Color Filter Array Pattern Recognition for Raw Images Generating

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Abstract— The main objective of this paper consist to identify firstly the CFA pattern recognition and secondly to generate CFA image in both from the same data raw. Our methodology have been developed using a fast algorithm of derawtisation, implemented using Dcraw resources, and incorporated under the Windows exploitation system. The results obtained show that the Bayer CFA filter present in the digital camera Fujifilm HS10 has a configuration BG/GR, and the CFA images obtained are images in grey levels.

Index Terms— derawtisation; CFA images; Bayer filter; raw data

1 Introduction

In order to facilitate the acquisition of low-cost color images for the general public, it has been necessary to develop a single-sensor color capture device (CCD: Charge-Coupled Device or CMOS: Complementary Metal Oxide Semiconductor) images on which is directly superimposed a device for filtering color stimuli. A color filter (CFA: Color Filter Array) is deposited on each photosite of the sensor; the image sensor is thus covered by a mosaic of color filters. Each photosite of the sensor can therefore receive only one wavelength corresponding to a single color component of the three primers used for the acquisition. These CFA filters are organized in different ways and vary from one manufacturer to another [1]. However, among the different existing configurations, the Bayer mosaic (Figure 1), introduced by Kodak in 1976, is the most used [2]-[3]. The Bayer filter has the particularity to use twice as many green elements as red and blue elements to get closer to the human visual system, which has more cones sensitive to wavelengths close to green [4]. Yang [3] has grouped the different mosaics of CFA filters into three types: CFA filters formed using RGB primaries, CFA filters formed using complementary colors (Cyan, Magenta, Yellow) and particular CFA filters (mixtures of primary / complementary or primary / white).

The unique sensor, used by most current color cameras, delivers an image in which only one color component is available in each pixel. This raw image, called CFA image, can be represented by a two-dimensional matrix with integer values in the range of 0 to 255. However, at the exit of each camera, one obtains CFA data which is not yet an image. To form an image from the obtained CFA data, the operation of derawtisation whose purpose is to generate a CFA image from the CFA data.

This operation of derawtisation which will be the main object of this paper.

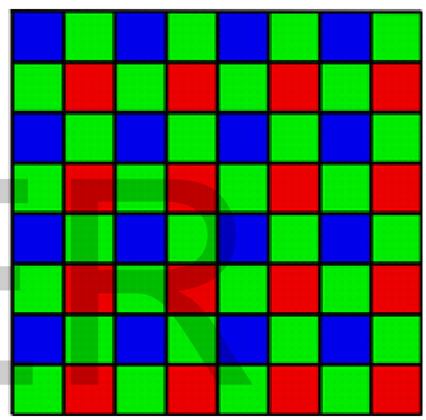

Figure 1. Example of a Bayer CFA filter [5]

2 MATERIAL AND METHODS

2.1 Material

Our materials are constituted essentially of raw data, also known as CFA data, obtained using a Fujifilm HS10 digital camera 14 bits, and Dcraw software running under Windows 10.

2.2 Methods

Our approach, based on the exploitation of Dcraw's DOS commands, was structured in four distinct steps, namely:

(i) Extract the metadata from the raw data and save it as a text file;

(ii) Extract the values of the components R (red color component) or G (green color component) or B (blue color component) from the raw data;

(iii) Encoder the values obtained on 16 bits, seen that the digital camera Fujifilm HS10 acquires the images in 14 bits;

(iv) Convert the resulting CFA image to an uncompressible PMG format.

The metadata text file and the resulting CFA image have the same name as the raw data source image, still called as CFA.

3 RESULTS AND DISCUSSION

3.1 Results of metadata extracted from raw data

The results of metadata are presented in table 1.

TABLE I. METADATA EXTRACTED FROM RAW DATA

Metadata	Raw data 1	Raw data 2	Raw data 3	Raw data 4
Filename	DSCF5353.RAF	DSCF5354.RAF	DSCF5356.RAF	DSCF5357.RAF
Timestamp	Sat Dec 28 15:12:02 2019	Sat Dec 28 15:12:19 2019	Sat Dec 28 15:20:15 2019	Sat Dec 28 15:21:02 2019
Camera	Fujifilm HS10 HS11	Fujifilm HS10 HS11	Fujifilm HS10 HS11	Fujifilm HS10 HS11
ISO speed	100	100	100	100
Shutter	1/630.3 sec	1/630.3 sec	1/512.0 sec	1/512.0 sec
Aperture	f/4.9	f/4.9	f/4.9	f/4.4
Focal length	32.7 mm	32.7 mm	31.5 mm	21.2 mm
Thumb size	2048 x 1536	2048 x 1536	2048 x 1536	2048 x 1536
Full size	3664 x 2742	3664 x 2742	3664 x 2742	3664 x 2742
Image size	3664 x 2742	3664 x 2742	3664 x 2742	3664 x 2742
Output size	3664 x 2742	3664 x 2742	3664 x 2742	3664 x 2742
Raw colors	3	3	3	3
Filter pattern	BG/GR	BG/GR	BG/GR	BG/GR
Daylight multipliers	1.519370 0.955454 1.671190	1.519370 0.955454 1.671190	1.519370 0.955454 1.671190	1.519370 0.955454 1.671190
Camera multipliers	389.0000 256.0000 547.0000 0.000000	389.00002 56.000054 6.0000 0.000000	389.000025 6.0000551. 00000.0000 00	389.000025 6.0000553. 00000.0000 00

The results obtained show that the acquisition parameters which are shutter, aperture and focal length have been adjusted in according to the need for use and depending on the lighting of the scene. Our conditions variations are according with the results reported by Du and Sun [6], who established that the acquisition parameters of a camera depend on the illumination of the scene. To maintain the acquisitions parameters constants, it is important to use as lighting the electroluminescence diodes.

We also note that raw captured by the Fujifilm HS10 has the extension .RAF, as indicated by the parameter "Filename".

We obtain also that the digital camera Fujifilm HS10 has a Bayer CFA (Color Filter Array) filter with a configuration BG / GR. This BG / GR configuration can be illustrated as a follows (Figure 2.).

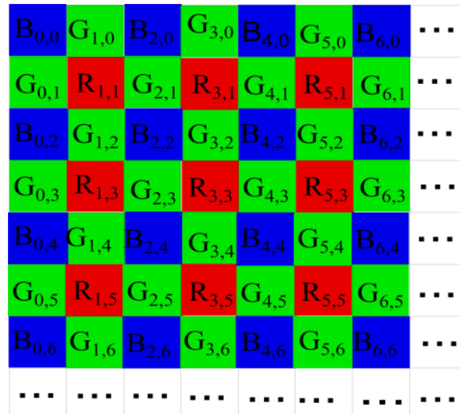

Figure 2. Configuration of a Bayer CFA filter used in the camera Fujifilm HS10

3.2 Results of CFA image extracted from raw data

The results of CFA images extracted from raw data named DSCF5353.RAF, DSCF5354.RAF, DSCF5356.RAF and DSCF5357.RAF are presented in figures 3, 4, 5 and 6. These CFA images are obtained after the operation of derawtisation.

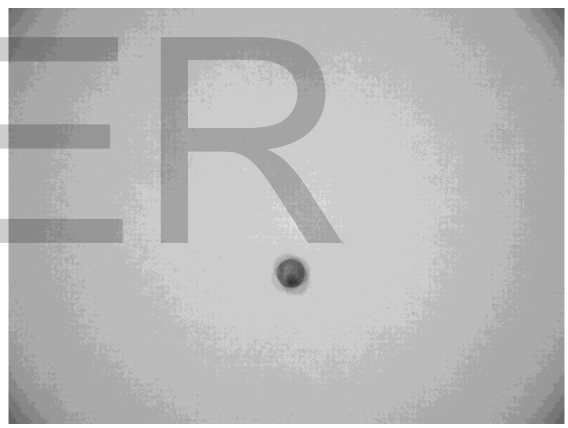

Figure 3. CFA image extracted from raw data 1 named DSCF5353.RAF

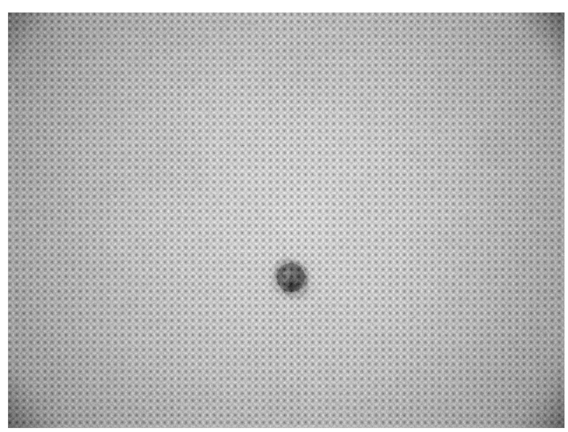

Figure 4. CFA image extracted from raw data 2 named DSCF5354.RAF

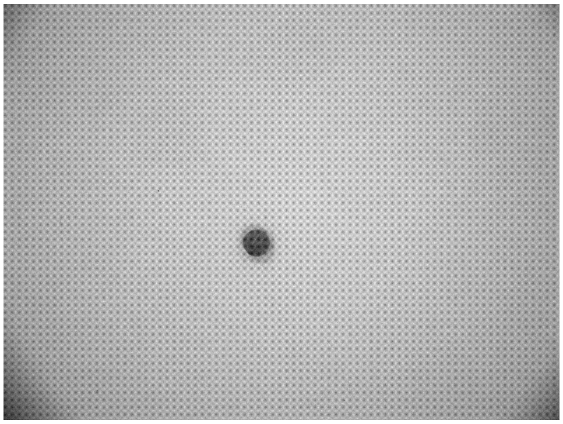

Figure 5. CFA image extracted from raw data 3 named DSCF5356.RAF

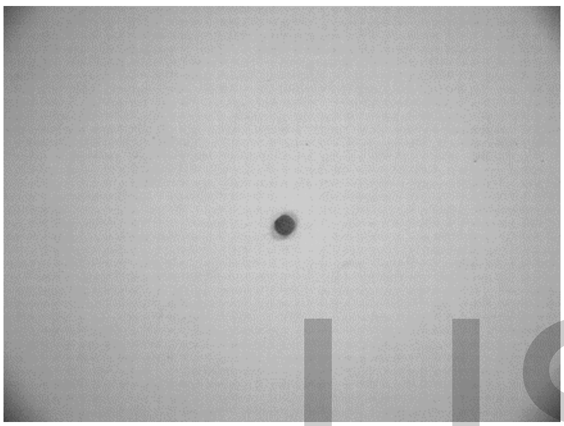

Figure 6. CFA image extracted from raw data 4 named DSCF5357.RAF

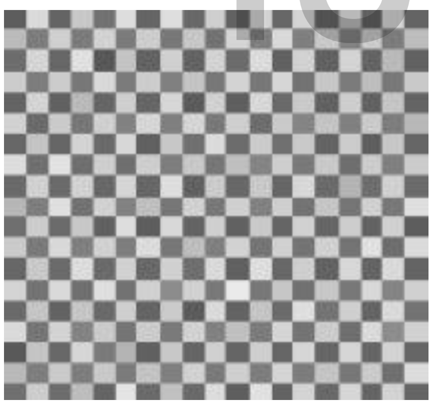

Figure 7. A portion of the background of the CFA image showed in figure 6.

Figures 3, 4, 5 and 6 show the CFA images obtained after the derawtisation operation; whose purpose is to generate a CFA image from a raw data. By observing these figures, it is indeed found that the CFA images obtained are grayscale images, in which the objects of interest are clearly distinguishable from the background used in photography. We note also in Figure 7 that the levels of the white background do not appear uniform on the image observed. This non-uniformity of the white background confirms the thesis of Deever et al. [7]; the results reported by the above-mentioned authors stipulate that the pixel levels of a neutral scene do not appear uniform in a raw (uncorrected) CFA image.

The non-uniform appearance of the white background necessarily implies that a CFA image must be pretreated before any other use.

Let ICFA the CFA image acquired by our Fujifilm HS10 digital camera. For each pixel p (x, y) of spatial coordinates x and y in the CFA image, a single red (R), green (G) or blue (B) component is associated. Let R all the pixels of ICFA from which the red level is available, G all the pixels of ICFA from which the green level is available and B all the pixels of ICFA from which the blue level is available. The alternation of color components found in Figure 7 allowed us to define the subset of pixels, and as follows:

$$\begin{cases} R = \{p(x,y) / x \ \ odd \ \ , \ \ y \ \ odd\} \\ G = \{p(x,y) / x \ \ , \ \ y \ \ with \ \ the \ \ same \ \ parity\} \\ B = \{p(x,y) / x \ \ even \ \ , y \ \ even\} \end{cases} \quad (1)$$

Each CFA image obtained contains only one color component per pixel, an interpolation of the missing colors is mandatory and this for each pixel. This is demosaicing, a step that produces the information of the final color image.

Referring to the work done by [6], [8] - [10], it is clear and easy that image analysis of food products implies a total control and control over the acquisition image of the product to image analysis. In addition, the analysis of food products images requires that the images must be not compressed before their exploitation; hence the interest of using the CFA images for food images analysis control. Theses CFA images can be subsequently pretreated, segmented or dematriate to obtain color images, in condition to not do compress them.

4 Conclusion

The objective of this work was to develop a fast algorithm to extract CFA images from raw data acquired by any camera. The implementation of our methodology based on a fast algorithm implemented using Dcraw resources incorporated under Windows, allowed us in the first to obtain the metadata parameters from data raw, and in the second we extracted easily CFA image from raw data. It is therefore clear that the implementation of this derawtisation approach will make it possible in the future to use uncompressed images of food products for the food control quality.

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