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Content based Adaptive Image Demosaicing using Random Forest Algorithm.

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Abstract

Health care, forgery and engineering are just a few of the many industries that rely on the content of images. Mobile phone cameras use image sensors with Bayer patterning. It is necessary to use a demosaicing algorithm to extract the full-colour image with requisite quality. Content-based adaptive demosaicing utilising random forest algorithm is proposed in this article, as it has the advantage of being easy to train and evaluate. Interaction curvature was used as the predictor. Interpolation techniques: linear, closest, cubic, rational v4 precede this section. For each pixel, 50 learning cycles are utilised, and all of this work is done using MATLAB software. Using random forest algorithms, ten pictures are used to calculate PSNR, SNR, SSIM, and MSSIM. All of the test photos were more efficient when using Random forest as a filter.

Keywords: Decision trees, Demosaicing, PSNR, Random forest, SSIM.

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Introduction

Images are playing a vital role in everyone's life. They play a dominant role in medical technology, sensor networks, forging, and even intelligent transportation.[1] Digital images are of higher resolution and are more suitable for processing in computers and smartphones.[2] The demosaicing algorithm estimates the missing features in the pixel in every color plane as the sensors capture one value for a particular pixel and the rest two are estimated via this. Various issues related to demosaicing algorithms are the misguidance of color artifacts, interpolation of color artifacts, and aliasing effect problems. There is a demosaicing algorithm proposed in this article that estimates the missing pixels by interpolating them with less colour artefacts and higher image quality. Different approaches have been used in past like, Filter bank methods have helped in reducing the aliasing effect problem by applying filter bank methods to the two-dimensional interpolation.[3] The Bayer pattern filters are also used in the Mastcam imaging system used by the Mars rover designed by NASA is to capture the images on the planet mars.[4] This designed and developed article,[5] resulted in the high-performance and restored the correlated signals. This algorithm worked in iterative mode and found the color difference in image domains and spatial adaptation criteria for compressing color misregistration. This article[6] also showed the performance of demosaicing algorithm subjectively where the missing green samples are estimated first based on color variance difference with different edge directions and afterwards the red and blue color components were estimated. The article[7] proposed an identified strategy that re-processes the analyzed image with eigen algorithms and builds a set of identifying features for the algorithm. The challenges faces by researchers are false-color artifacts, edge blur in images, and zippering. To overcome this, an architecture which performed two operations jointly i.e., denoising and demosaicing on the camera sensors.[8] In,[9] the spatial adaption technique with a jacobian matrix with color maps was presented. The demosaicing with color filter array will help restore the full-color image, exploit the spatial image values, and image spectral correlation values and even characterize the demosaicing artifacts with the correlation technique.[10] Also, in,[11] GAN was used generate the demosaicing images and this network improved the discriminant ability of the network and hence the image quality. This is a new convolutional

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neural network that estimates a linear subspace for the result at local image patches A few combination coefficients of the subspace bases decide the result in an image patch, making the minimization problem tractable. In,[12] a computing approach of convolutional neural network was utilized and via combination of coefficients of subspace bases, in an image patch was determined which finally yielded superior quality. In this article, the following contributions are made:

- Developed a new adaptive demosaicing algorithm for images using random forest method and reduced the image's unwanted artifacts.
- Improved the quality of the reconstructed image by using the proposed adaptive demosaicing algorithm concerning parameters such as SNR, PSNR, SSIM, and MSSIM values.
- Compared the proposed adaptive algorithm with the conventional methods.

This paper is classified into four sections. Section 1 explains the literature survey of the demosaicing algorithms and related works. Section 2 describes the proposed system model. Section 3 discusses the results obtained and the comparison part, Section 4 concludes the paper with results analysed and performance comparison with the conventional methods.

Proposed System Model

In the proposed model, the training images are given to the GRBG pattern in which the RGB color components are being arranged by Bayer pattern. The Bayer color filter array places the color filters which each sensor records RGB data in the digital camera. This pattern will divide the image matrix into R, G, and B matrixes. The five interpolation techniques in each plane, i.e., R plane, G plane, and B-plane were implemented separately. The training and testing procedure is shown in Figure 1.

The input images were taken from Kodak data suite.[16] 50 images were used for the training part and 10 were used for testing, as shown in Figure 2 and metrics were calculated for these. Before going into training part, firstly the selection of window size id done and from recurrent executions, the window size of 7X7 came out to be best, so it was used in this work.

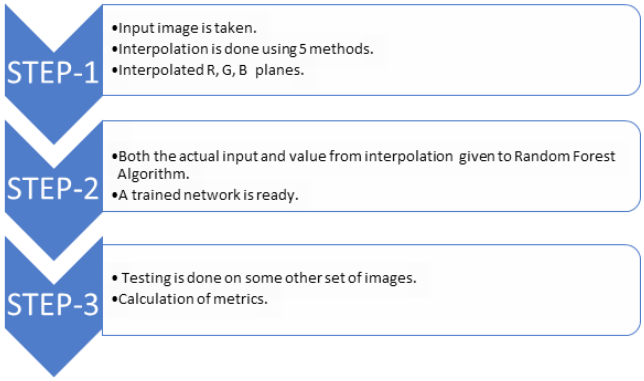

Figure 1: Workflow of proposed model.

Then the interpolation is done by five methods viz. linear, nearest, cubic, v4, rational and interpolated R, G, B planes are created. So, the output received from this is fed to the random forest block, where one input to this is the original image i.e., the known value of the pixel and another input is the value from the preceding stage. By selecting the best method with the nearest value to the original pixel value is selected and further based on features of training set, some set of rules are formulated by the random forest to make the predictions. Finally, when the images for testing were given then based on these predictions, the demosaiced image is achieved. The image quality metrics were calculated by comparing the original and demosaiced output from the proposed model.

Experimental Results

This section discusses the results obtained after applying the random forest algorithm to calculate PSNR, SNR, SSIM, and MSSIM. When compared to other values.[15] Figure 3(a), (b), and (c) 1 displays a comparison of PSNR for red, green and blue planes.

With the help of MATLAB's image processing package, the picture quality metrics for the KNN demosaiced images were generated. On the basis of Table 1, it is clear that random forest produces high-quality photos. PSNR values for ten Kodak photos have been calculated.[9,10,13,14] It is common to determine average PSNR values. There are high

Figure 2: Kodak test Image suite Ten Test images

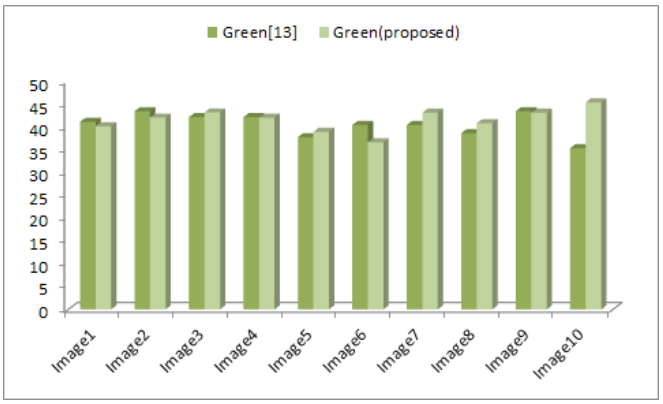

Figure 3 (a): PSNR value comparison for Green Plane

Table 1: Comparison of results (PSNR)

						Proposed method		
Image No.	*Bi-linear*	*[9]*	*[10]*	*[13]*	*[14]*	*R*	*G*	*B*
1	37.12	38.3	39.1	39.6	39.9	40.51	40.12	41.32
2	34.5	40.5	41.5	41.7	42.8	43.14	42.01	43.17
3	33.77	38.6	40	40.6	40.6	46.18	43.13	44.6
4	33.5	40.8	41.6	42.1	42.6	40.17	41.98	43.47
5	29.28	35.3	25.7	36	36.7	45.26	38.89	43.49
6	32.35	37.3	39	39.4	39.4	36.75	36.56	43.54
7	31.64	38.5	40.7	40.4	41.4	46.34	43.08	43.94
8	30.47	36.5	37.8	38.2	38.5	43.72	40.76	46.85
9	35.21	41.5	41.9	42.2	42.9	50.11	43.07	47.69
10	26.71	31.9	34.7	35.4	34.8	45.36	45.34	47.82
Average	32.455	37.92	38.2	39.56	39.96	43.754	41.494	44.589

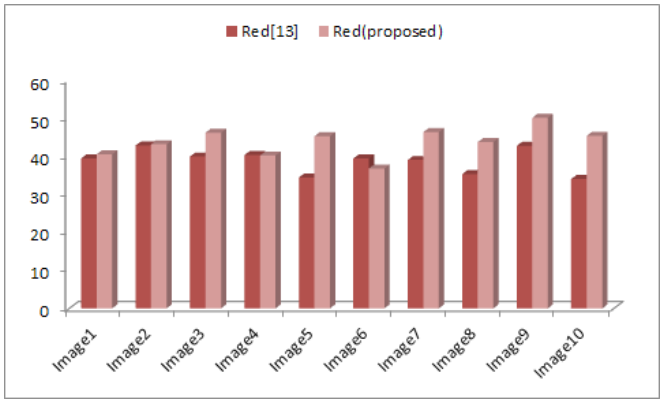

Figure 3 (b): PSNR value comparison for Red Plane

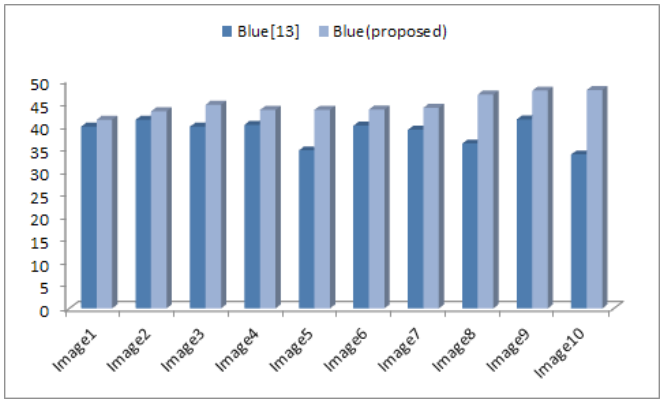

Figure 3 (c): PSNR value Comparison for Blue Plane

PSNR average values in Random Forests. In comparison with the bi-linear technique, the proposed model exhibits a 25% improvement in performance With an average PSNR value of 37.92, compared to the random forest method,[9] total efficiency is enhanced by 12.38%. According to the proposed work, the average PSNR value of 38.30 is achieved by applying the following method: spectral and spatial correlation employing colour filter array filter.[13] The edge

Table 2: Image quality metrics using Random Forest

Image No.	*SNR*	*SSIM*	*MSSIM*
1	86.43	0.9954	0.9989
2	81.12	0.9967	0.9945
3	96.23	0.9975	0.9983
4	86.65	0.9979	0.9988
5	87.37	0.9975	0.9991
6	82.76	0.998	0.9939
7	99.45	0.9972	0.9991
8	85.56	0.9982	0.999
9	98.34	0.9981	0.9981
10	103.29	0.9982	0.9989
Average	92.02	0.998	0.9984

adaptive demosaicing suppression has an average PSNR of 39.54, which is 8.59% better than proposed method.[14] The following approach is the new colour filter array interpolation architecture method, and the average PSNR value is 39.25; this is a 7.66% improvement. The proposed method has shown improvements in picture quality, resolution size, and predicting pixel colour values using adaptive technique, compared to conventional methods such as bilinear method, principal vector method, spectral and spatial method, colour filter array interpolation method, and image demosaicing process with content and colour correlation techniques. According to SNR, SSIM, and MSSIM values, image quality is within the desired range. The image quality metrics values for 10 test photographs are shown in Table 2.

As seen in the table above, PSNR and SNR values are compared for different test images. 10 original test

photographs, such as a red door, a female in red with a painted face, two macaws and a mountain cabin are included in this set of test images: Calculated using MATLAB, the greatest SNR and PSNR values are shown in image 10.

Conclusion

To reduce the cost and size of cameras, single sensors are used to collect images, paired with a color filter array, which is a type of coating on the sensor arrays that allows just one color to pass and the other two to be blocked at one point. Some demosaicing technique must be used to obtain the values of the remaining two colors for that pixel. In this research, five linear interpolations based on image content were utilized, and for final predictions, the random forest algorithm was applied, which focused on improving system performance and yielding higher efficiency. The demosaiced output images were of higher quality, and multiple measures were used to corroborate this. The Random forest algorithm outperformed the state-of-the-art approaches in terms of efficiency.

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References

[1] Anagnostopoulos, C. N. E., Anagnostopoulos, I. E., Loumos, V., & Kayafas, E. (2006). A license plate-recognition algorithm for intelligent transportation system applications. IEEE Transactions on Intelligent Transportation Systems, 7(3), 377–392.

[2] Y Yuan, Y., & Wang, F. Y. (2016). Towards blockchain-based intelligent transportation systems. Proceedings of the IEEE International Conference on Intelligent Transportation Systems, 2663–2668.

[3] Hirakawa K., & Parks, T. W. (2005). Adaptive homogeneity-directed demosaicing algorithm. IEEE Transactions on Image Processing, 14(3), 360-369.

[4] Chiman, K., Chou, B., & Bell, J. F. (2019). Comparison of deep learning and conventional demosaicing algorithms for Mastcam images. Electronics, 8, 308-329.

[5] Li, Xin., (2005). Demosaicing by successive approximation. IEEE Transactions on Image Processing, Vol. 14(3), 370-379.

[6] Hirakawa, Keigo, & Parks, Thomas W. (2005). Adaptive homogeneity-directed demosaicing algorithm. IEEE transactions on image processing, 14(3), 360-369.

[7] Chung, K-H., & Chan., Y-H. (2006). Color demosaicing using variance of color differences. IEEE transactions on Image Processing, 15(10), 2944-2955.

[8] Takamatsu, J., Matsushita, Y., Ogasawara, T., & Ikeuchi, K. (2010). Estimating demosaicing algorithms using image noise variance. IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 279-286.

[9] Kakarala, R., & Baharav, Z. (2002). Adaptive demosaicing with the principal vector method. IEEE Transactions on Consumer Electronics. 48(4), 932–937.

[10] Chang, L. & Tan, Y.P. (2004) Effective use of spatial and spectral correlations for color filter array demosaicking. IEEE Transactions on Consumer Electronics, 50,355–365.

[11] Luo, J., & Wang, J. (2020). Image Demosaicing Based on Generative Adversarial Network. Mathematical Problems in Engineering, 1, 1-13.

[12] Tang, J., Li, J., & Tan, P. (2021). Demosaicing by Differentiable Deep Restoration. Applied Sciences, 11(4), 1649.

[13] Lee, J., Jeong, T., & Lee, C. (2007). Edge-adaptive demosaicking for artifact suppression along line edges. IEEE Transactions on Consumer Electronics, 53(3), 1076–1083.

[14] Lukac, R., Plataniotis, K.N., Hatzinakos, D., & Aleksic, M. (2006). A new CFA interpolation framework. Signal Processing, 86(7), 1559–1579.

[15] Shao, L., & Rehman, A. U. (2014). Image demosaicing using content and colour-correlation analysis. Signal Processing, 84–91.

[16] K Lossless, True Color Image Suite. (Online), Available from: ⟨http://r0k.us/graphics/kodak/⟩.