruction. The images in the dataset comes from Berkeley and VOC 2007. The Berkeley.edu almost contains 3000 test images for Segmentation and Salient Object Detection. The VOC 2007 dataset is widely used for Image Search and Reconstruction of an image. In our task we choose VOC 2007 dataset from external database, which includes about 5000 test images in total for image search and reconstruction. The total time required on an average for Salient Object Detection and Image reconstruction for single image is between 47.40sec to 61.71sec. Note that Salient object Detection and Segmentation Algorithm are implemented in C++ and GUI is made in Visual Basic 2010. The images used for testing ranges between 86kb to 122kb[9] ranging from low resolution pixels to high resolution pixels.

B. Evaluation Parameters

The evaluation parameters used in the proposed system Time, Accuracy, Precision and Recall. The test images and relevant parameter is show in table and corresponding data size is listed. The time required to calculate the reconstruction of an image is measured in Millisecond. The 3 parameters Accuracy, Precision and Recall is measured in Percentage. We returned the results for 5 images which will be used for the first layer operation. In the second layer, top 5 color matched patches are selected for images for distortion optimization image synthesis in third layer i.e. I=5. The patches are chosen $P=\sqrt{W*H}$ to image size, W is width and H is Height of image and P=0.06 is scale parameter as default in texture synthesis. The search of an image is computationally possible on small number of samples for images.

C. Results and Discussions

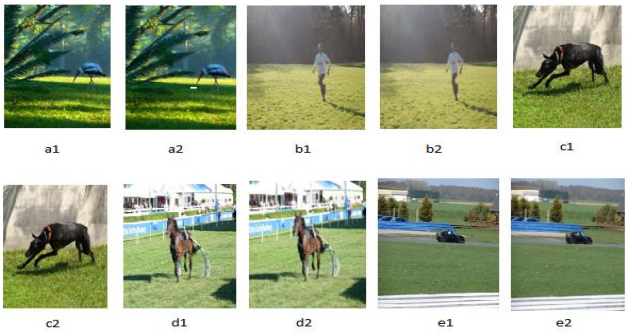

Figure 3 Examples of test images

The results are calculated in tabular format for the given images.

Image no	Time (sec)	Recall (%)	Precision (%)	Accuracy (%)
Image a	47.04	95.54	86.01	91.66
Image b	33.53	97.36	83.01	89.94
Image c	58.20	93.46	85.94	87.89
Image d	61.71	97.77	91.76	94.26
Image e	57.64	97.63	83.49	91.28

Table no 1: TEST IMAGES AND RELEVANT PARAMETERS OF PROPOSED SYSTEM

Image no	Time (sec) Existing(Serial)	Time (sec) Proposed(Parallel)
Image a	67.40	47.40
Image b	53.51	33.53
Image c	78.53	58.20
Image d	81.19	61.71
Image e	67.60	57.64

Table no 2: TEST IMAGES AND RELEVANT PARAMETERS FOR TIME COMPARISON

Image no	Accuracy(%) Existing(Serial)	Accuracy(%) Proposed(Parallel)
Image a	80.66	91.66
Image b	75.94	89.94
Image c	72.89	87.81
Image d	84.26	93.26
Image e	86.28	91.28

Table no 3: TEST IMAGES AND RELEVANT PARAMETERS FOR FMEASURE COMPARISON

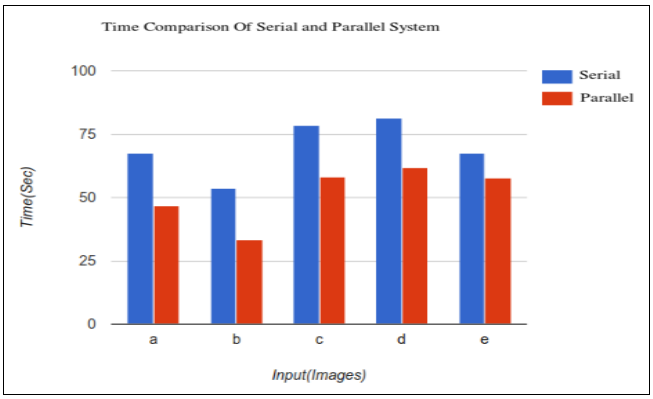

Figure 4 Time comparison of Serial approach and Parallel approach

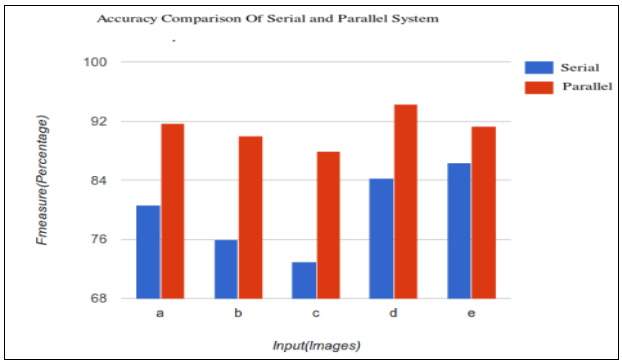

Figure 5 Accuracy(Fmeasure) comparison of Serial approach and Parallel approach

The relevant parameters of the test images are shown in table 1 numbered from image 'a' to image 'e'. The image size ranges from small too big and corresponding results are Accuracy(Fmeasure) of the Salient Object Regions for image quality. The values of Recall, Precision, Accuracy(Fmeasure) are calculated on basis of Percentage. For fair comparison, we have compared out technique with existing technique. We can see that proposed approach shows superior performance in the terms of Time, Recall, Precision and Fmeasure. In fig 4. the bar graph is generated for the parameter Time and in fig 5. the bar graph is generated for parameter Fmeasure. The time required by existing approach is more than the proposed DRM Technique.

V. CONCLUSION

The proposed hierarchical approach offers higher result for proposed system than the ROI approaches or the existing approach. To obtain visually satisfying result for reconstruction of background image, the hierarchical structure consist of 3 layers i.e. relevant image search, patch making and optimized image synthesis. The proposed approach works on 4 parameters such as Time, Recall, Precision and Accuracy (Fmeasure). The results obtained for Time and Accuracy (Fmeasure) is compared. The Time require to reconstruct the image is 5-6% less than the existing approach and the Accuracy (Fmeasure) calculated is 8% to 10% more than the existing approach. Benefiting from the proposed, the future work can be done on Video Reconstructing.

ACKNOWLEDGMENT

I would like to thank all the people who have been supported me and my authors throughout my research work. I would like to express my gratitude towards all my colleges to support me, who has helped me directly or indirectly during the course of work.

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