MAT JOURNALS

Journal of VLSI Design and Signal Processing
Volume 4 Issue 3

Demosaicking of Color Image Using Residual Interpolation

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DOI: *http://doi.org/10.5281/zenodo.1622997*

Abstract

Demosaicking of color image by residual interpolation aims at reconstructing a full color image from the unfinished color sample output of a picture device. Because of the high value and maintenance, most of the colour device cameras are organized with CFA (Color Filter Array), it produces the mosaicked image. The colour filter array accommodates 3 primary colours red inexperienced and blue and it samples just one color element at every picture element location. The method of estimating the opposite 2 missing color parts at every picture element location is understood as demosaicking. The planned algorithmic program uses the foremost wide accepted technique, residual interpolation for image demosaicking. This technique involves generating the tentative estimates of red and blue pictures and conniving their residuals, that are the distinction between the determined and tentatively calculable picture element values. This technique produces higher correct results. Then the reconstructed image is evaluated to seek out the performance.

Index Terms: *Demosaicking, color filter array, residual interpolation.*

INTRODUCTION

Color filter array(CFA) plays a major role in capturing digital images. Images obtained using CFA involves only one color value at each pixel location the other values are interpolated using a technique called demosaicking. Better performance can be achieved only by using high quality images which can be achieved using different types of demosaicking algorithms. For such algorithms CFA places a major role the choice of such CFA has a greater influence on performance. One such commonly used CFA is bayer CFA. Using such CFA algorithm first interpolate G pixel values because G pixel values have greater domination when compared to red and blue pixel values. Then, color differences(R-GorB-G) are calculated at the R and B pixels and color difference interpolation is performed. Finally, the interpolated G image is added to the interpolated color difference images to acquire R and B images. In this method residual interpolation is been proposed. Here residuals are estimated from tentative values.

Thus if tentative estimates are properly been estimated then the proposed method shows a better performance. Accurate tentative estimates are generated using guided filter which turns to be a powerful edge preserving filter. After which the residuals are generated it is interpolated.

PROPOSED RESIDUAL INTERPOLATION

Outline

By considering the cost most digital cameras use color filter array to acquire color image. Because of which it capture only one color value at each pixel location. This image obtained from such a camera incorporating such a CFA is known as mosaicked image. There exist different

types of CFA which differs from the way the color values are arranged. The most common type of CFA is bayer CFA (Fig.1). Demosaicking mainly concentrate on estimating the missing color component at each pixel location. Improper demosaicking can also arise different types of artifacts.

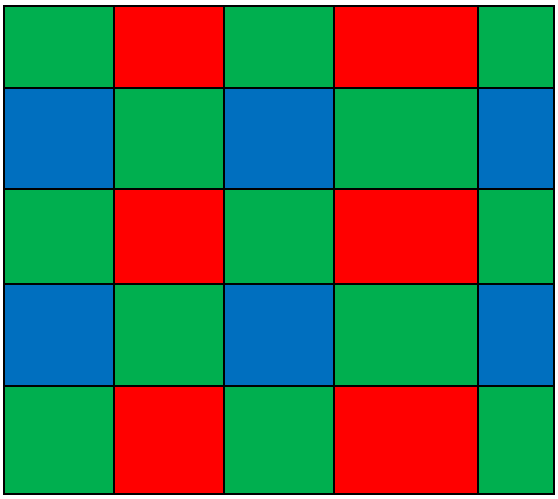

Fig 1: *Bayer CFA.*

The proposed method uses residual interpolation which calculates residuals from tentative estimate values. Residual interpolation involves two steps first is component image estimation, second is Estimation error compensation.

Component-image Estimation

In this step guided filter has two inputs followed by one output. Here the guided filter filters the input image using the other guidance image. This is done using linear regression process. Rectangular window used here plays a major role whose dimension is predetermined.

Estimation – error Compensation

Once the estimated image is obtained from the first step residuals are calculated. Residuals are the difference between the tentative estimate values.

Block diagram

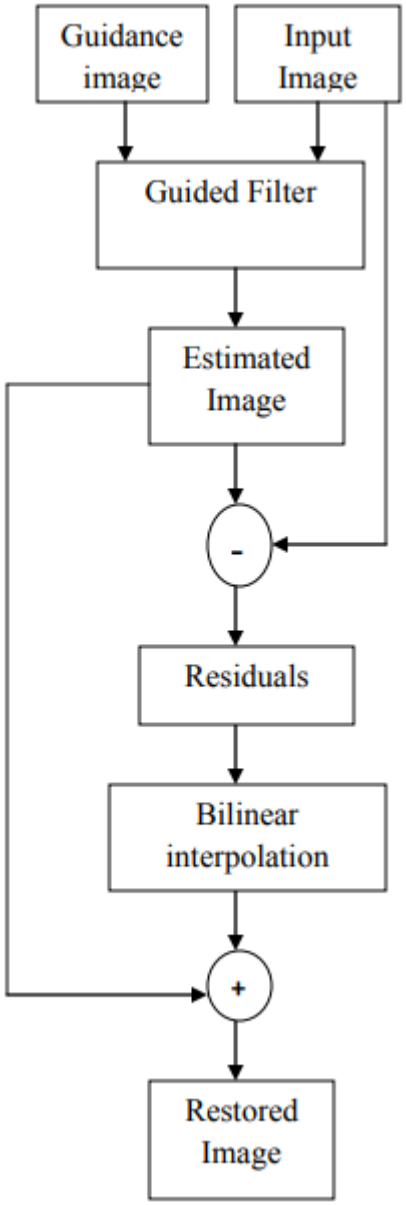

Fig 2: *Block Diagram of the Proposed Technique*

Guidance image

G pixels can be interpolated using three steps: first involves using Hamilton and adams interpolation formula to estimate G pixel in horizontal and vertical directions, similarly for R and B pixel values in G pixel positions. Second step involves calculating difference using the above horizontal and vertical estimate. Third step involves calculating G pixel values at R and B pixel locations by adding those corresponding values to the final color

difference. Estimation of R pixel values at G pixel location in horizontal direction is given as follows.

$R^{\wedge H}_{i,j}=(R_{i,j-1}+R_{i,j+1})/2+(2\times G_{i,j}-G_{i,j}-2-G_{i,j+2})/4$

The linear color difference interpolation as:

$R^{\wedge H}_{i,j} - G_{i,j} = (R_{i,j-1} - \tilde{} G^{H}_{i,j-1})/2 + (R_{i,j+1} - \tilde{} G^{H}_{i,j+1})/2,$

G^{H} is the horizontally estimated G pixel value at the R pixel calculated as:

$G^{H}_{i,j-1} = (G_{i,j-2} + G_{i,j})/2, \tilde{} G^{H}_{i,j+1} = (G_{i,j}+ G_{i,j+2})/2.$

Guided filter

Guided filter has two inputs on is the pixel to be restored and the other is the full resolution G pixel value. The guided filter filters the given input using that G pixel image. This includes both the pixels with ground truth and those with missing values, corresponding to the shaded and unshaded pixels on the input image. This estimation is achieved by performing a linear regression process between input and guidance image.It uses a M ×N local window, w(i,j) centered at the pixel (i,j), formed by individually pairing up the shaded pixels in input image and their corresponding interpolated G values from the same pixel locations, respectively. The dimension of the rectangular window w(i,j) (i.e., M ×N) is pre-determined, and it is fairly important. Thus the guided filter produces the tentative estimates of the R pixel.

Residuals

Once the tentative estimate is obtained, the residuals which is the pixel-wise difference between tentative estimate of R pixel and the input is computed. It should be noted that the subtractions can only be taken place at those pixels with ground-truth values on the input image (i.e., those shaded pixels).

s.

Bilinear interpolation

The computed residual is then subjected to interpolation to obtain the interpolated residual with full resolution. The role played by the interpolation is essentially to predict the estimation error possibly yielded at those non-shaded pixels on the input. Based on the assumption that the residual is highly smooth. It would be quite sufficient to exploit a simple interpolation technique (e.g., the bilinear interpolation) soas to obtain the interpolated residual. Finally, the R pixel values at the G pixels are estimated by adding the tentative estimate to the interpolated residual image.

The resultant R pixel value can be expressed as:

$\hat{R}^{H}_{i,j} = (R_{i,j-1} - \check{} R^{H}_{i,j-1})/2 + (R_{i,j+1} - \check{} R^{H}_{i,j+1})/2 + \check{} R^{H}_{i,j}$

EXPERIMENTAL RESULTS

Evaluation is carried out for two commonly available datasets i.e. Kodak and IMAX datasets and the proposed method shows a better performance when compared to all other demosaicking algorithms.

Performance evaluation

The performance is evaluated using peak signal to noise ratio(PSNR) and Structural similarity(SSIM). Both have been measured for each color channel separately as well as for all the three channels jointly. Note that pixels that are less than 10 pixels from the image borderare excluded from the calculation of these measurements. For the combined measurement of the PSNR, a widely-used PSNR measurement metric, called the color peak signal-to- noise ratio (CPSNR), is adopted. For a joint

measurement of the SSIM, we simply compute the average SSIM over the three SSIM values individually obtained from the three channels.

Table 1 *The PSNR and CPSNR of 20 images from Kodak database*

S.No	PSNR			CPSNR
	R	G	B	
1	32.822609	35.965936	34.356904	34.194749
2	33.971974	43.149709	41.132397	37.560094
3	31.457813	34.093965	32.103227	32.414465
4	35.632053	37.955286	36.659043	36.646430
5	36.306388	39.934864	36.400453	37.253402
6	30.822871	34.552182	31.976765	32.188881
7	38.237039	41.301921	38.407527	39.107277
8	38.064154	40.667339	38.783278	39.039526
9	34.847918	38.854384	37.192030	36.651584
10	38.688971	43.596886	39.773424	40.233783
11	31.980041	33.282223	32.007275	32.382178
12	35.059339	42.320396	40.581939	38.162518
13	40.494410	42.439511	40.227596	40.948212
14	39.483757	40.954981	38.708892	39.619057
15	33.959011	36.814286	34.809324	35.037409
16	36.489635	39.219283	36.965641	37.405559
17	37.968812	40.280498	37.163585	38.282467
18	35.155482	37.426880	35.341308	35.859847
19	34.662828	38.522862	35.124817	35.797484
20	34.193545	36.080235	33.430921	34.432189

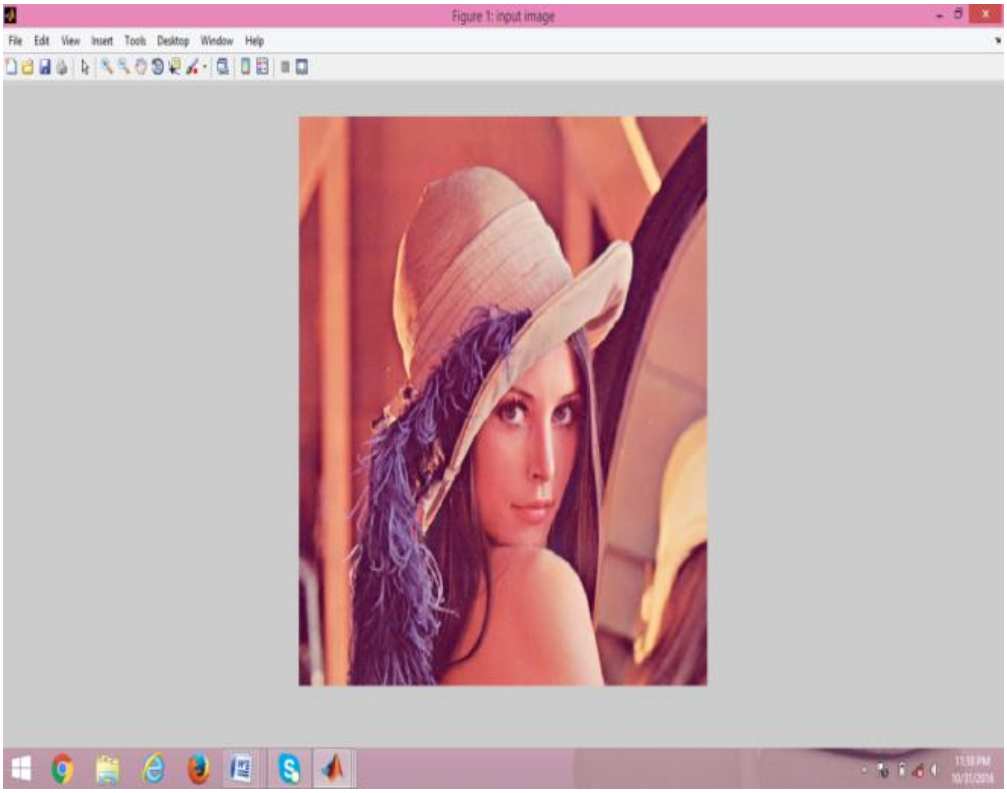

Fig 3: *Input image*

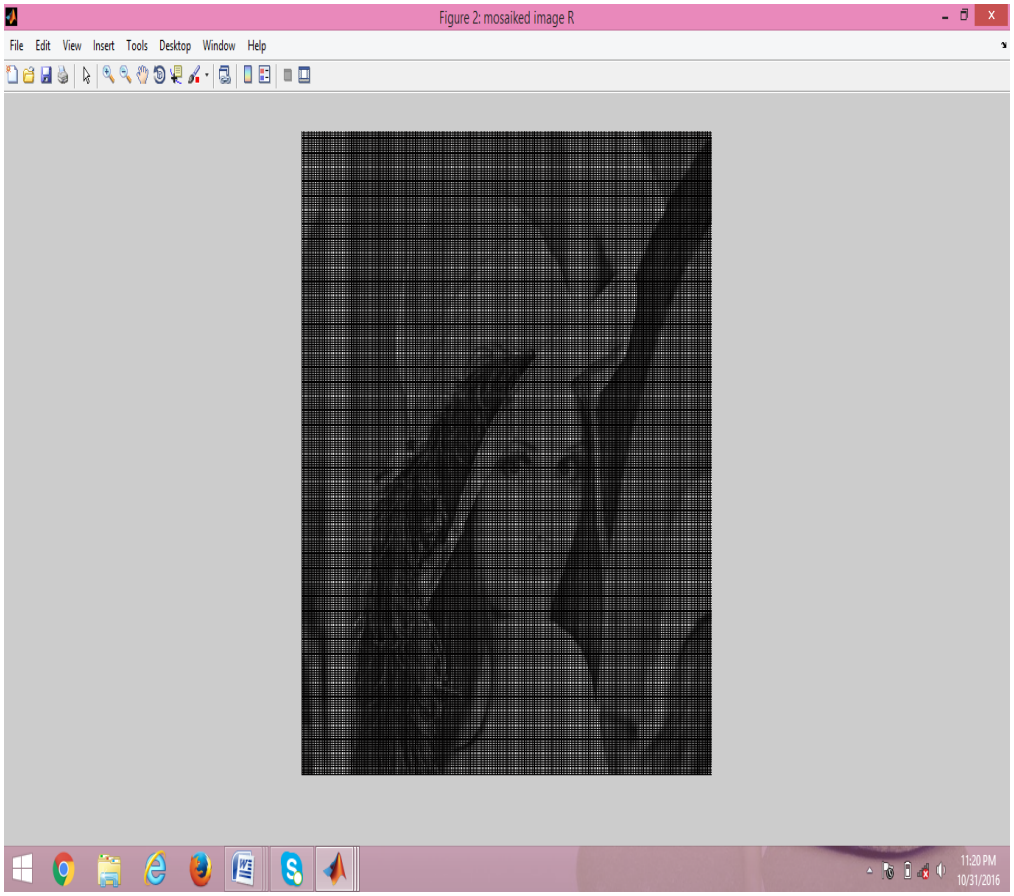

Fig 4: *Mosaicked image of red*

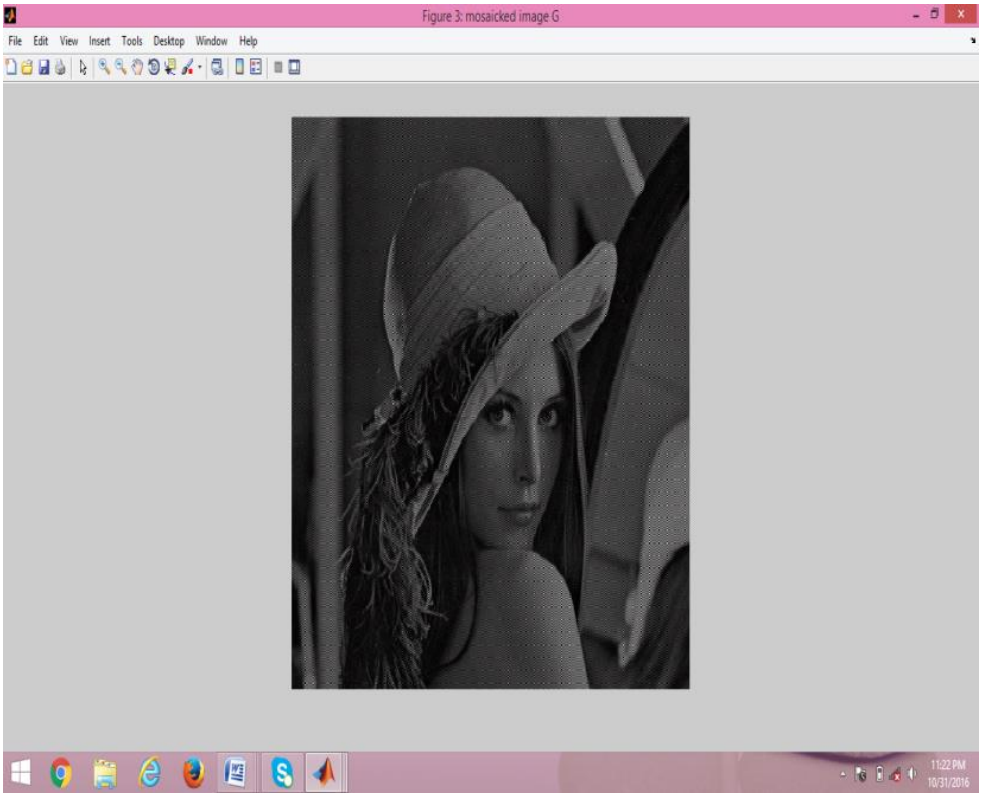

Fig 5: *Mosaicked image of green*

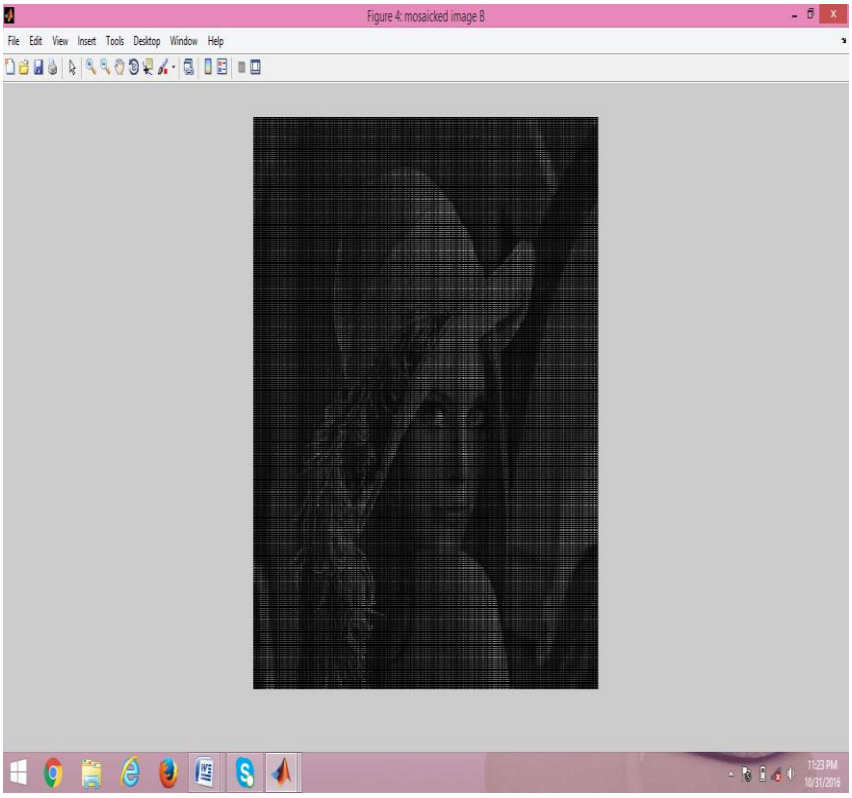

Fig 6: *Mosaicked image of blue*

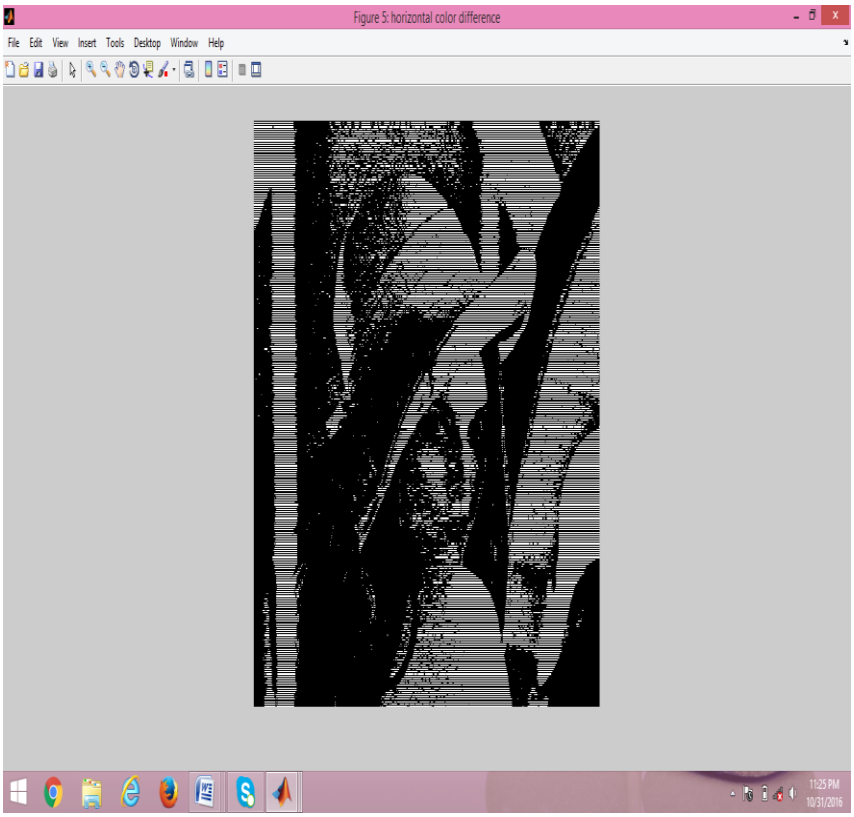

Fig 7: *Horizontal color difference*

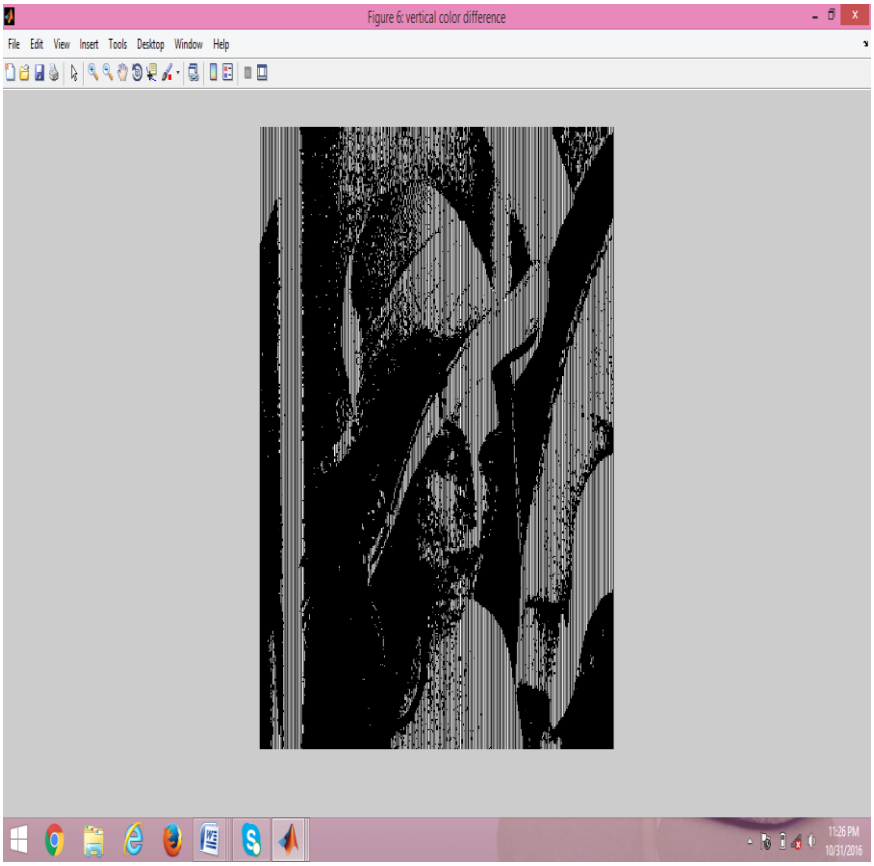

Fig 8: *Vertical color difference*

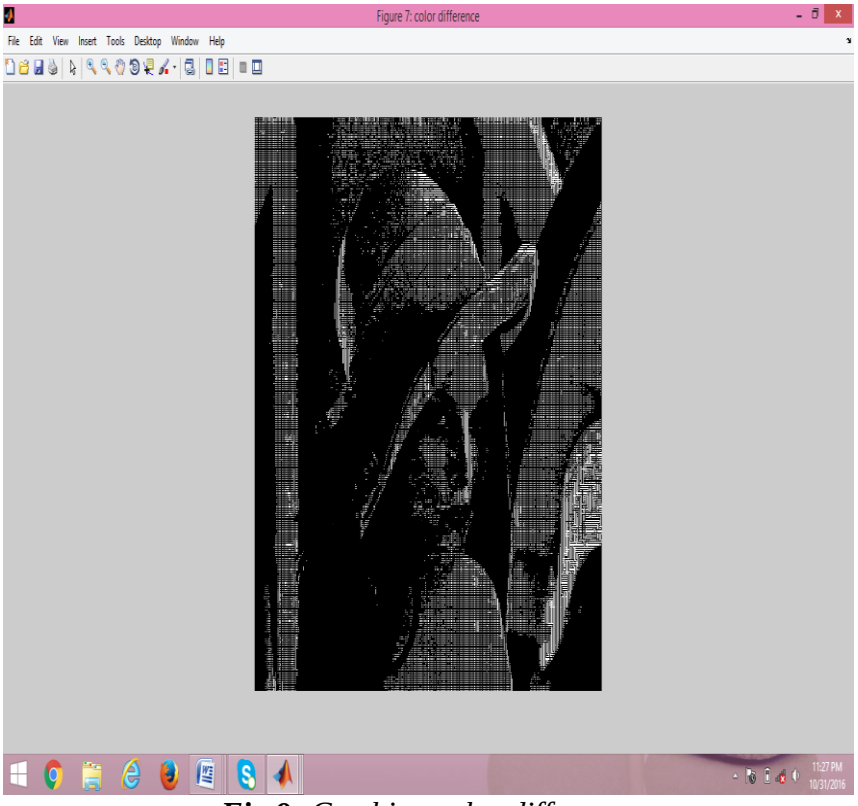

Fig 9: *Combine color difference*

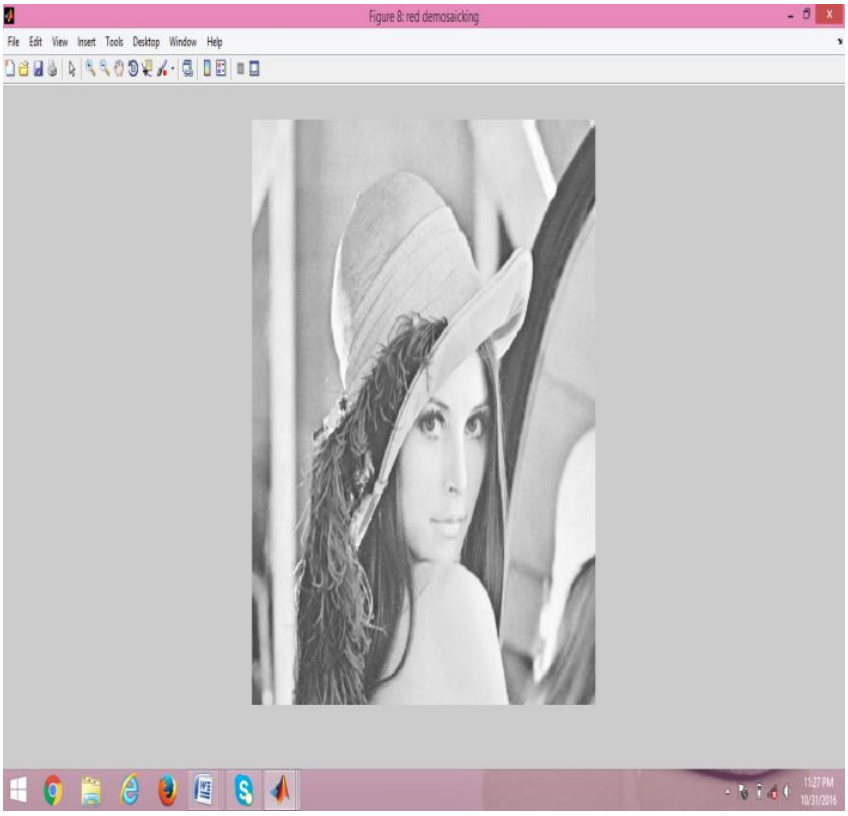

Fig 10: *Red demosaicking*

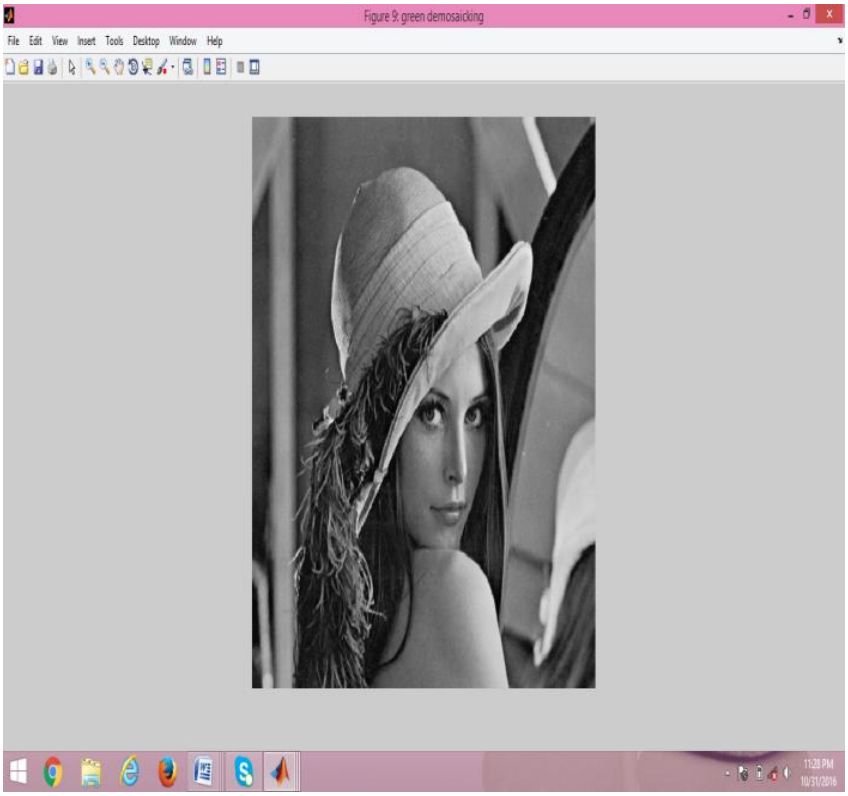

Fig 11: *Green demosaicking*

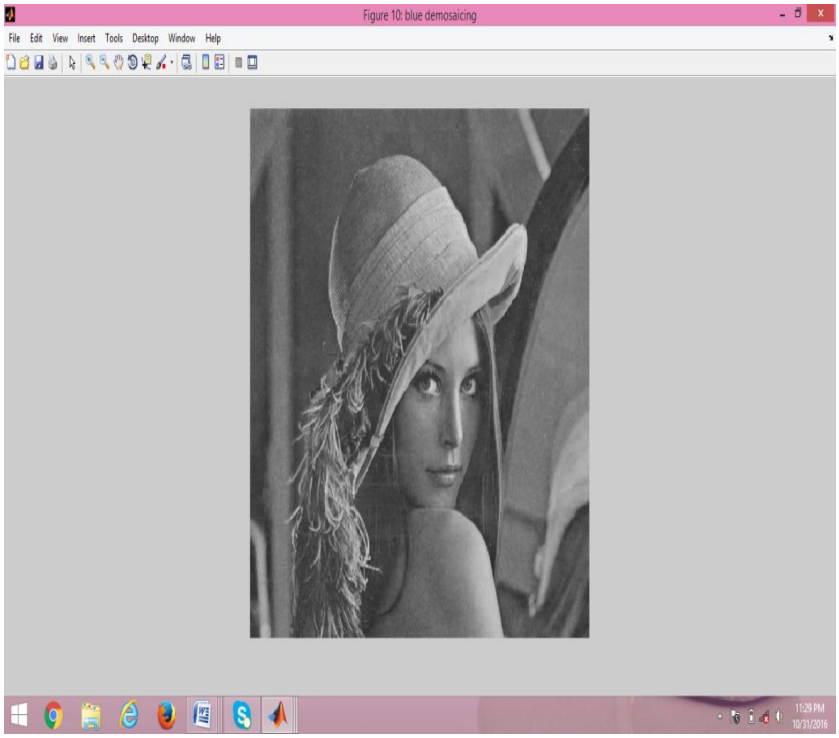

Fig12: *Blue demosaicking*

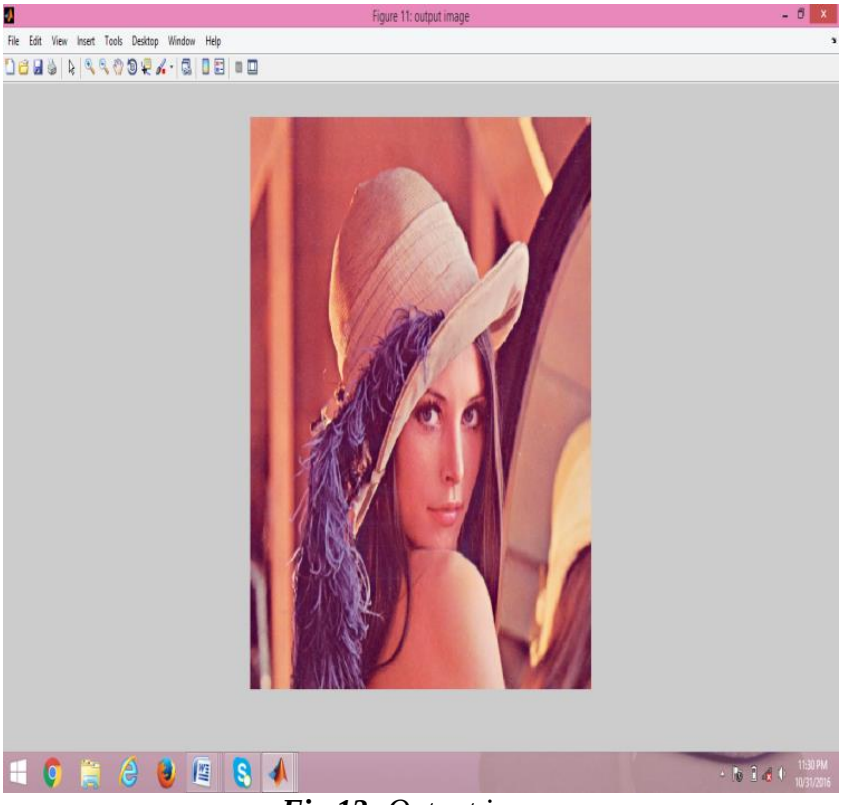

Fig 13: *Output image*

CONCLUSION

In this project, the residual interpolation is used as an alternative to the widely used color difference interpolation. Here the residual interpolation is shows a better performance over residual domain. The guided filter used in residual interpolation delivers the superiority in the estimation of missing color pixels. Compared to the other interpolation techniques residual

interpolation provides better results.

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Cite this article as: S.G.Gayathri. (2018). Demosaicking of Color Image Using Residual Interpolation. Journal of VLSI Design and Signal Processing, 4(3), 1–10. http://doi.org/10.5281/zenodo.1622997