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Noise processing methods for Media Processor SOC

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Abstract: Images taken with both digital cameras and conventional film cameras will pick up noise from a variety of sources. Many further uses of these images require that the noise will be (partially) removed - for aesthetic purposes as in artistic work or marketing, or for practical purposes such as computer vision. Various types of noises include improper black level, salt-and-pepper noise, speckle noise, etc. These noises can be removed with the help of a media processor SOC. The approach mentioned here explains the methods that can be used to remove the above mentioned noises. Each method is explained in detail with necessary diagrams.

Keywords: noise processing; black level; speckle noise; salt and pepper noise; median filter

1. INTRODUCTION

Some common types of noises found in images from digital camera are: Improper black level, fixed pattern noise, salt-and-pepper noise, and speckle noise. These noises can be partially or fully removed by properly processing the image data. No single method is available which will remove all these noises simultaneously. Each one has to be taken care of individually. The data coming out of the image sensor [1] will commonly be in Bayer format. In raw Bayer data [2], each image pixel will have only one color component (Red, Blue or Green). The noise processing algorithms [3] can be highly effective in this stage. Hence the algorithms discussed here modify the data in raw Bayer format itself, before it is converted to RGB format by the media processor SOC.

Improper values of Black level leads to the whitening of image dark region and perceived loss of overall contrast. Dark current from the sensor and lens flare from the lens are the main reasons. This type of noise shall be removed from the image before any other processing [4] has happened on the data. When there is a random variation in pixel values in an image with uniform brightness, it is said to contain speckle noise. These variations are caused by the sensor's unique physical properties. When white and black pixels occur randomly in an image, it is called salt and pepper noise. These normally occur when the pixel values goes out of allocated range. In the coming section, each noise is considered and the methods that can be used to remove them are explained. These methods can be incorporated [5] in a media processor SOC to get good quality images.

2. PROPOSED SCHEME

Here, noise removal method for each type of noise is explained separately.

2.1 Improper black level

Offset and multiplier values can be applied to the image data to successfully correct the black level [6]. First, a pre-offset can be applied to correct any improper black level is provided by the sensor. Then a multiplier can be used to make sure that the image data is in the optimum range. Then post-offset can be applied to remove any improper shift in black level still present in positive or negative direction. Each color in Bayer data will have separate offset and gain values. But all the pixels in a particular Bayer channel will be processed with a single value.

$$\text{Output data} = ((\text{Input data} + \text{Pre-offset}) * \text{Multiplier}) + \text{Post-offset} \quad (1)$$

To identify the offsets and multiplier values required, image is captured with lens cap on. Then a histogram is plotted with the received Bayer data. A sample histogram for Red component in Bayer data is shown. An unwanted offset can be seen in the left portion of the histogram (Unwanted because the image is captured with lens cap on).

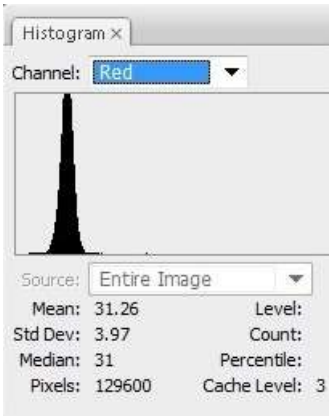

Figure 1. Histogram – Red channel without correction

This offset is configured as the pre-offset value (with negative sign). Multiplier value is also configured to make the data range optimal to take care of bright as well as dark images. Finally, a post-offset is used if required. The histogram of the result image, with the unwanted offset corrected is shown below.

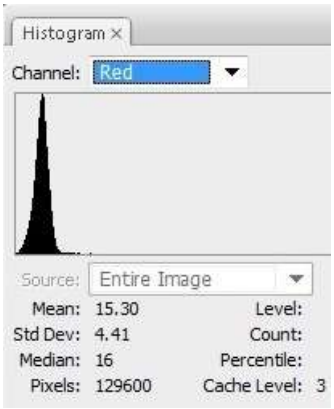

Figure 2. Histogram – Red channel after correction

2.2 Speckle and Salt and Pepper noise

A median filtering method can be used to remove both these noises [7]. Since these noises affect only certain individual pixels without changing the values of neighboring pixels, a median value from the selected neighborhood can be used to replace the affected pixel. Range of the neighborhood has to be properly selected to make sure that the application of this filter does not adversely affect the clarity of the image. The neighborhood can be selected as shown below:

00-G	01-R	02-G	03-R	04-G
10-B	11-G	12-B	13-G	14-B
20-G	21-R	22-G	23-R	24-G
30-B	31-G	32-B	33-G	34-B
40-G	41-R	42-G	43-R	44-G

Figure 3. Green Median Selection

Pixel 22 is the pixel of interest. Green median = median (02, 11, 20, 31, 42, 33, 24, 13, 22). This median will be compared with pixel 22.

00-R	01-G	02-R	03-G	04-R
10-G	11-B	12-G	13-B	14-G
20-R	21-G	22-R	23-G	24-R
30-G	31-B	32-G	33-B	34-G
40-R	41-G	42-R	43-G	44-R

Figure 3. Red Median Selection

Pixel 22 is the pixel of interest. Red median = median (00, 02, 04, 20, 22, 24, 40, 42, 44). This median will be compared with pixel 22. Similar median is selected from blue pixels also.

A threshold value has to be defined which decides whether a pixel has to be replaced with the median value or not. Each pixel will be taken and compared with the median from its neighborhood. If the difference between these two pixels exceeds the configured threshold value, then the pixel of interest can be replaced with the median value. If not, the pixel can be left as such. Such a median method is superior to the method of averaging the pixels in that the sharpness of the image will not be greatly affected [8] with median method.

3. CONCLUSION

In this paper we propose two methods for effectively removing some most common noises in digital video. These methods can be easily implemented in a media processor SOC to deliver good quality video. The advantage of these methods is that this will not be such an overhead to the computing tasks of the media processor. Hence the media processor SOC when run at high frequencies can encode this corrected image data for recording or streaming over network.

4. REFERENCES

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