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Implementation of A New Colour Filter Array with Improved Quality for Noiseless and Noisy Colour Image

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ABSTRACT—*The Colour Filter Array is overlaid on the digital camera. Digital camera takes the images by using this colour filter array. The growing popularity of digital camera demands the improvement in the quality of the images, speed of acquiring the images.Digital camera should have High sensitivity properties such as to reduce the exposure time, to increase the aperture, or to use a lower ISO setting and a less destructive de-noising process while acquiring a picture. In this paper we present the CFA with new optimal properties which provide trade-off between robustness to aliasing, chrominance noise and luminance noise. The proposed CFA has a natural and simple demosaicking algorithm associated to it, inspired by its characteristics in the Fourier domain. The demosaicking algorithm used is simple and efficient which fully exploits the spectral properties of the CFA. The proposed CFA work superiorly for acquisition of noiseless and noisy images and has six colours and a periodic pattern of size 2*3. A sensor with the proposed CFA will provide images with higher perceived resolution because the anti-alias filter can be removed from the sensor and better quality than the standard Bayer CFA. It is less sensitive to Inter-chrominance aliasing & chrominance axis. The proposed CFA developed will provide less amplified chrominance noise than Hirakawa CFA. The proposed CFA is developed which will provide robustness in aliasing and luminance & chrominance noise.*

Keywords— Color filter array (CFA), Demosaicking of images, luminance/chrominance basis, Spatio-spectral sampling.

1. INTRODUCTION

The growing popularity of digital camera demands the improvement in the quality of the images, speed of acquiring the images. Sensor is the heart of any digital or video camera i.e.it is 2-D array of photosites which measures the amount of light absorbed during the exposure time. The color information is obtained by means of a color filter array (CFA) overlaid on the sensor, such that each photosite is covered by a color filter sensitive to only a portion of the visible light spectrum The Colour Filter Array is overlaid on the digital camera. Digital camera takes the images by using this colour filter array. From the mosaicked image acquired by the camera, some processing is required to recover a full color image with three components per pixel, carrying information in the red (R), green (G) and blue (B) spectral bands to which the human visual system (HVS) is sensitive. This reconstruction operation is called demosaicking,[8]-[10].

2. LITERATURE SURVEY

Literature survey is the most important step in software development process. Before developing the tool it is necessary to determine the time factor, economy and company strength. Once these things are satisfied, then next steps is to determine which operating system and language can be used for developing the tool. Once the programmers start building the tool the programmers need lot of external support. This support can be obtained from senior programmers, from book or from websites. Before building the system the above consideration are taken into account for developing the proposed system.

The Bayer CFA, which consists of filters with the primary colors is the most popular and dominates the consumer market. There is a vast literature dealing with the best way to reduce aliasing artifacts during the demosaicking process, but these artifacts are inherent to the spectral characteristics of the Bayer CFA,[1]-[2].

Kodak patented new CFAs containing transparent (panchromatic) filters, in addition to filters. Other CFAs have been proposed in the literature. However, all these CFAs have been designed empirically and are not based on a thorough theory for CFA design.

A breakthrough in the field was made by Hirakawa, who proposed to design CFAs directly in the Fourier domain, without constraints on the colors of the filters in the spatial domain [2].

Based on previous work characterizing the spectral properties of the Bayer CFA and showing that the mosaicked image actually consists of the superposition of modulated signals encoding the color information, they proposed to design a CFA so that these signals tile the frequency plane with minimum overlap. This paradigm is quite general; however, it leaves open questions about the choice of the many parameters of the model.

Further insides where some degrees of freedom in this spatio-spectral formulation of CFA design are re-expressed as solutions of a constrained optimization problem, so as to minimize the norm of the demosaicking operator.

The increasing progress in CFA design and demosaicking gives minimum aliasing artifacts due to spectral overlap of modulated colour channels in mosaicked image. By increasing the resolution of the sensors, aliasing has become a minor issue.

Thus robustness to the noise is more important than the robustness to the aliasing. Digital camera should have High sensitivity properties such as to reduce the exposure time, to increase the aperture, or to use a lower ISO setting and a less destructive de-noising process while acquiring a picture. This is important for photography in lower light level environments. Hence we need new CFA with improves sensitivity to pack maximum energy of the colour scene into the mosaicked image.

3. SYSTEM ANALYSIS

3.1 Existing System

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Kodak patented new CFAs containing transparent (panchromatic) filters, in addition to filters. Other CFAs have been proposed in the literature [4],[5]. However, all these CFAs have been designed empirically and are not based on a thorough theory for CFA design [10],[11].

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3.2 Proposed System

The proposed CFA has a natural and simple demosaicking algorithm associated to it, inspired by its characteristics in the Fourier domain. The demosaicking algorithm used is simple and efficient which fully exploits the spectral properties of the CFA. The proposed CFA work superiorly for acquisition of noiseless and noisy images and has six colours and a periodic pattern of size 2*3. A sensor equipped with the proposed CFA instead of the standard Bayer CFA will provide images with higher perceived resolution and better quality. It is less sensitive to Inter-chrominance aliasing & chrominance axis. The proposed CFA developed will provide less amplified chrominance noise than Hirakawa CFA. The proposed CFA is developed which will provide robustness in aliasing and luminance & chrominance noise.

4. MODULE DESCRIPTION:

4.1 Load Image:

Loading the particular image for the image processing, in the particular bitmap. This is by opening the dialog box and selecting the particular image file. After alteration, can save the particular image.

4.2 Image Processing Techniques:

Various processing technique are included in the project (invert, grayscale, brightness, contrast, gamma and color).

4.3 Color Filter:

The color filters are filters placed over the pixel sensors of an image sensor to capture color information. Color filters are needed because the typical photosensors detect light intensity with little or no wavelength specificity, and therefore cannot separate color information. The color filters filter the light by wavelength range, such that the separate filtered intensities include information about the color of light. For example, the Bayer filter gives information about the intensity of light in red, green, and blue (RGB) wavelength regions. The raw image data captured by the image sensor is then converted to a full-color image (with intensities of all three primary colors represented at each pixel) by a demosaicing algorithm which is tailored for each type of color filter. The spectral transmittance of the CFA elements along with the demosaicing algorithm jointly determine the color rendition.[4],[17].

4.4 HSL Color Space:

HSL and **HSV** are the two most common cylindrical-coordinate representations of points in an RGB color model, which rearrange the geometry of RGB in an attempt to be more intuitive and perceptually relevant than the Cartesian (cube) representation. They are used for color pickers, in color-modification tools in image editing software, and less commonly for image analysis and computer vision.

HSL stands for hue, saturation, and lightness, and is often also called **HLS**. HSV stands for hue, saturation, and value, and is also often called **HSB** (B for brightness). A third model, common in computer vision applications, is **HSI**, for hue, saturation, and intensity. Unfortunately, while typically consistent, these definitions are not standardized, and any of these abbreviations might be used for any of three or several other related cylindrical models.

4.5 Binarization:

Image binarization converts an image of up to 256 gray levels to a black and white image. Frequently, binarization is used as a pre-processor before OCR. In fact, most OCR packages on the market work only on bi-level (black & white) images.

The simplest way to use image binarization is to choose a threshold value, and classify all pixels with values above this threshold as white, and all other pixels as black. The problem then is how to select the correct threshold. In many cases, finding one threshold compatible to the entire image is very difficult, and in many cases even impossible. Therefore, adaptive image binarization is needed where an optimal threshold is chosen for each image area.

4.6 Morphology:

Morphological operators often take a binary image and a structuring element as input and combine them using a set operator (intersection, union, inclusion, complement). They process objects in the input image based on characteristics of its shape, which are encoded in the structuring element. Usually, the structuring element is sized 3×3 and has its origin at the center pixel. It is shifted over the image and at each pixel of the image its elements are compared with the set of the underlying pixels. If the two sets of elements match the condition defined by the set operator (*e.g.* if the set of pixels in the structuring element is a subset of the underlying image pixels), the pixel underneath the origin of the structuring element is set to a pre-defined value (0 or 1 for binary images).

4.7 Edge Detectors:

Edge detection module is for feature detection and feature extraction, which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities. The same problem of finding discontinuities in 1D signal is known as step detection.

5. ALGORITHM FOR PROPOSED SYSTEM:

5.1 Demosaicking Algorithm for the Proposed CFA:

1) By modulation with the carrier wave of the chrominance **C1**, Compute the image **V1** from **V**,

$$V1[k]= (-1)^{k1+1} / \gamma_C \sin(2\pi k_2/3)\, v[k]$$

2) Apply an appropriate low-pass filter :$dem^{c1}= V1 * h$

3) By modulation with the carrier wave of the chrominance **C2**, Compute the image V**2** from **V** as,

$$V2[k]= (-1)^{k1}\sqrt{2} / \gamma_C \cos(2\pi k_2/3) V[k]$$

4) Apply the same low-pass filter : $dem^{c2}= V2 * h$

5) Estimate the luminance by subtraction of the remodulated Chrominance

$$\mathrm{dem}^L[\mathbf{k}] = \Big(v[\mathbf{k}] + \gamma_C(-1)^{k_1}\sqrt{2}\sin(2\pi k_2/3)\mathrm{dem}^{C_1}[\mathbf{k}] - \gamma_C(-1)^{k_1}\sqrt{2}\cos(2\pi k_2/3)\mathrm{dem}^{C_2}[\mathbf{k}]\Big)/\gamma_L.$$

6) Compute **dem^{R}, dem^{G} , dem^{B}** by pixelwise change of basis from **dem^{C1}, dem^{C2} , dem^{L}**

We remark that if h is sufficiently lowpass, the step 5) is equivalent to a convolution: , **dem^{L}= V * h** where

$$g[\mathbf{k}] = \left(\delta_{\mathbf{k},\mathbf{0}} - (-1)^{k_1}\cos(2\pi k_2/3)h[\mathbf{k}]\right)/\gamma_L$$

The Kronecker symbol is defined by $\delta_{x,y}$ ={1….. if x=y=,0…..else}.This can be interesting computationally if the luminance is to be computed in parallel with the chrominance.

The proposed algorithm can be easily adapted to handle other CFAs, simply by using the appropriate carrier waves for the chrominance in steps 1), 3), 5). For the 2*4 CFA proposed by Hirakawa, the method reverts to the one detailed. Note, however, that for the Bayer and Hirakawa CFAs, the estimation of the luminance is not equivalent to a convolution any more. With the proposed CFA, the complexity of the demosaicking process is limited to two convolutions. In addition, they use the same filter and can be performed in parallel. By contrast, with the Bayer CFA, three convolutions with distinct filters must be performed[1],[5] .

6.PERFORMANCE ANALYSIS:

6.1 Results of Demosaicking:

For evaluating the performances of our new CFA, we compare it to the Bayer CFA and Hirakawa. The following figure shows Demosaicking results for the synthetic image which consists of a sine with pulsation oscillating between green and magenta(A).With the CFA of Hirakawa , aliasing between the two chrominance bands appears (b),while with our CFA, there is only aliasing between the chrominance and the luminance(c),[3],[11].

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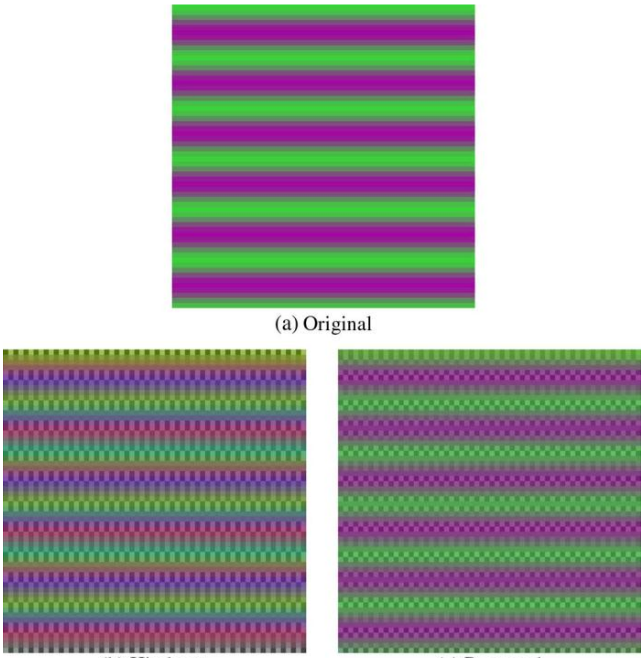


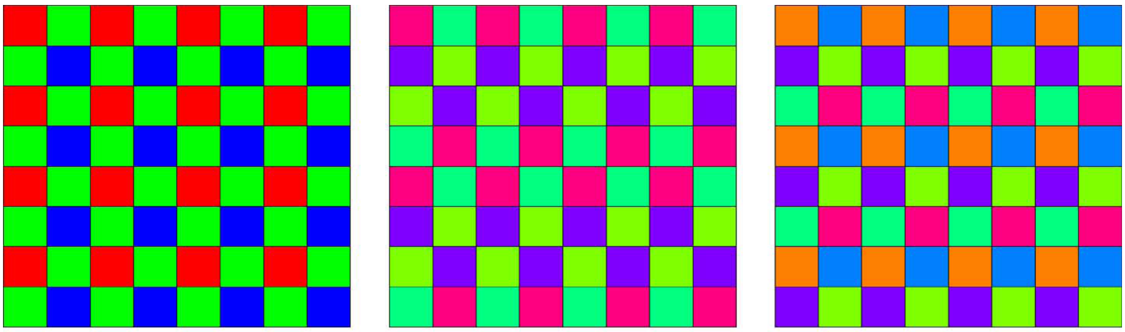
(a) Original

(b) Hirakawa (c) Proposed

Figure: Demosaicking results for the synthetic image (a), which consists of sine with pulsation oscillating between green and magenta.With the CFA of Hirakawa, aliasing between the two chrominance bands appears (b), while with our CFA, there is only aliasing between the chrominance and the luminance (c).

(a) Original; (b) Hirakawa; (c) proposed.

6.2 Comparison of CFA's:



(a) (b) (c)

(a) Bayer pattern (b) Hirakawa's pattern with four colors (c) the proposed 2 *3 pattern with six colors.

7. CONCULSION AND FUTUREWORK

The proposed CFA has a natural and simple demosaicking algorithm associated to it, inspired by its characteristics in the Fourier domain. The demosaicking algorithm used is simple and efficient which fully exploits the spectral properties of the CFA. The proposed CFA work superiorly for acquisition of noiseless and noisy images and has six colours and a periodic pattern of size 2*3. A sensor with the proposed CFA will provide images with higher perceived resolution because the anti-alias filter can be removed from the sensor and better quality than that of the standard Bayer CFA.

It is less sensitive to Inter-chrominance aliasing & chrominance axis. The proposed CFA developed will provide less amplified chrominance noise than Hirakawa CFA. The proposed CFA is developed which will provide robustness in aliasing and luminance & chrominance noise and it is less sensitive to interchrominance aliasing. In future work, we will investigate the choice of the precise spectral sensitivity functions of the six colors defining the new CFA.

All the visual results of this paper can be reproduced using the Matlab code. In future work, we will concentrate on the choice of the precise spectral sensitivity functions of the six colorsfor defining the new CFA [17].

REFERENCES

[1]A New Color Filter Array With Optimal Properties For Noiseless And Noisy Color Image Acquisition, Laurent Condat, Member, Ieee Transactions On Image Processing, Vol. 20, No. 8, August 2011

[2] L. Condat, “A new color filter array with optimal sensing properties,” presented at the IEEE Int. Conf. Image Processing, Cairo, Egypt, Nov. 2009.

[3] K. Hirakawa and P. J. Wolfe, “Spatio-spectral color filter array design for optimal image recovery,” IEEE Trans. Image Process., vol. 17, no.10, pp. 1876–1890, Oct. 2008.

[4] M. Kumar, E. Morales, J. Adams, and W. Hao, “New digital camerasensor architecture for low light imaging,” presented at the IEEE Int.Conf. Image Processing, Cairo, Egypt, Nov. 2009.

[5] Y. M. Lu and M. Vetterli, “Optimal color filter array design: Quantitative conditions and an efficient search procedure,” presented at the SPIE Conf. Digital Photography V, San Jose, CA, Jan. 2009.

[6] L. Condat, “A new random color filter array with good spectral properties,” presented at the IEEE Int. Conf. Image Processing, Cairo, Egypt, Nov. 2009.

[7] P. Hao, Y. Li, Z. Lin, and E. Dubois, “A geometric method for optimal design of color filter arrays,” IEEE Trans. Image Process., to be published.

[8] B. K. Gunturk, J. Glotzbach, Y. Altunbasak, R. W. Schaffer, and R.M. Mersereau, “Demosaicking: Color filter array interpolation,” IEEESignal Process. Mag., vol. 22, no. 1, pp. 44–54, Jan. 2005.

[9] X. Li, B. K. Gunturk, and L. Zhang, “Image demosaicing: A systematic

survey," presented at the IS&T/SPIE VCIP, San Jose, CA, Jan. 2008, vol. 6822.

[10] D. Menon, "Color Image Reconstruction for Digital Cameras," Ph.D.

dissertation, Univ. Padova, Padova, Italy, 2008.

[11] K. Hirakawa and P. Wolfe, "Second-generation color filter array and demosaicking designs," presented at the SPIE VCIP, 2008, vol. 6822.

[12] E. Dubois, "Filter design for adaptive frequency-domain Bayer demosaicking," in *Proc. IEEE Int. Conf. Image Processing*, Atlanta, GA, Oct. 2006, pp. 2705–2708.

[13] B. C. de Lavarène, D. Alleysson, B. Durette, and J. Hérault, "Efficient demosaicing using recursive filtering," presented at the IEEE Int. Conf. Image Processing, San Antonio, TX, Sep. 2007.

[14] D. Alleysson, L. Meylan, and S. Süsstrunk, "HDR CFA image rendering," presented at the Eusipco, Sep. 2006.

[15] A. Foi, "Clipped noisy images: Heteroskedastic modeling and practical denoising," *Signal Process.*, vol. 89, no. 12, pp. 2609–2629, Dec. 2009.

[16] L. Condat, "A simple, fast and efficient approach to denoisaicking: Joint demosaicking and denoising," presented at the IEEE Int. Conf. Image Processing, Hong Kong, China, 2010.

[17] M. Parmar and S. J. Reeves, "Selection of optimal spectral sensitivity functions for color filter arrays," in *Proc. IEEE Int. Conf. Image Processing*, Oct. 2006, pp. 1005–1008.

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