

FPGA Based Multifocus Image Fusion using Variance Method

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Abstract: *In image processing, Image fusion is very interested area. Nowadays image fusion is broadly used in satellite area, military area. Image fusion generates a new composite image of two or multiple images of same scene. The composite image has more suitable for human visual perception. The resultant (composite) image improves the quality of information. This paper presents spatial domain image fusion. A pixel level image fusion method is employed and implemented using field programmable gate array. This work incorporates fusion technique that is variance method. Different parameters of fused image are calculated using MATLAB.*

Keywords: FPGA, spatial domain, MATLAB, multifocus images.

1. INTRODUCTION

Image fusion is one of the interested fields of image processing in which two or more images are fused to create one image in that all the objects are focused. The resultant image has more information than any one of input image. The everywhere focusing image contains more information than those of focused one object [1]. These images are very useful in digital imaging, microscopic imaging, computer vision, remote sensing and robotics [1]. Multifocus images are captured from the different focal distances that images are used as input images. Sometimes that images shows the half objects blurred and half objects cleared. To solve this problem, image fusion is used. Fusion process creates one relevant image from input image. There are different processing levels like pixel level, feature level and block level. Pixel level processing is basic level. This level is used to merging of measured physical parameter. The fused image is generated by a set of pixel and that contains more information. In Feature level processing, input images segmented into different regions and then calculate features of those regions. Block level processing allows high level information based on the output of individual images.

Paper presents pixel level fusion process. Fused image is created from the more multifocus images. Input images are read by using the software MATLAB and then processing of fusing images is done on the FPGA using Arduino platform with c code.

Output or fused image is generated in the MATLAB code. Different parameters of the fused image are calculated in MATLAB.

2. RELATED WORK

Image fusion has many techniques like spatial domain and transform domain.

Mingjing Li and Yubing Dong propose Simple averaging technique used in spatial domain. Pixel level fusion processing is used in simple average method [2]. Anita, Moses propose Select minimum/maximum technique also spatial domain. In this method select the pixel of maximum or minimum intensity and put it as a output for fused image[3]. Sunil Kumar Pattanaik and K. K. Mahapatra propose a lossless image compression technique and implement it on FPGA[4]. Firouz Abdullah Al-Wassai, N.V. Kalyankar, Ali A. Al-Zuky propose Intensity Hue saturation technique which is based on RGB-HIS conversion model[5]. In 2008, Vijay P. Shah, Nicolas H. Younan, propose Principle Composite Analysis used to reduce multidimensional dataset into lower dimensions for analysis[6]. Simrandeep Singh, Narwant Singh Grewal, Harbinder Singh propose Gaussian Pyramids and Laplacian Pyramids [7]. P. Phanindra, J. Chinna Babu, V. Usha Shree proposes a system implementation on FPGA using technique DWT image fusion[8]. Abhijeet Nimbalkar and R. Sathyanarayana propose fusion of medical images using discrete wavelet transform implementation on FPGA using MATLAB and VB[9].

3. PROPOSED METHOD

There are many methods of image fusion in spatial domain. In this paper variance method is used to fuse the two images. The variance method is based on or works on the pixel level processing. That fused image contains more information than two source images. This method used for the multifocus images. In the variance method, firstly two source images are splitted into the 3*3 matrix subimages. This matrix has 9 pixels. The index of center pixel (5th) is compared with the other neighboring pixel index. Then take the addition of all the differences of that 3*3 matrix. As like this way, calculate the sum of difference of second image 3*3 subimages. Then compared that both sum and select the maximum sum for every matrix.

In this way whole images are processed in FPGA. And the maximum variance is selected for fused image. This fused image then sends to PC serially. And that fused image read by using MATLAB and calculated the different parameters of fused image. Fused image enhance the PSNR ratio.

The fig. 1 shows a block diagram of system. This system use a PC and FPGA hardware as well as MATLAB and Pipllio Arduino C softwares. The matlab code is used to read or select the image from PC. Then this PC is connected to FPGA board via serial port which is inbuilt on the FPGA board.

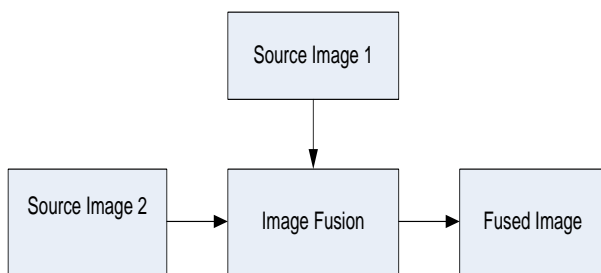


Fig. 1 Block Diagram

4. METHODOLOGY

Step 1: the input or source images read in MATLAB and RGB to Gray conversion is done. Those images are splitted into 3*3 matrix subimages.

Step 2: those subimages send to FPGA serially by using serial port and baud rate 9600.

Step 3: calculate variance for each subimage using c code. And select maximum variance subimage for resultant image.

Step 4: all the resultant 3*3 subimages are sending serially to PC. And in MATLAB fused image is displayed.

Image Parameters:

The image fusion process has general requirement is that it should preserve all information from source images. Therefore in this paper, the different performance parameters are calculated using MATLAB software. The different parameters are SSIM, MAE, PSNR, BER, average gradient, entropy and image quality etc.

- 1) Structural Similarity (SSIM): it measures similarity between the images.
- 2) Mean Absolute Error (MAE): Mean absolute error measures average difference between source image and fused image.
- 3) Peak Signal to Noise Ratio (PSNR): It is maximum ratio of power of signal.
- 4) Bit Error Rate (BER): the number of bit error per unit time.

5) Average Gradient: it gives mean value of image gradient. Image gradient is change in intensity of image. It is used to extract information from source images.

6) Shannon Entropy: it is average value of the information contained in image.

7) Image Quality: it measures the received image degradation means output image is compared with original image.

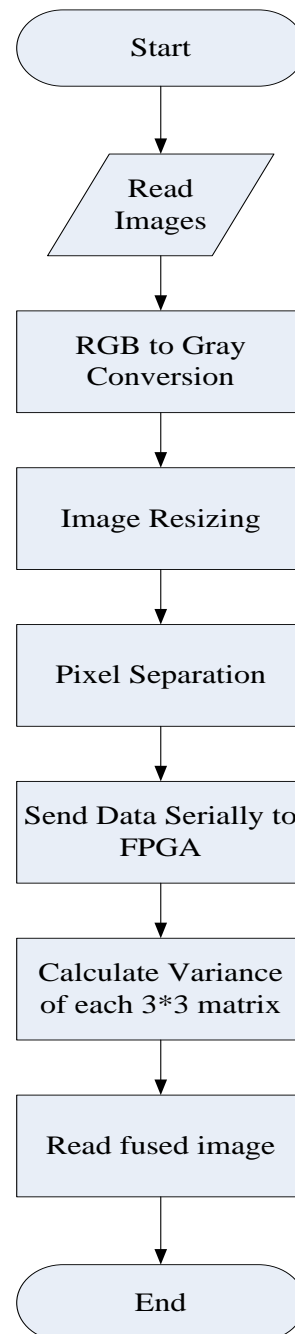


Fig.2 Flow Chart

5. RESULT

The variance method is used to image fusion. The fig. 3 shows left focused image and fig.4 shows right focused image. By using proposed method the fused image of these both images is shown in fig.5. The fused image parameters also calculated.



Fig.3 "Left focused image"



Fig.4 "Right focused image"



Fig.5 "Fused image"

The table 1 shows the parameter values which are calculated in MATLAB for fused image. Table 2 shows parameter values of fused images and source images and compare that values for showing fused image has better parameters than source images.

TABLE 1: PARAMETER VALUES CALCULATED USING MATLAB

Parameter	BER	PSNR	MSE	SSIM
Values	0.053	89.351	8.2303	0.9361

TABLE 2: PARAMETER VALUES CALCULATED BY USING MATLAB

Parameter	Avg. Gradient	edge Intensity	Shannon entropy
Fused image	10.058	94.8324	7.0529
Left focused image	5.34	47.006	7.006
Right focused image	4.575	53.5572	6.9591

6. CONCLUSION

In this paper, the image fusion hardware implementation has been presented for digital camera images, multifocus images. The variance method is spatial domain image fusion method. This method has high PSNR. Average gradient, edge intensity and Shannon entropy parameters are calculated for fused fusion, left focused image and right focused image. These parameter values for fused image are better as compared with input images. The hardware implementation is based on FPGA technology which provides fast, compact and low power consumption for image fusion.

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