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An Analysis of Robust Exemplar-Based Inpainting Algorithm Using Region Segmentation and Block Computation

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***Abstract*— An image is 2d rectilinear array of pixel. Now a days Demands on texture synthesis and image restoration of digital images are growing according to population of consumer digital cameras. Nowadays, an important part of scientific and artistic works is stored in form of film and image archive, so image processing becomes a very important task. Image inpainting is filling in damaged or missed regions in an image in an undetectable form. In this paper we propose the robust exemplar based algorithm using block processing .Robust Exemplar-based inpainting methods iteratively search the source region and fill the missing or damaged region, i.e., target region, with the most similar patch in the source region. The proposed method uses block processing to improve the computation time. The proposed can used to increase the speed of image inpainting.**

***Keywords*— Robust Exemplar-based inpainting; Segmentation map; Robust priority function..**

I. INTRODUCTION

Demands on texture synthesis and image restoration of digital images are growing according to population of consumer digital cameras. Inpainting algorithm has been used in various post processing applications. It is helpfully used for restoration of old films and object removal in digital photographs. It is also applied to red-eye correction, hole-filling in depth image based rendering (DIBR), super resolution, compression, and so on. Image inpainting fills the missing or damaged region in an image utilizing spatial information of neighboring region. Exemplar-based inpainting iteratively synthesizes the unknown region, i.e., target region, by the most similar patch in the source region. According to the filling order, the method fills structures in the missing regions using gradient information of neighboring regions. This method is an efficient approach to reconstructing large target regions. Generally, exemplar-based inpainting methods use a fixed patch size and search the whole region of the source region. However, the use of a fixed-size patch can give some drawbacks because exemplar-based methods assume that texture patterns in the source region are distinguishable with appropriate patch size. If the size of each patch is not appropriate to fill the part of a target region, structure and texture information cannot be assigned properly.

For example, if the size of each patch is too large, structure can be incorrectly reconstructed. On the contrary, if the patch is too small, it is too time consuming to synthesize a large region that has similar texture patterns.

Inpainting algorithm using block processing is combined with a parameter selection method of the robust priority functions. The proposed method improves robustness of inpainting results, and increase the processing time.

II. RELATED WORK

Efros and Leung proposed a method that the image gap is filled-in recursively, inwards from the gap boundary: each “empty” pixel P at the boundary is filled with the value of the pixel Q (lying outside the image gap, i.e. Q is a pixel with valid information) such that the neighborhood Ψ(Q) of Q (a square patch centered in Q) is most similar to the (available) neighborhood Ψ (P) of P. But main disadvantage of this algorithm are its computational cost. And selection of neighborhood size. [8]

Drori, D. Cohen-Or, and H. Yeshurun proposed method that takes circular patches around the target region. And adaptive size reflecting structured component are computed. But disadvantage of this method is that the performance is directly depend on the richness of fragment. And it can deal with only 2D images it cannot deal with the 3D images. [6]

A. Criminisi, P. Perez, and K. Toyama proposed that exemplar based inpainting algorithm used. which can changed the filling order from the original “onion-peel" fashion to a priority scheme where empty pixels at the edge of an image object have higher priority than empty pixels on at regions. limitation of this algorithm is that we have to manually select the neighbourhood size. and object with curved body cannot inpaint correctly.[3]

III. PROPOSED IMAGE INPAINTING METHOD

Figure 1 shows the block diagram of proposed method. First the proposed method can take an input image then the target region selection can be done. Then block computation of image can be done ,then robust exemplar inpainting algorithm can simultaneously implemented on each block. And at the end all blocks are fusioned to get an inpainted image.

Region Segmentation

We use a graph-based region segmentation algorithm. An initial graph G = (V, E) is refined as a segmentation map M that provides significant structural information of I, where V represents initial vertex set and E denotes the corresponding set of edges. A segmentation map M is a set of properly refined regions through iterative merging process. In each merging step, components of vertices Ck and Ck+1 are merged into one segment if the difference between two components is smaller than internal difference of two components. First, the segmentation algorithm is used to produce an initial segmentation map. Next, we merge segments in T of the initial segmentation map into one segment and then assign a new label that indicates the target region. The segmentation map in the robust exemplar-based inpainting method performs two functions: as an indicator of T and as selection criteria of patch size and candidate source Regions.

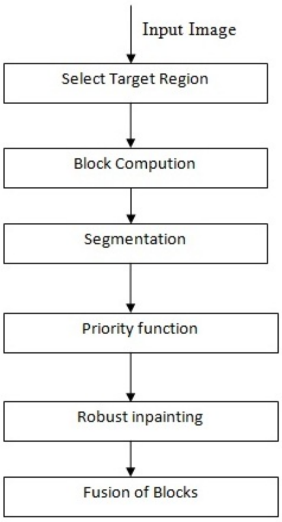
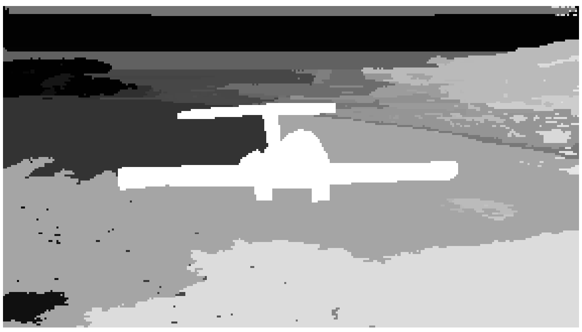


Figure:-1

Figure:-2 Region segmentation result. (a) Original image.



Region segmentation result.(b)Segmentation map of (a).

Parameter selection of robust priority function

Criminisi et al. proposed the priority function P(p) that is defined as the product of confidence term C(p) and data term D(p) [1][13].

P (p) = C(p)D(p) (1)

where p is center pixel of a patch. P(p) can be rapidly decreased when the number of iterations increases due to dropping of the confidence term. The confidence term C(p) is expressed as

$$C(p) = \frac{\sum_{q \in \Psi p \cap S} C(q)}{|\Psi p|} \quad (2)$$

where |Ψp| represents the number of pixels in the patch and initial values of C(p) are defined as

$$C(p) = \begin{cases} 0 & \forall p \in T \\ 1 & \forall p \in S \end{cases} \quad (3)$$

The confidence is determined by the number of pixels that belong to S. It measures the amount of texture information of a target patch. After several iterations of the filling process ,the confidence term induces the dropping effect because confidence values become close to zero. Using the priority function, we can determine the filling order of the target region, which is important to reconstruct structural information. The data term D(p), which is defined as

$$D(p) = \frac{\left| \nabla I_p^{\perp} . n_p \right|}{255} \quad (4)$$

is used to encourage the propagation of linear structure into the target region. A normalization value of 255 is chosen for 8-bit images. We compute directional similarity between the normal component of intensity gradient , $\nabla I_p^{\perp}$ where the superscript ⊥ represents the normal component, and normal vector n_p at pixel p. With the data term, linear structures are synthesized first. However, due to the dropping effect, structural information cannot be adequately assigned to the target region when the confidence is rapidly dropped. Cheng et al. proposed the robust priority function to avoid the dropping effect , which is defined as

$$RP(p) = \alpha . Rc(p) + \beta . D(p), \quad 0 \le \alpha, \beta \le 1, \quad \alpha + \beta = 1 \quad (5)$$

with the regularized confidence term RC(p) expressed as

$$Rc (p) = (1-\omega).C (p) \omega \quad (6)$$

where ω is set to 0.7 and fixed weighting parameters α and β are manually selected by users in Cheng et al.'s algorithm .However, according to the parameter setting of α and β, the inpainting algorithm shows visually varying results. Thus, selection of appropriate parameter values is one of the primary problems to obtain good inpainting results. The proposed method uses DoG values to determine the weighting parameters. DoG is not only robust against noise components but also can enhance edge and detail of images. The data term D(p) in (5) has much influence in propagating structure components. For accurately propagating structure components, we adaptively choose a coefficient β of data term of the robust priority function according to the local image features. Thus, we set β to the average values of the normalized absolute DoG values in each segment, where absolute DoG values are divided by the maximum absolute DoG value for normalization, and α is set to 1–β.

Robust exemplar inpainting

In Robust exemplar inpainting contains two main function first is patch size selection in which if patch is located on boundary of two segment the default window size 9×9 is used. And if patch is located in one segment then maximum 17×17 window size is selected for quality of result. The second function is search for source region as we know image is build according to texture so search area is restricted to neighbouring region.

IV. Result And Comparisions

Here I apply this algorithm to a variety of images, ranging from purely synthetic images to full colour photographs that include complex textures. Where possible, we make side-by-side comparisons to previously proposed methods. The experiment results show that the inpainted images are visually pleasant and computational efficiency is improved using Robust Exemplar-Based Inpainting Using Block Computation Method. It works well for all textured and structured Images and large objects removal.
In this project, I have also tested by dividing the image in four parts for same algorithm i.e. Robust Exemplar- Based inpainting Using Block Computation and check and compare the result of this with not divided the image in Robust Exemplar-Based inpainting Using Region Segmentation. Finally we compare speed and accuracy of a picture using Robust Exemplar-Based Inpainting Using Region Segmentation and Divided image in Robust Exemplar-Based Inpainting. Divided the image in Robust Exemplar-Based Inpainting is a good in computation time and accuracy than Robust Exemplar-Based Inpainting Using Region Segmentation. But Divided the image in Robust Exemplar-Based Inpainting is not good for all type images. It completely fail on synthetic (paint) Images.

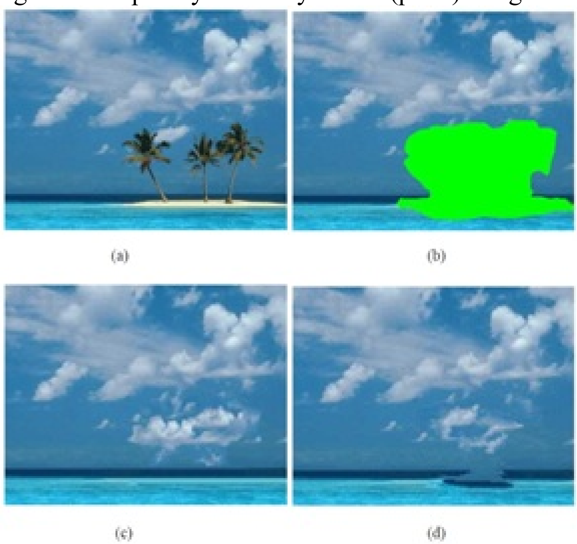


Figure-3

Figure-3(a) shows the original image. Figure-3(b) shows the target region which has to remove. 3(c) Result after removing tress by robust exemplar inpainting by region segmentation method. Required execution time for this is 272790. 3(d) Result after removing tress by robust exemplar inpainting by block computation method. Required execution time for this is 199750. Fig 4 shows the comparision graph for two methods.

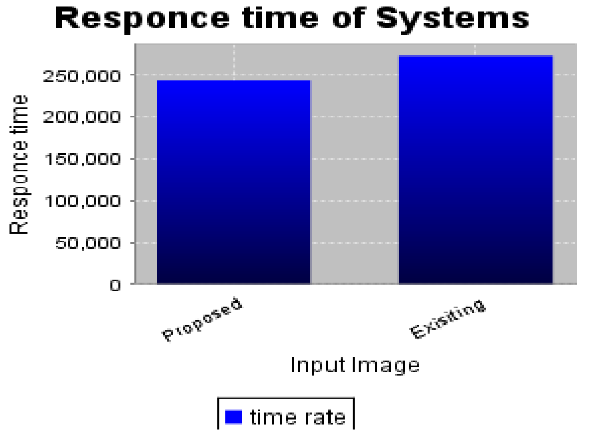


Fig-4 Comparison of two methods

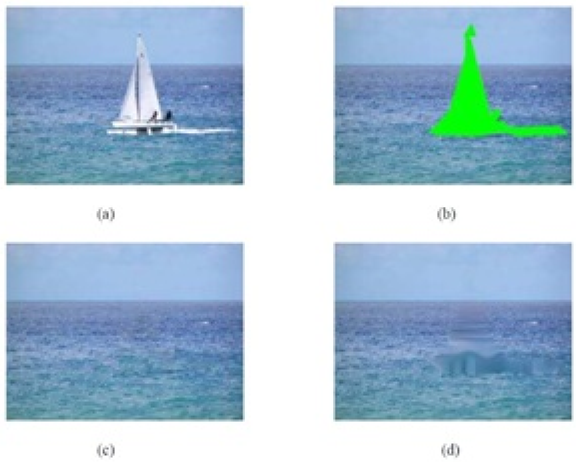


Figure-5

Figure-5(a) shows the original image. Figure-5(b) shows the target region which has to remove. 5(c) Result after removing tress by robust exemplar inpainting by region segmentation method. Required execution time for this is 140541sec. 5(d) Result after removing tress by robust exemplar inpainting by block computation method. Required execution time for this is 128830sec. Fig 6 shows the comparision graph for two methods.

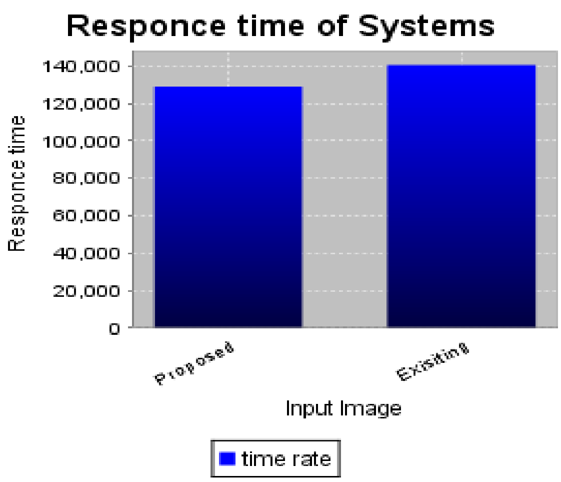


Fig-6 Comparison of Two methods

V. CONCLUSION

We propose a faster and efficient method for robust exemplar-based inpainting method using region block processing. The proposed method use block processing which divide image in to blocks. Then proposed method utilizes structure and texture information using a segmentation map. The structure and texture information are used to determine appropriate patch size and candidate source regions and to automatically select robust parameter values.

With this approach, we can reduce the number of iterations and error propagation caused by incorrect matching of source patch.

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