International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org
Volume 4, Issue 5(1), September - October 2015 ISSN 2278-6856

Spatial domain image fusion using adaptive cross filtering

Snehal Sakharam Sanap[1] , Lohiya Govindkumar Balkisan [2]

[1]M.E. student, DMCE, Mumbai University, India

[2]Assistant Professor, DMCE, Mumbai university, India

Abstract

We present an algorithm for multifocus image fusion in spatial domain using adaptive cross filtering. The basic idea is to extract the edge information from the source images and then segment the source images into blocks using the soft blending technique instead of splitting them in to simple fixed size blocks. The differences between the average edge information from both the source images is computed and the mean of these differences is set as the threshold. Only those blocks for which the difference exceeds the threshold are chosen and incorporated into the final fused image. A further enhancement is achieved by making this process iterative. In every next iteration, the image is divided adaptively such that each block is subdivided in four parts to the divisions used in the last iteration. Also the number of iterations is varied as per size of image. The performance of this method has been tested on many pairs of multifocus images shows improved results when in comparison with existing methods.

Keywords: Image fusion, Multifocus images, Spatial domain, Edge extraction, Cross filtering

1. INTRODUCTION

An image a graphical representation of the external form of a thing in 2D. It is a photograph taken by a camera of a smartphones. The problem with the images taken with such cameras is that, the focus of the image is concentrated only at a particular region of the image because of its single objective and limited depth of field. We cannot get the desired focused information from a single image captured by our phone camera [1]. If all the objects of the image be in focus called “all in focus” images cannot be obtained from these devices used nowadays. Fig. 1 shows multi-focused image taken from smartphone. From many years image fusion finds an attractive applications in the field of biomedical [2], where it is used to fuse the CT scan images with the MRI scan images [3]. These scans individually do not give significant details, but when fused, generate extra amount of information. Fusing these two scans provide us with crucial information of the location of a tumor in a particular part of the brain. Image fusion is the technique in which multiple images are combined to form a single image. This single fused image provides more information than the source images. Multifocus images are obtained generally when a photo is clicked for the objects which are at a distance from each other and the focal length of the camera can focus one.

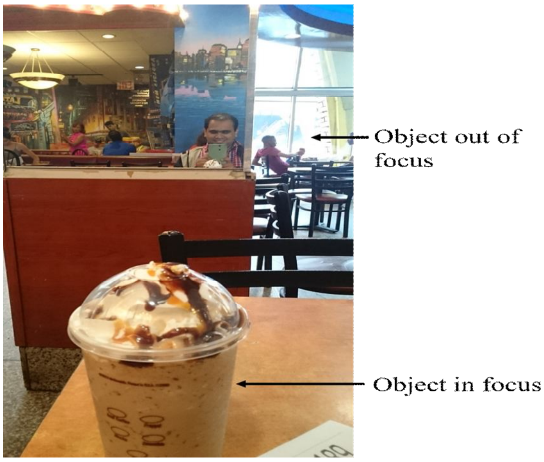

Figure 1 Multi-focused **i**mage taken from smartphone

This problem becomes even more significant while taking satellite images because there could be a layer of clouds overlooking the earth. Fig. 2a and 2b are examples of multi-focus images.

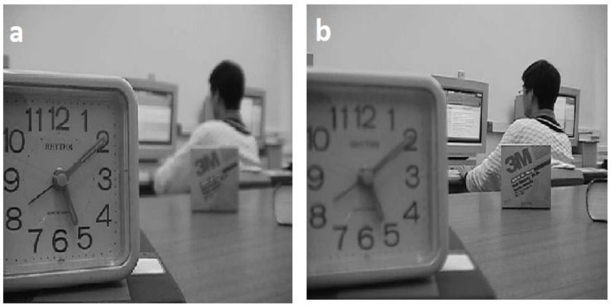

Figure 2 a) Image with foreground in focus. b) Image with background in focus

There are two methods in which image fusion can be carried out namely 1) spatial domain image fusion and 2) spectral domain image fusion. In spatial domain image fusion, the source images are divided in spatial domain and then considered for the fusion process. In spectral domain fusion, frequency of the images is extracted. The most popular method of image fusion used is wavelet transform. In this method, even images of high resolution and low resolution can be merged by decomposing into components called wavelet components. The low resolution DC components are padded up with the high resolution images to get focused images. Our algorithm uses the spatial domain image fusion because of its high speed and no complex components are encountered. In this paper, we have proposed an algorithm which fuses multi-focus images in spatial domain to give a smoothly fused final image.

2.LITERATURE REVIEW

Image fusion can be as easy as taking pixel-by-pixel average of the two source images, but that often leads to undesirable side effects such as reduced contrast. Fusion can broadly be classified as, fusion in frequency domain and in spatial domain [4]. It can be implemented using various fusion rules such as 'mean' or 'max' where fused coefficient is average or maximum value of the source pixel coefficients respectively [5]. One can also take 'weighted average' instead of simple average, where fused coefficient is weighted average [5-6] of source coefficients. Analogous to other forms of information fusion, image fusion can be usually performed at any of the three processing levels, which are signal, feature and decision. Signal-level image fusion [7], also known as pixel-level image fusion, defines the process of fusing visual information associated with each pixel from a number of registered images into a single fused image, representing a fusion at lowest level. As the pixel-level fusion [8] is part of the much broader. Subject of multi-focus and multi-sensor image fusion has attracted many researchers in the last two decades. In the last two decades, a lot of research has been carried out in the area of multi-focus and multi-spectral image fusion [7]. Multi-spectral image fusion based on intensity, hue saturation method and that based on Laplacian pyramid mergers. The multi-focus image fusion proposed by Haeberli et.al. uses the fact that the focused area of the image will have highest intensity compared to that of unfocused areas.

3. METHODOLOGY

Image fusion is the process of merging two or more photos with different objects in focus as shown in Fig. 3a and 3b. Image fusion gives a fused image which provides more information than both images combined.
In this paper we have used the canny edge detector outputs are as shown in Fig. 4a and 4b. Basic idea is to detect at the zero crossings of the second directional derivative of the smoothed image in the direction of the gradient where the gradient magnitude of the smoothed image being greater than some threshold depending on image statistics. After extracting the edge information, the source images are divided into a fixed number of blocks. The images were divided into 4 blocks. Next, the edge information obtained from the two source images are compared and the image block with higher edge activities are selected to be part of the fused image. However, that the certain blocks extracted from different source images might contain almost similar number of edges and thus the selection procedure for such blocks was by default first image.

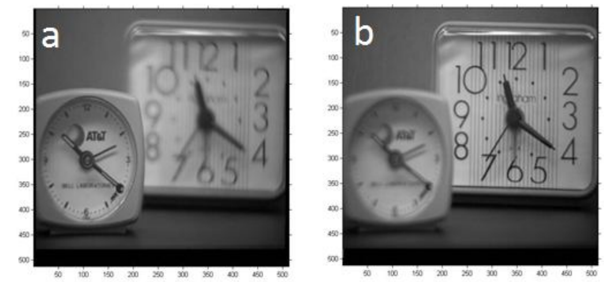

Figure 3 a) Image with foreground in focus. b) Image with background in focus

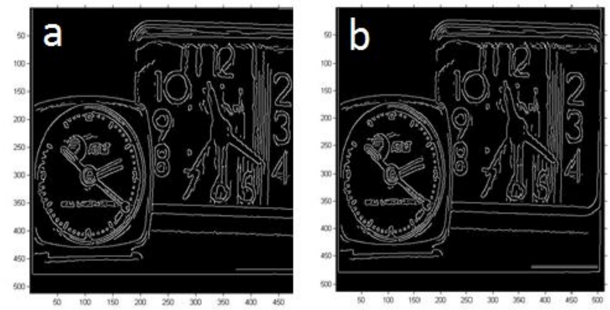

Figure 4 Canny edge detector output for a) Image with foreground in focus. b) Image with background in focus

In this algorithm, selection is made in three iterations described as follows:
Firstly, the source images are divided into a certain number of blocks. Then, the difference between edge information from the two source images is computed for each block. Next, the mean of all these differences is calculated and set as the threshold (T). Now, the differences are compared with this threshold T and only those blocks for which the difference exceeds the threshold are chosen and incorporated into the final fused image from their corresponding source image. The rest of the blocks are passed on to the next iteration. In the second iteration, the mean of the differences of the regions passed over from the last iteration is calculated and set as the new threshold. Once again, the difference between the averages of the number of edges for corresponding image block from different source images, is compared with the threshold, and if the difference is higher than the threshold then the respective block with higher edge information is incorporated into the fused image.
In the third iteration, cross filtering is used in which first image is passed through low pass filtering algorithm to extract edges and high frequency components of image. This components are then subtracted from second image to extract missing details. This entire process of extracting information about other image is called cross filtering. The lower missing information block is substituted in final fused image.

4. RESULTS AND DISCUSSIONS

The following images show the results obtained after running our algorithm. As seen in the Fig. 4a and 4b, the canny edge detection of the image having background in focus shows more edges on the background clock and the canny edge detection of the image having foreground in focus shows more edges in the clock present in the foreground.

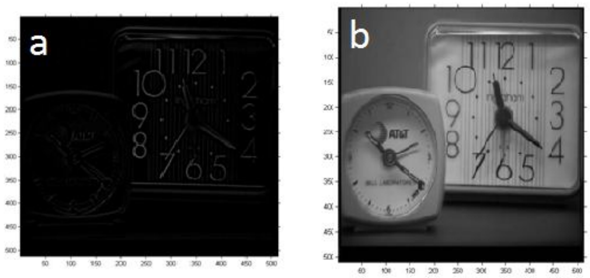

Figure 5 Output for a) Cross filtering. b) final image fusion with cross filtering.

Fig. 5a represents the output obtained after performing the cross filtering operation. Fig. 5b represents the final fused image output.

5. Conclusions

The results show that the proposed technique is suitable for image fusion of multi-focus images even when processed in spatial domain [6]. The addition of cross filtering produces smoothens the final image. In addition, the proposed method also yield excellent clarity and edge preservation along with increase in mutual information and correlation, hence giving better visual quality at the final output.

Acknowledgement

Authors would like to thank Dr. Pete Dnyandeo for the in valuable guidance. We would also like to thank our principal Sudhirkumar D. Sawarkar for encouragement and all the staff members of DMCE for their support and infrastructure.

References

[1] Haeberli, Paul. "System and method of cropping an image." U.S. Patent No. 6,587,596. 1 Jul. 2003.
[2] Shah, Parul, Shabbir N. Merchant, and Uday B. Desai. "An efficient spatial domain fusion scheme for multifocus images using statistical properties of neighborhood." Multimedia and Expo (ICME), 2011 IEEE International Conference on. IEEE, 2011.
[3] Xiao-Bo, Qu, et al. "Image fusion algorithm based on spatial frequency-motivated pulse coupled neural networks in nonsubsampled contourlet transform domain." Acta Automatica Sinica 34.12 (2008): 1508-1514.
[4] Wang, Zhijun, et al. "A comparative analysis of image fusion methods." Geoscience and Remote Sensing, IEEE Transactions on 43.6 (2005): 1391-1402.
[5] Mehendale, Ninad Dileep, and Snehal Ajit Shah. "Programmable chemical reactions." Communication, Information & Computing Technology (ICCICT), 2015 International Conference on. IEEE, 2015.
[6] Chauhan, Nupur Dinesh, and Manish N. Tibdewal. "Image Fusion using Discrete Wavelets Transform." (2014).
[7] Shah, Ankit, and Ninad Mehendale. "Decrypted Stegnography." International Journal of Scientific & Engineering Research 4 (2013): 1154-1156.
[8] Mehendale N. and Shah S. "Image Fusion Using Adaptive Thresholding and Cross Filtering." IEEE International Conference on Communication and Signal Processing-ICCSP' 4 (2015)
[9] Goshtasby, A. Ardeshir, and Stavri Nikolov. "Image fusion: advances in the state of the art." Information Fusion 8.2 (2007): 114-118.

AUTHORS

Sakharam Sanap received the B.E. and Currently pursuing her Masters of Engineering from university of Mumbai.

Lohiya Govindkumar Balkisan received the M.E. degrees in Electronics Engineering. Currently working as Assistant professor in the department of Electronics engineering at DMCE College Mumbai University Having overall experience of more than 19 years of teaching.