Bayer-Filter Sensor and Beyond

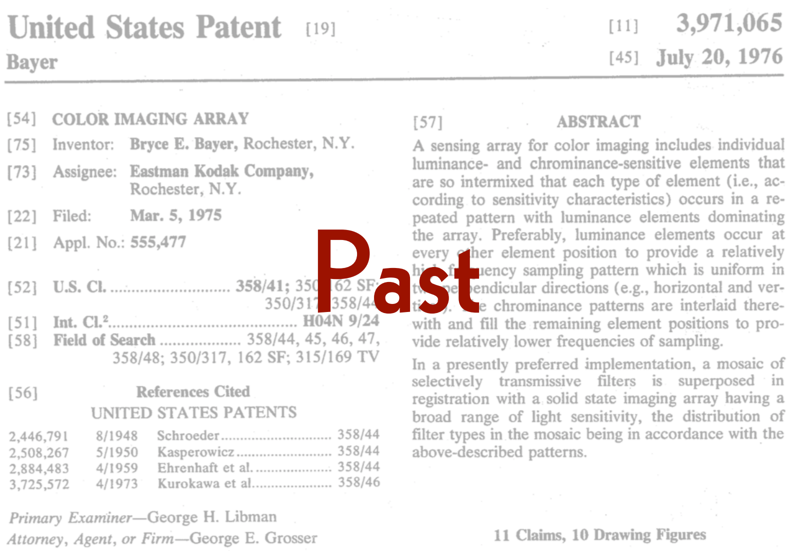
Reto Kromer • AV Preservation by reto.ch

Archives of the Future: Open, Sustainable and Equitable
IASA Conference
Mexico, 26–29 September 2022

Summary

- past
- present
- future

Past



United States Patent [19]
Bayer

[11] **3,971,065**
[45] **July 20, 1976**

[54] COLOR IMAGING ARRAY
[75] Inventor: **Bryce E. Bayer**, Rochester, N.Y.
[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.
[22] Filed: **Mar. 5, 1975**
[21] Appl. No.: **555,477**

[52] **U.S. Cl.** .... **358/41**; 350/162 SF; 350/317; 358/44
[51] **Int. Cl.²** **H04N 9/24**
[58] **Field of Search** .... 358/44, 45, 46, 47, 358/48; 350/317, 162 SF; 315/169 TV

[56] **References Cited**
UNITED STATES PATENTS

2,446,791	8/1948	Schroeder	358/44
2,508,267	5/1950	Kasperowicz	358/44
2,884,483	4/1959	Ehrenhaft et al.	358/44
3,725,572	4/1973	Kurokawa et al.	358/46

Primary Examiner—George H. Libman
Attorney, Agent, or Firm—George E. Grosser

[57] **ABSTRACT**

A sensing array for color imaging includes individual luminance- and chrominance-sensitive elements that are so intermixed that each type of element (i.e., according to sensitivity characteristics) occurs in a repeated pattern with luminance elements dominating the array. Preferably, luminance elements occur at every other element position to provide a relatively high frequency sampling pattern which is uniform in two perpendicular directions (e.g., horizontal and vertical). The chrominance patterns are interlaid therewith and fill the remaining element positions to provide relatively lower frequencies of sampling.

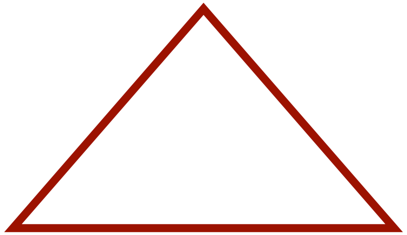
In a presently preferred implementation, a mosaic of selectively transmissive filters is superposed in registration with a solid state imaging array having a broad range of light sensitivity, the distribution of filter types in the mosaic being in accordance with the above-described patterns.

11 Claims, 10 Drawing Figures

Digital Video

- resolution
- bit depth
- linear, power, logarithmic encoding
- colour model
- chroma subsampling and compression
- illuminant

image quality



encoding time

file size

5

Uncomfortable Truths

- sensors are colour blind
- Bayer sensors do not generate full RGB

6

Bryce E. Bayer (1929–2012)

7

United States Patent [19] [11] **3,971,065**

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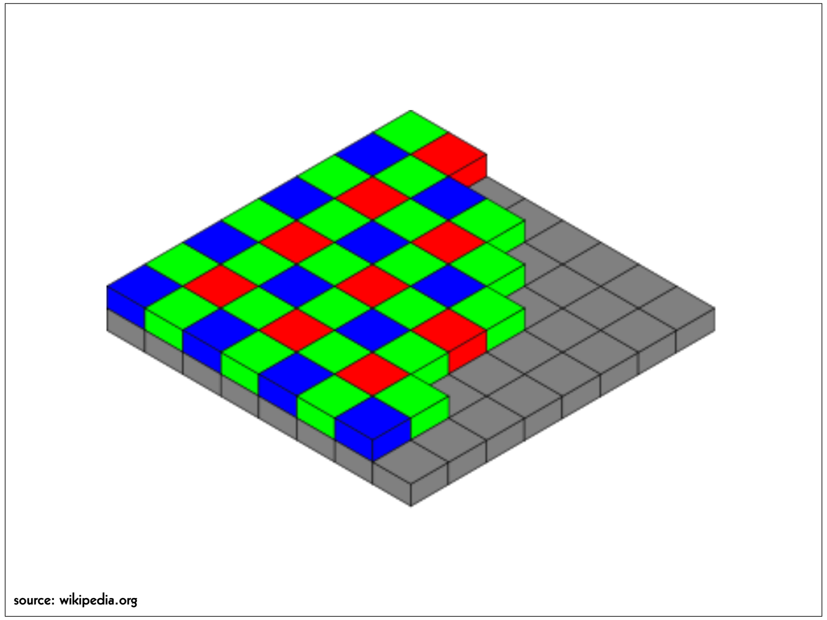
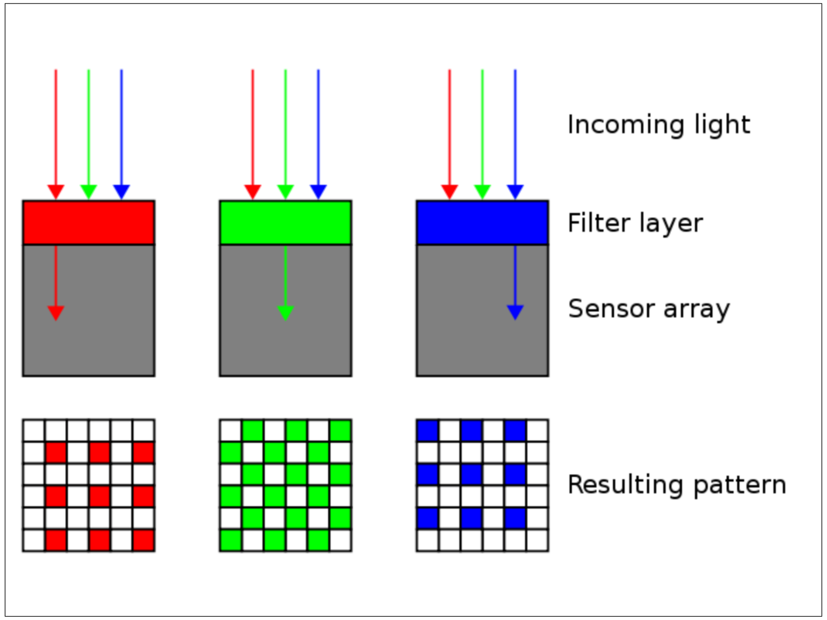
11 Claims, 10 Drawing Figures

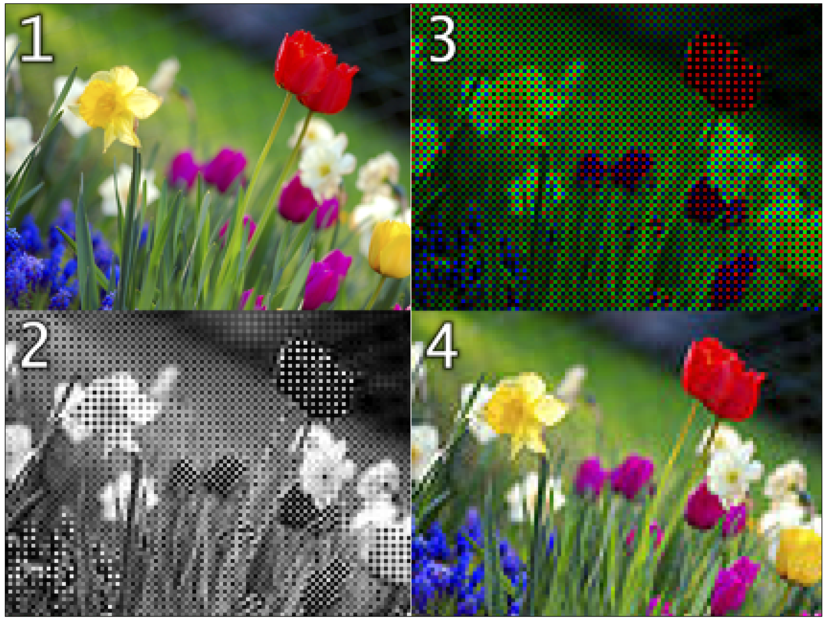
8


source: wikipedia.org

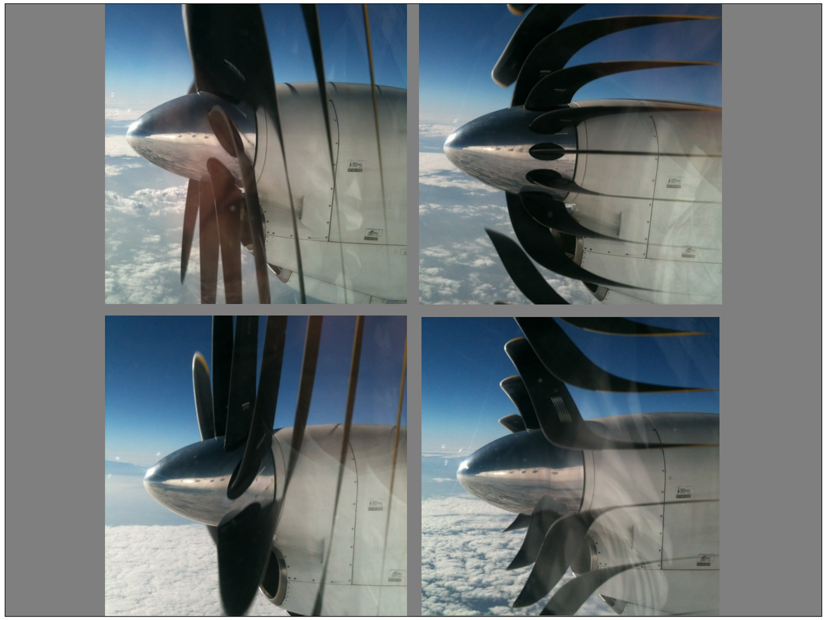
9


Incoming light
Filter layer
Sensor array
Resulting pattern

10


1
3
2
4

11

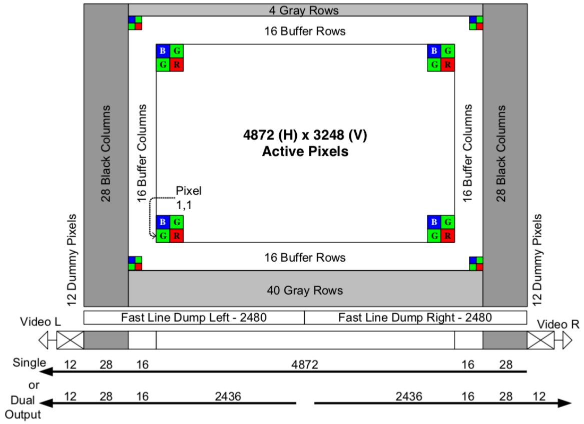


12

Kodak
Image Sensor Solutions

DEVICE DESCRIPTION

ARCHITECTURE



Kodak
Image Sensor Solutions

COLOR WITH MICROLENS QUANTUM EFFICIENCY

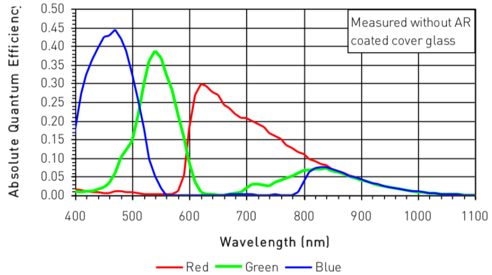


Figure 5: Color with Microlens Quantum Efficiency

Kodak
Image Sensor Solutions

LINE TIMING CONTINUOUS MODE

Line Timing Single Output

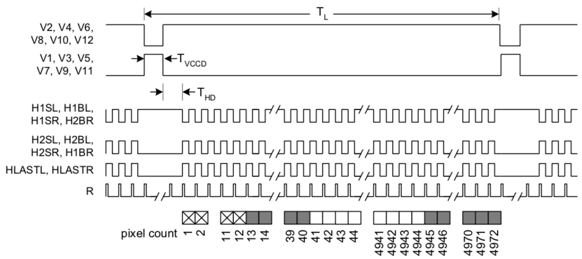
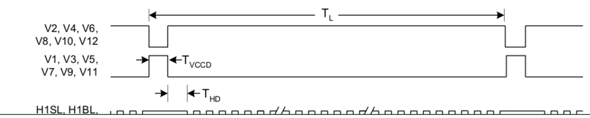


Figure 10: Line Timing Single Output

Line Timing Double Output



Fast Dump Gate Trailing Delay	T_{FDT}	0.5			µs	
VCCD Line Clock Leading Edge Delay	T_{VL}	0.2	0.3	0.4	µs	
VCCD Line Clock Trailing Edge Delay	T_{VT}	0.0	0.2	0.4	µs	

MAIN TIMING – CONTINUOUS MODE

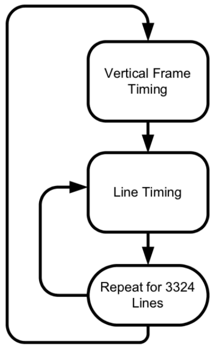


Figure 8: Main Timing - Continuous Mode

 www.kodak.com/go/imagers Revision 5.0 MTD/PS-1027 p18

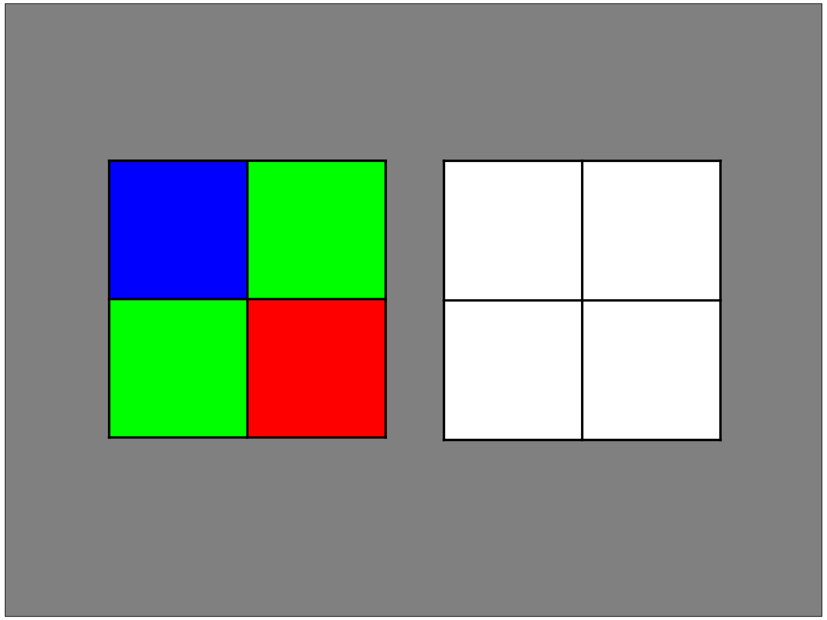
```
01110101001010101000101101010111110
01001101010101010101000010111101010
01110101001010101000101101010111110
00011101010101010101000010111101010
01101010100101010100010110101011111
00101010101010100001011101010100000
01110101001010101000101101010111110
01010101010101010000101110101001100
10010111010100101010100010110101010 1
11100101010101010100001011101010101 0
01110101001010101000101101010111110
01010101010101010011010101000000001
00101000101010101010010101010101010 1
```

Present

17

```
01110101001010101000101101010111110
01001101010101010101000010111101010
01110101001010101000101101010111110
00011101010101010101000010111101010
01101010100101010100010110101011111
00101010101010100001011101010100000
01110101001010101000101101010111110
01010101010101010000101110101001100
10010111010100101010100010110101011
11100101010101010100001011101010101
01110101001010101000101101010111110
01010101010101010011010101000000001
00101000101010101010010101010101010
```

18



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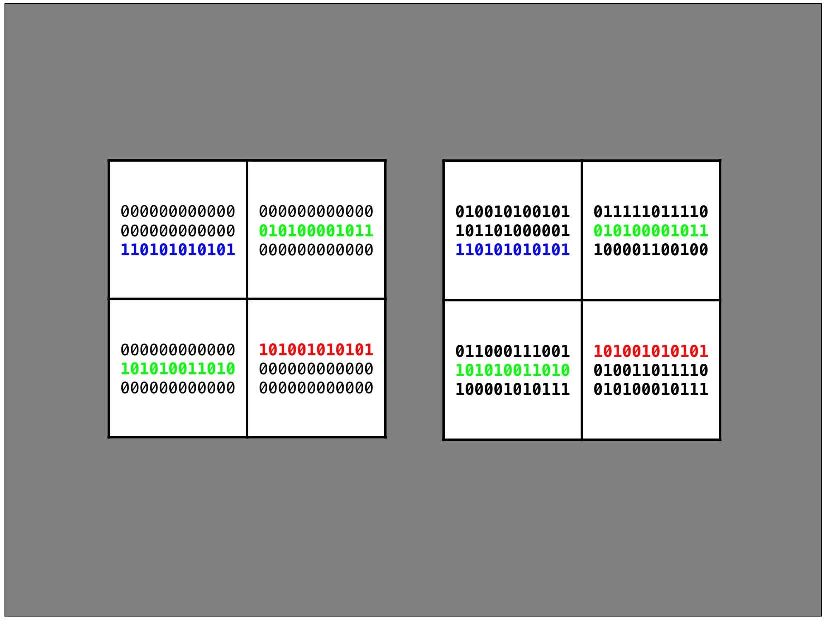

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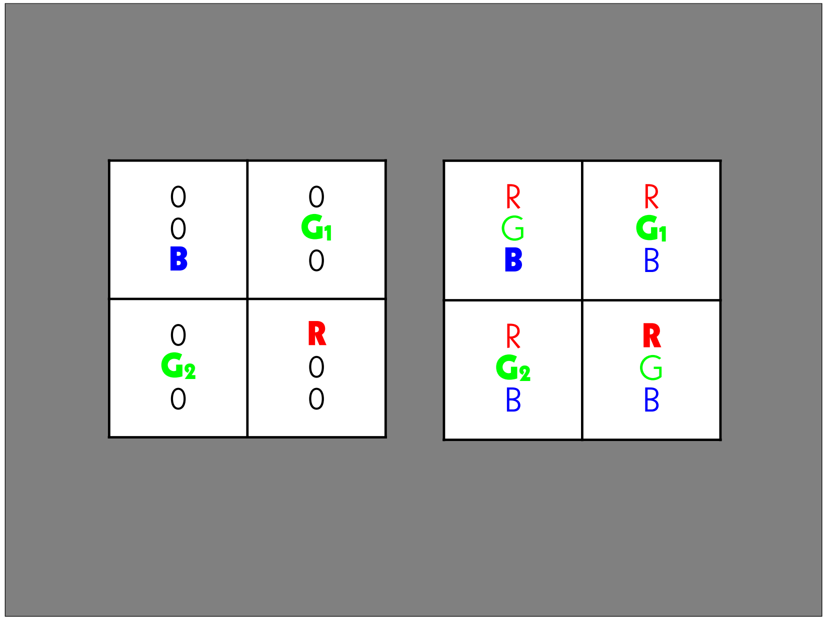
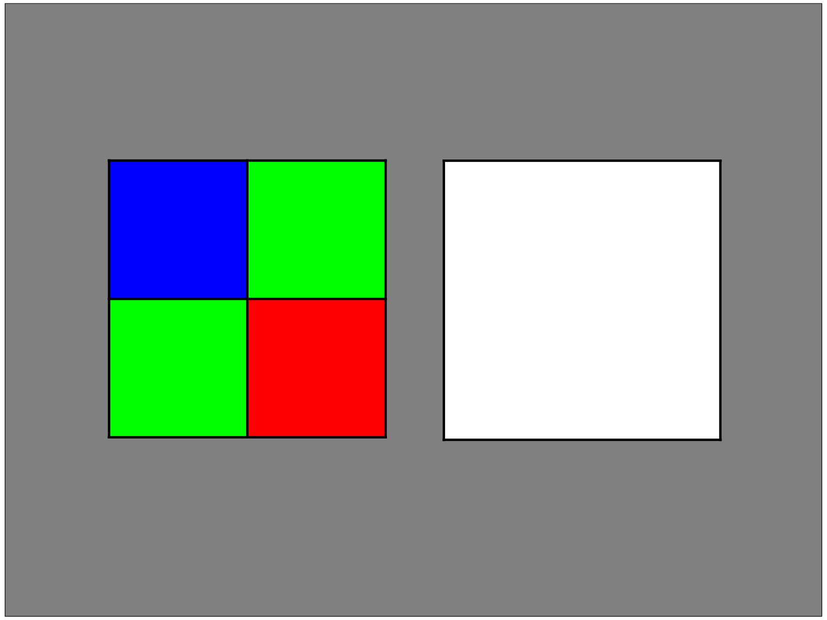

0
0
B
0
G1
0
0
G2
0
R
0
0
R
G
B
R
G1
B
R
G2
B
R
G
B

21



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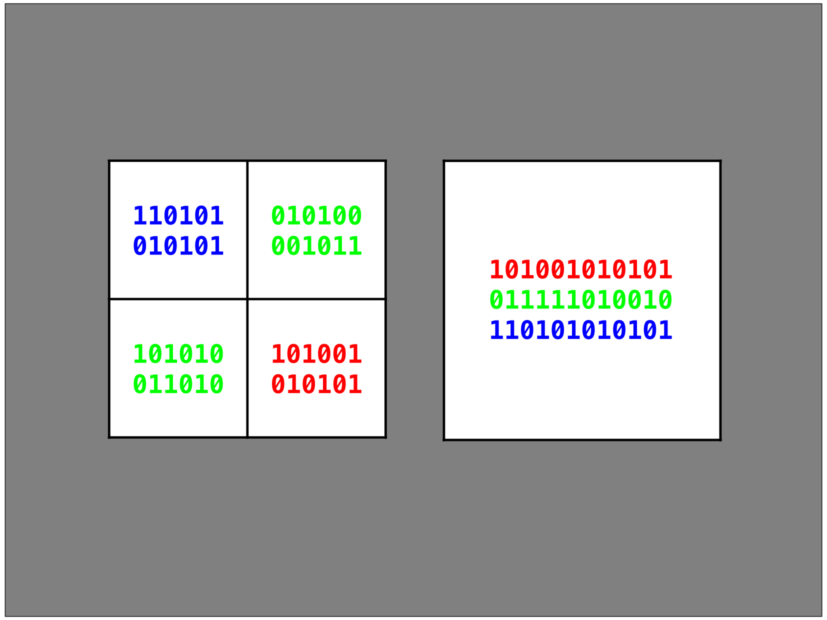
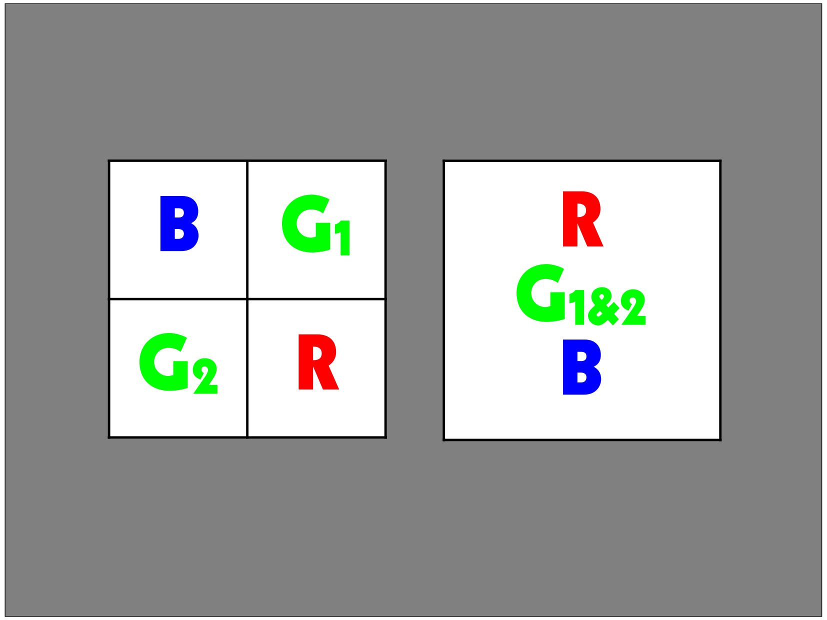

110101
010101
010100
001011
101010
011010
101001
010101
101001010101
011111010010
110101010101

23


B
G1
G2
R
R
G1&2
B

24

Two ways to use Bayer data

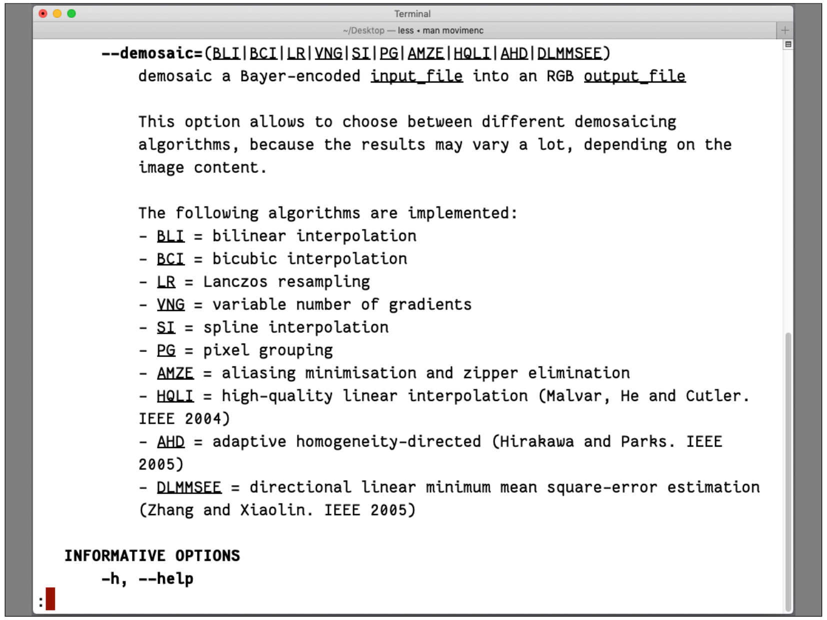
digital blow-up to RGB

- 3 times the amount of the generated data
- the file has the full sensor resolution
- only ⅓ of the data are real

digital reduction to RGB

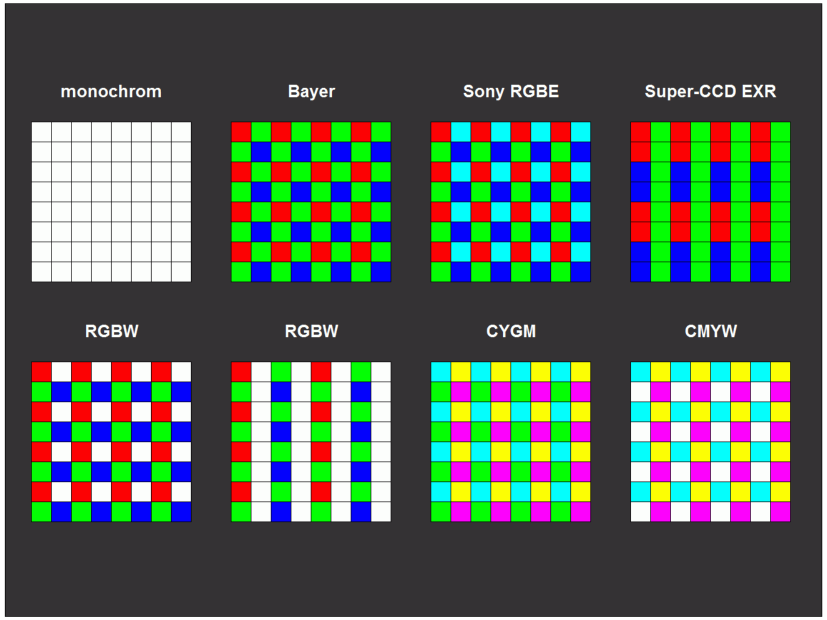
- ¾ the amount of the generated data
- the file has ½ of the sensor resolution
- all data are real

25

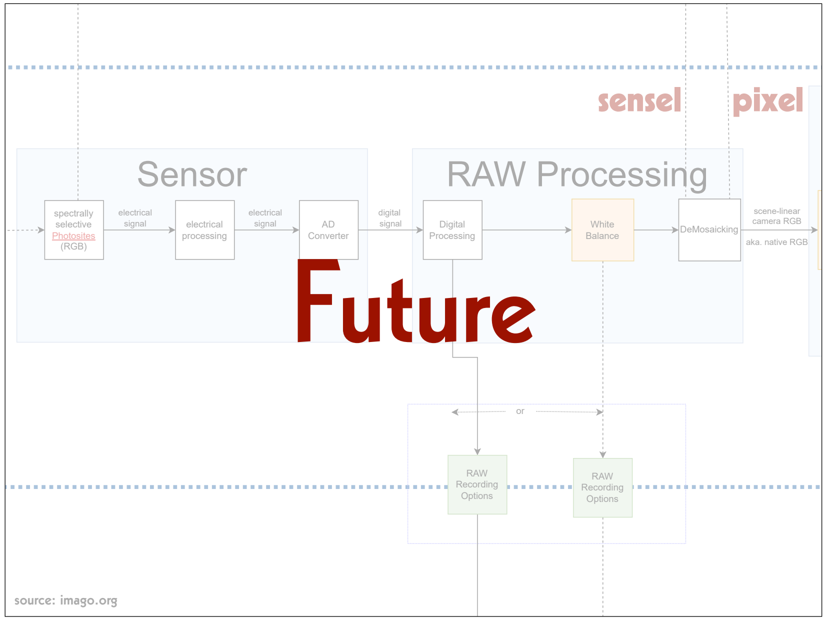


```
Terminal
~/Desktop — less ◂ man movimenc

     --demosaic=(BLI|BCI|LR|VNG|SI|PG|AMZE|HQLI|AHD|DLMMSEE)
         demosaic a Bayer-encoded input_file into an RGB output_file

         This option allows to choose between different demosaicing
         algorithms, because the results may vary a lot, depending on the
         image content.

         The following algorithms are implemented:
         - BLI = bilinear interpolation
         - BCI = bicubic interpolation
         - LR = Lanczos resampling
         - VNG = variable number of gradients
         - SI = spline interpolation
         - PG = pixel grouping
         - AMZE = aliasing minimisation and zipper elimination
         - HQLI = high-quality linear interpolation (Malvar, He and Cutler.
         IEEE 2004)
         - AHD = adaptive homogeneity-directed (Hirakawa and Parks. IEEE
         2005)
         - DLMMSEE = directional linear minimum mean square-error estimation
         (Zhang and Xiaolin. IEEE 2005)

 INFORMATIVE OPTIONS
     -h, --help
:
```

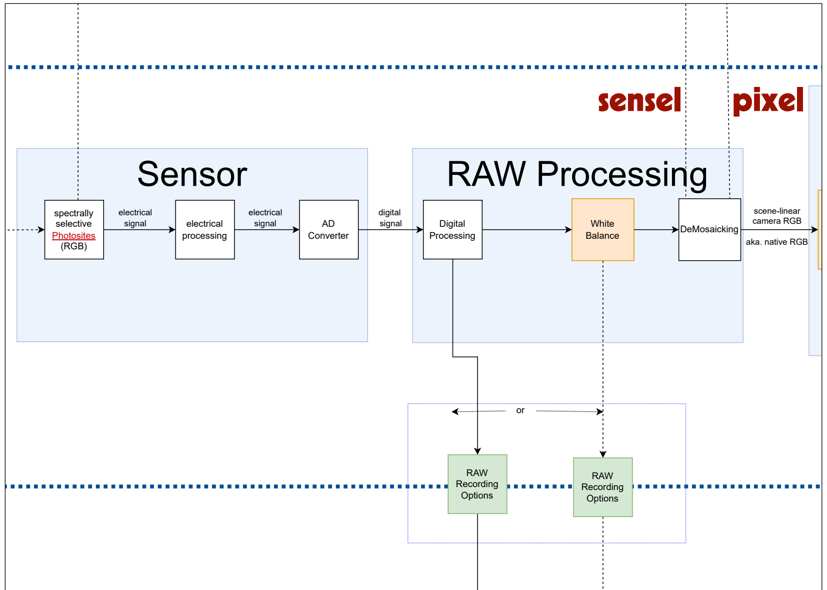
26



27



28



source: imago.org

29

Stream: Internet Engineering Task Force (IETF)
RFC: 9043
Category: Informational
Published: August 2021
ISSN: 2070-1721
Authors: M. Niedermayer D. Rice J. Martinez

RFC 9043
FFV1 Video Coding Format Versions 0, 1, and 3

Abstract

This document defines FFV1, a lossless, intra-frame video encoding format. FFV1 is designed to efficiently compress video data in a variety of pixel formats. Compared to uncompressed video, FFV1 offers storage compression, frame fixity, and self-description, which makes FFV1 useful as a preservation or intermediate video format.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

30

FFV1: Directions (1)

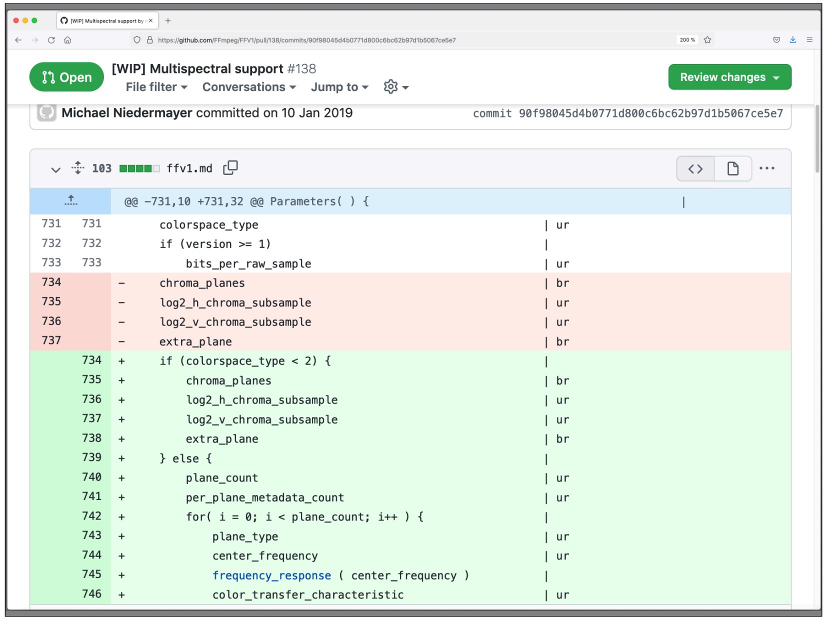
- support of the Y′CoCg colour model
- support of Bayer-type data
- support of any channel
- support of 1D and 3D LUTs
- support of HDR

31

FFV1: Directions (2)

- revision of the bit stream
- tuning of the compression algorithm (speed and rate)

32



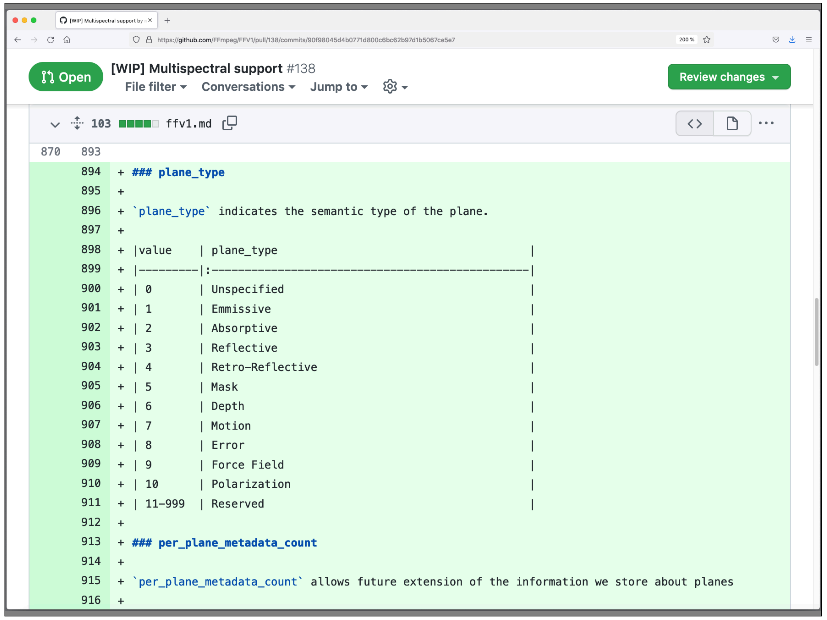
Open [WIP] Multispectral support #138
File filter Conversations Jump to
Review changes

Michael Niedermayer committed on 10 Jan 2019 commit 90f98045d4b0771d800c6bc62b97d1b5067ce5e7

103 ffv1.md

```
@@ -731,10 +731,32 @@ Parameters( ) {                    |
      colorspace_type                                    | ur
      if (version >= 1)                                  |
          bits_per_raw_sample                            | ur
-     chroma_planes                                      | br
-     log2_h_chroma_subsample                            | ur
-     log2_v_chroma_subsample                            | ur
-     extra_plane                                        | br
+     if (colorspace_type < 2) {                         |
+         chroma_planes                                  | br
+         log2_h_chroma_subsample                        | ur
+         log2_v_chroma_subsample                        | ur
+         extra_plane                                    | br
+     } else {                                           |
+         plane_count                                    | ur
+         per_plane_metadata_count                       | ur
+         for( i = 0; i < plane_count; i++ ) {           |
+             plane_type                                 | ur
+             center_frequency                           | ur
+             frequency_response ( center_frequency )    |
+             color_transfer_characteristic              | ur
```

33



Open [WIP] Multispectral support #138
File filter Conversations Jump to
Review changes

103 ffv1.md

```
+ ### plane_type
+
+ `plane_type` indicates the semantic type of the plane.
+
+ |value    | plane_type                                   |
+ |--------|:---------------------------------------------|
+ | 0      | Unspecified                                  |
+ | 1      | Emmissive                                    |
+ | 2      | Absorptive                                   |
+ | 3      | Reflective                                   |
+ | 4      | Retro-Reflective                             |
+ | 5      | Mask                                         |
+ | 6      | Depth                                        |
+ | 7      | Motion                                       |
+ | 8      | Error                                        |
+ | 9      | Force Field                                  |
+ | 10     | Polarization                                 |
+ | 11-999 | Reserved                                     |
+
+ ### per_plane_metadata_count
+
+ `per_plane_metadata_count` allows future extension of the information we store about planes
+
```

34

until 31st January 2023

AV Preservation by

reto.ch

zone industrielle Le Trési 3
1028 Préverenges
Switzerland

Web: reto.ch
Twitter: @retoch
Email: info@reto.ch

35

from 1st March 2023

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reto.ch

Sandrainstrasse 3
3007 Bern
Switzerland

Web: reto.ch
Twitter: @retoch
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36