International Journal For Technological Research In Engineering
Volume 2, Issue 5, January-2015 *ISSN (Online): 2347 - 4718*

EXEMPLAR BASED INPAINTING USING WAVELET TRANSFORM

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Abstract: In the modern world of digitalization peoples are trying to preserve their memories event in the format of pictures. But fact is that as time passes this image may get corrupted. Images are damages due to cracks, noise and it may possible that some unwanted person also came in image. So recovery of this corrupted image becomes the necessary for preserving this image. Inpainting is art of modifying this type of image. Inpainting technique is used to modify this type of image such that recovered image having close resemblance with original image and common observer will find difficulty for identifying difference between damaged image and modified image. In this paper two algorithms of inpainting are combined. Exemplar based inpainting which used to remove object with surrounding information and Progressive image inpainting based on wavelet transform which evaluate the energy of pixels are used for recovering of image. The results provided by this algorithm are more efficient and produce in quick time as compared to other technique.

Keywords: Inpainting, Exemplar, Wavelet transform, time complexity, energy, Isophote.

I. INTRODUCTION

Image inpainting is ancient technique of restoring images. In the museums this technique mostly used to restore images. From the museums this technique is propagated and applied to daily uses of life so that user able to restore the image of real life also. The general process if image inpainting is for recovering the image divided into few steps. In first step user selects the object which user want to remove. Then user finds more promising pixel from the image. This more promising pixel is found from surrounding information available from the image. After finding this patch information is propagated into the image. In last step after propagating the image information from find pixels user gets the recovered image. The image obtained using this algorithm is such accurate that common observer will not able to distinguish between damaged image and recovered image. There are many techniques are developed for recovering of images inpainting. Criminisis provided region filling and object removal technique for removal of object [1-2]. In this technique surrounding information of image is consider for recovering of image based on priority of pixel. For finding the priority of pixel the product of confidence term and data term is found. And after that this pixels are applied to that damaged image to get the recovered image. Disadvantage of this approach is it founds in depth of ambiguities if more than one pixel are came with same priority. Pulkit Goyal et. al. provided approach in which Criminisis approach is used with mean square error metric method [2]. In this approach all steps of Criminisis approach are performed but for finding the maximum accurate patch mean value and variance is considered for getting the maximum accurate patch. Advantage of this technique is user avoids the ambiguities of Criminisis approach. But disadvantage of this approach is it founds difficulty for recovering large size object. Zhang et. al. designed fast and adaptive exemplar based inpainting algorithm in which Criminisis approach is combined with Fourier transform [3]. In this technique to find patch user need to navigate in horizontal directional only. By limiting the search in horizontal user found the patch in less time. The reason behind this user need no to search entire image for finding patch. User searches image in horizontal direction for finding best patch. Disadvantage of this algorithm is that if to find the patch in horizontal direction user need to performed more number of iterations which again increases the time complexity. Chen [4] provided inpainting algorithm based on wavelet transform. In this energy of pixel is considered for recovering of images. Above discussed all algorithms are used for recovering of object. These algorithms are having advantages and disadvantages. These are algorithm worked well for recovering the object but they are lacking in providing efficient result with respect to time factor also. Figure 1 shows the process of inpainting. In this process the person doing the bungee jump is removed from the image. The person is removed with the help of image inpainting process. And image filled with the help of surrounding information. The organization of this paper consists of studying existing exemplar based inpainting in section 2. In section 3 our proposed algorithm is defined. Section 4 consists of experimental result. In section 5 finally we conclude.

Fig.1 Image Inpainting Process

II. EXISTING EMPLAR BASED INPAINTING ALGORITHM

The core of Exemplar based inpainting algorithm is Isophote driven approach. Exemplar based approach used for both propagating linear structure and two dimensional images. The working of this technique is as follow [1]. In this algorithm first user need to select the target region to removed Ω. The source region is defined as entire image minus target region (Φ = I- Ω). Secondly user needs to specify the template window. Default template window size of 9 X 9 pixels is used. But other than this user can use other template window size. This window is of common size. After this step user needs to find the priorities of patches. For finding the priorities user need to consider the strong edges of images. The strong edges of image contents more details as compared to smoother parts. The priority term is product of confidence term C (p) and data term D (p). For the area Ψp centered at point p the priority term is given by following formulae:

$$P(p)=C(p)D(p) \quad (1)$$

Where C (p) and D (p) is given by following formulae:

$$C(p) = \frac{\sum_{q\varepsilon\Psi p \cap (I-\Omega)} C(p)}{|\Psi p|} \quad (2)$$

$$D(p) = \frac{|\Delta Ip\, np|}{\alpha} \quad (3)$$

Where $|\Psi p|$ is area of patch, α is normalization factor, np is unit vector in orthogonal direction with δ Ω.

Next step is propagating texture and structure information here user find patch with maximum accuracy. By using maximum accuracy pixel value user selects accurate patch to propagate into the target region.

$$\Psi q = \arg\min_{\Psi q\, \varepsilon\, \Phi} d(\Psi p, \Psi p) \quad (4)$$

In the last step after propagating the patch confidence value need to be updated. For updating confidence value following formulae is considered.

$$C(q) = C(p) \quad \forall \varepsilon\, \Psi p \cap \Omega \quad (5)$$

In this way this algorithm is worked for the inpainting of images.

III. OUR PROPOSED ALGORITHM

In this proposed algorithm exemplar based inpainting is combined with wavelet transform. In this algorithm all the steps of exemplar based inpainting are performed, first user selects the target region form the image to be removed. Then patch size is selected. After that confidence value is found. After finding maximum value user need to insert that information into the image. And in last step confidence value is updated. But disadvantage of this technique is that, it doesn't work for large scale images and also founds itself in ambiguities. For avoiding this we combine the approach of exemplar with wavelet transform. Wavelet transform evaluate the energy of pixel value.

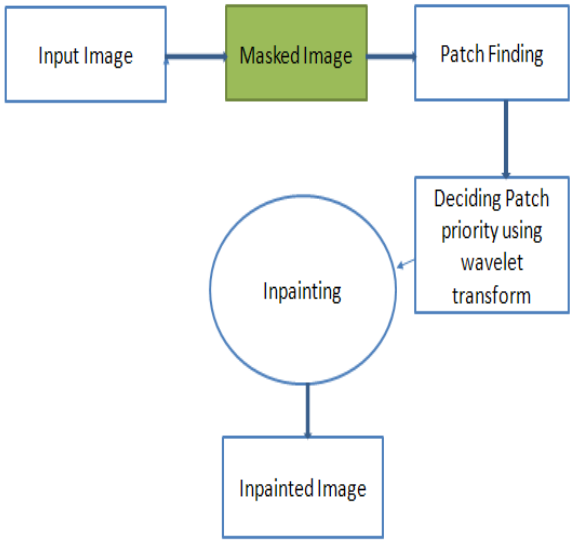


Fig 2 Block diagram of proposed algorithm

Figure 2 shows the working of our proposed algorithm after inputting the image and finding the target region user finds the priority of pixel. In the step of finding the priority of pixel we also evaluate the energy of that pixel. In the equation 1 were we find the priority of pixel we applied the wavelet transform. Wavelet transforms the pixel into high, medium, low frequency components. After finding this frequency components summation of energy coefficient is take place in vertical, horizontal and vertical direction. Means by using mathematical model the necessary computations are done. After applying this mathematical equation optimization need to be done where need to find more promising patch of the image which provides the maximum accuracy. Then integration is applied on that method to get recovered image with no single pixels damaged. After completing this process the final inpainted image will get by using exemplar based inpainting using wavelet transform.

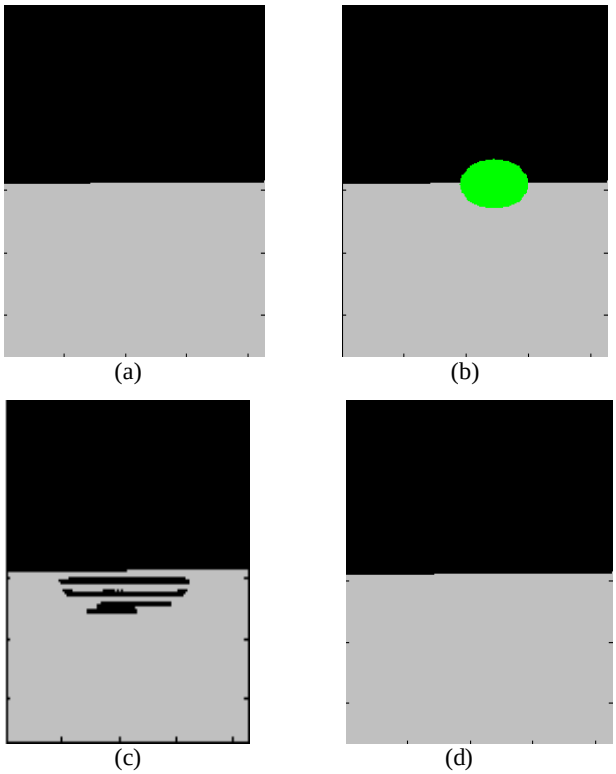
$$CEtotal = CV2\,LH + CV2HL + CV2HH \quad (6)$$

Above defined equation is used to evaluate the total energy of pixel. Maximum energy specifies the maximum accuracy. It indicates that the energy is directly proportional to accuracy of image. If we found more than one pixel with same energy in that case distance dependant criterion is used. The pixel which is at nearest distance is used to complete the image. After finding the maximum accurate image pixel it applied to image for restoring purpose. In this way equation 1 and equation 6 combine to get maximum accurate image.

IV. EXPERIMENTAL RESULTS

By combining these two techniques we get accurate result in timely manner. If we compare the time complexity with other approaches then it is observed that for 240 X 180 size images on 1.6 GHz PC processor requires around 91 to 228 seconds approximately which is typical computation time. By using our proposed algorithm we can reduce time for completition of image for 240 X 180 size image from 20 to 130 seconds.

Comparison with Criminisis:



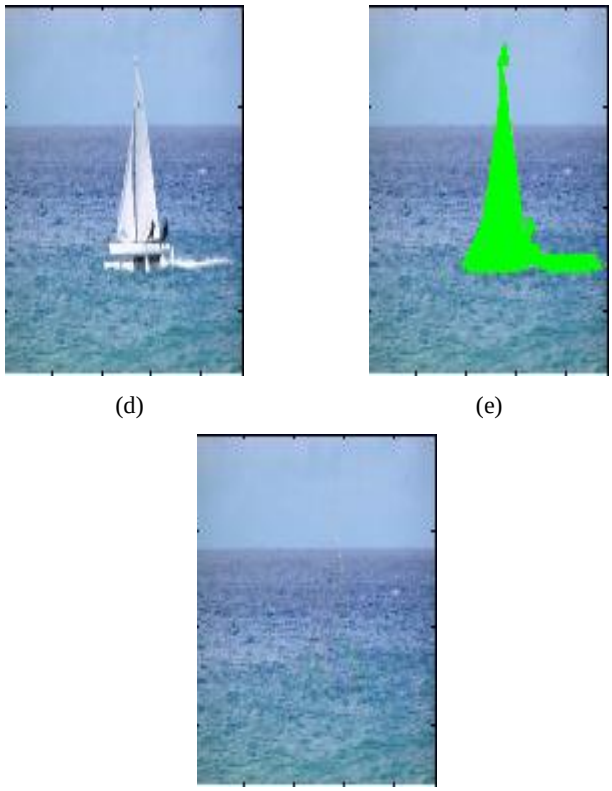
(a) (b) (c) (d)

Fig 3 Comparison with Criminisis approach: (a) original image (b) masked image (c) result using Criminisis (d) result using proposed algorithm

As shown in figure 3 we compared our technique with Criminisis approach. Figure 3 (a) is used as input image. Figure 3(b) is marked with target region. 3(c) shows the result obtained using Criminisis approach. It is easily observed that result obtained using Criminisis consist of blur type result. And 3(d) shows the result obtained using proposed algorithm. Result obtained using our technique is more accurate than Criminisis approach. No blurring type result is occurred with our algorithm.

Real Time Example:

(a) (b) (c)



(d) (e) (f)

Fig 4 Examples of image Inpainting (a, d) input image (b, e) masked image (c, f) output image after object removal

Figure 4 shows some real time examples of removing object from image. 4(a, d) consist of input image, (a) consist of person stands in front of waterfall and (d) consist of ship in the river. 4(b, e) consist of masked image. In which person in front of waterfall is masked and ship is masked in another image respectively. Final images 4(c, f) consist of output image in which person is completely removed in front of waterfall and ship is removed from the river. Larger objects are easily removed with help of this technique. The time required for completition of inpainting algorithm is lesser as compared to other inpainting process. Fragment based approach [6] requires 4980 to 9480 seconds to complete the image in inpainting process. Criminisis algorithm requires 11223 to 61286 seconds. Our proposed techniques require around 22 to 128 seconds for completition of image with help of inpainting algorithm. By using wavelet transform along with Criminisis approach able to reduce time required for completition of images with maximum accuracy.

V. CONCLUSION

In this paper two different techniques are combined. Criminisis approach and wavelet transform combine together for providing the efficient results. Criminisis approach used to remove object but it has several disadvantages. Wavelet transform provides adaptive method for searching the patch from surrounding information. Wavelet transform used to update confidence value with maximum efficiency. Exemplar based approach works for simple structure and objects. If images with complex textures are come then efficiency of image decreased. Wavelet transform is capable

of producing good result in less time as compared to other approaches. Larger objects are removed with maximum accuracy. Exemplar based inpainting using wavelet transform good result with respect to time and pleasant result is produced with respective time.

REFERENCES

[1] A. Criminisi, P. Perez, and K. Toyama, "Region filling and object removable exemplar- based image inpainting', IEEE Trans. Image Process., vol. 13, pp. 1200– 1212, 2004.
[2] Criminisi, P. Peres and K. Toyama, "Object removal by exemplar-based inpainting", Proceedings of the 2003 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'03).
[3] Anupam, Pulkit Goyal, Sapana Diwakar, "Fast and enhanced algorithm for exemplar based inpainting", Fourth Pacific-Rim Symposium on Image and Video Technology, 2010.
[4] Zhang Hongying, Jin Yuhong, Wu Yadong "Image Completion by a Fast and Adaptive Exemplar-Based Image Inpainting" International Conference on Computer Application and System Modeling, 2010.
[5] Yen–Liang Chen, "Progressive image inpainting based on wavelet transform", IEICE Trans, Fundamental VOL.E88-A No.10 October 2005.
[6] Iddo, C. O. Daniel, and Y. Hezy, "Fragment Based Image Completion," ACM Transactions on Graphics, 2003, 22(3) 303-312.

