Application Report
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ISS Image Pipe for Alternate CFA Formats

Mayank Mangla, Gang Hua, Shashank Dabral

ABSTRACT

TDAxx ISS offers a powerful and feature rich Image Pipe for processing RAW sensor data and generating a high quality output stream. Image pipe is configurable allowing the users to adjust image quality based on sensor properties and tuning preferences. To enable this TI delivers example processing pipelines in Vision Software Development Kit (SDK) and PC based graphical tool for image quality tuning. A limitation of ISS is that was designed originally for Bayer Color Filter Array (CFA) image format. Bayer format is very popular in viewing applications. However, some Advanced Driver Assistance Systems (ADAS) applications require ISP for other applications (like analytics, autonomous driving, self-parking, and so forth) where non Bayer formats are required. This paper explains how some of the alternate CFA formats can be supported on ISS Hardware Image Pipe with no SW pixel processing.

Contents

1 RCCC Format 2
2 Monochrome 3
3 Device Description 3
4 RCCB 4
5 References 4

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1 RCCC Format

1.1 Introduction

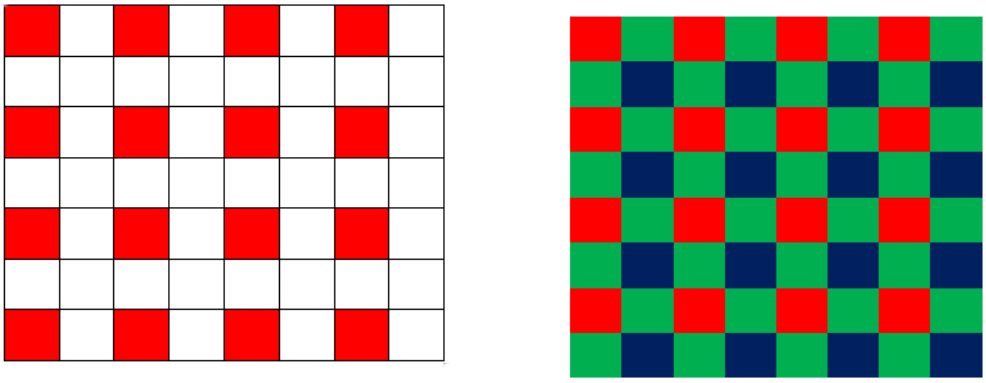

Figure 1. RCCC Format vs Bayer (RGGB)

Bayer CFA has 25% R, 25%B and 25G pixels. For each pixel, only R, G or B is available, but for full color rendering complete RGB information is needed. ISP does it by a technique called CFA Interpolation or de-mosaicing. Interpolation parameters are programmable through a register interface.

RCCC has 75% “clear” pixels which give the light intensity information and no color information. 25% of the pixels have RED color information. Blue is completely dropped. This is acceptable for either monochrome viewing or for analytics applications where Red information is enough (for example, traffic signal detection). The advantage of this format is that it provides more sensitivity to light and therefore works better in dark conditions.

1.2 Changes Required in ISP

1.2.1 CFA Interpolation Parameters

Table 1. CFA Interpolation Parameters

	Bayer	RCCC
HPF Threshold	600	8192
HPF Slope	570	
MIX Slope	10	1023
Non Directional Weight	16	0

For details and MMR addresses of these registers, see the *Safety Modules* chapter of the *TDA3x SoC for Advanced Driver Assistance Systems (ADAS) Silicon Revision 2.0, 1.0A, 1.0 Technical Reference Manual* (SPRUHQ7H).

1.2.2 Auto White Balance

To be disabled.

1.2.3 Auto Exposure

Same algorithm as for bayer format. However, H3A statistics must be interpreted differently. For example, Vision SDK has a function for converting H3A statistics in bayer format to RGB uses a RGB2YUV matrix multiplication to calculate average luminance. With RCCC format, the statistics already have luminance information. Therefore, this calculation can be bypassed.

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1.2.4 Color Correction

To be disabled. Use a unity matrix for RGB2RGB1 and RGB2RGB2.

1.2.5 RGB2YUV Conversion

RGB2YUV conversion step is required to separate Luma and Red components of RCCC image. This is done by using the following conversion matrix.

```
                        [
                             [0,      256,   0]
[Y, U, V]  = [R, G, B]       [256,    0,     0]
                             [0,      0,     0]
                        ]
                      - [0, -128, -128]
```

After the conversion:

- Y contains Luminance information
- U contains Red information
- V contains only zeroes

1.2.6 Rest of Image Pipe

Most of the image pipe is expected to remain the same. IP blocks specific to color must be bypassed or disabled. These include blocks like 3DLUT, Chroma Noise Filter, Chromatic Artifact Reduction etc. LSC and Noise Filters are expected to usable, but the tuning strategy and tuning tool designed for Bayer will not work.

2 Monochrome

2.1 Introduction

3 Device Description

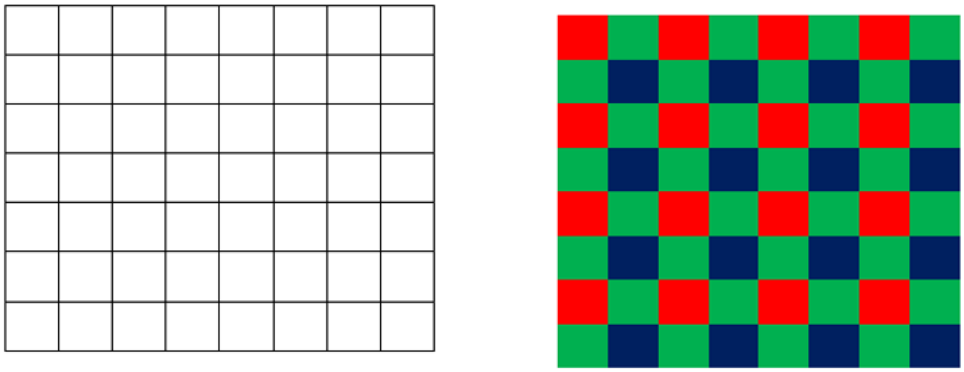

Figure 2. Monochrome Format vs Bayer (RGGB)

Monochrome has 100% “clear” pixels which give the light intensity information and no color information. This is acceptable for either monochrome viewing or for analytics applications where no color information is required (for example, driver monitoring). The advantage of this format is that it provides more sensitivity to light and therefore works better in dark conditions.

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3.1 Changes required in ISP

3.1.1 DPC, H3A, NSF3

Treat 12b monochrome input as 12-bit Bayer

3.1.2 GLBCE

Programmed as 12-bit -> 8-bit Gamma.

3.1.3 Auto White Balance

To be disabled.

3.1.4 Auto Exposure

Same algorithm as for bayer format. However, H3A statistics must be interpreted differently. For example, Vision SDK has a function for converting H3A statistics in bayer format to RGB uses a RGB2YUV matrix multiplication to calculate average luminance. With RCCC format, the statistics already have luminance information. Therefore, this calculation can be bypassed.

3.1.5 Rest of Image Pipe

Bypassed. 8-bit YUV is available from GLBCE output stage.

4 RCCB

4.1 Introduction

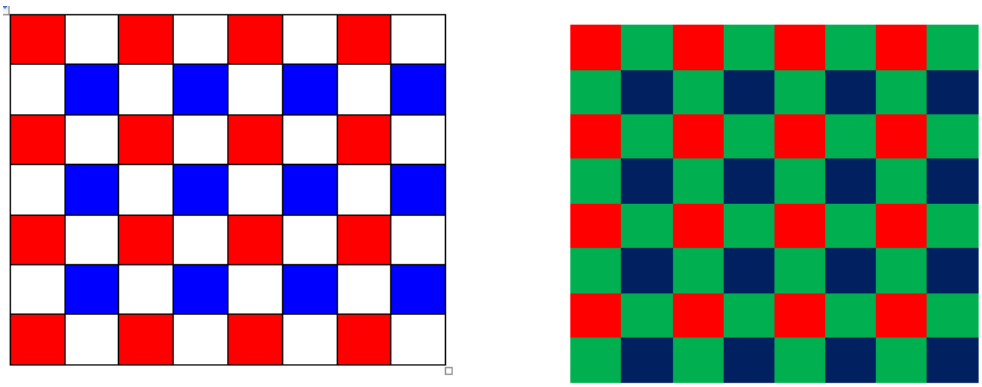

Figure 3. RCCB Format vs Bayer (RGGB)

RCCB is similar to Bayer (RGGB) with the exception that half of the pixels are clear instead of green. The advantage of this format is that clear pixels provide more low-light sensitivity, thus leading to lower noise. This format has potential to allow the same camera for visual as well as analytic application.

4.2 Changes Required in ISP

No change needed. All of the processing to remain same as Bayer. However, strong AWB color gains are needed to make the image visually correct. This may require a modification to AWB algorithm or tuning procedure.

5 References

Safety Modules chapter in the *TDA3x SoC for Advanced Driver Assistance Systems (ADAS) Silicon Revision 2.0, 1.0A, 1.0 Technical Reference Manual* (SPRUHQ7H)

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