RAW Color Cameras

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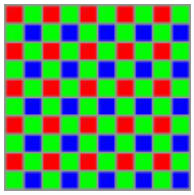
RAW color cameras

Many recent camera models feature RAW color coding. Fire-i™ 3.0 Software and Fire-iAPI™ 3.0 Development Toolkit are able to support these models. Customers not familiar with this operation mode may find here a brief explanation.

A camera sensor can only deliver one piece of information per pixel. This is perfect for a monochrome camera, where every pixel reacts to all the wavelengths of the spectrum at same time and outputs a unique result being … the total luminous information (called “luminance” or Y).



For color imaging, 3 pieces of information per pixel are needed. Depending of the use of the picture, it can be (YUV) or (RGB) triplets. YUV is often preferred when the picture is intended to human vision, where RGB fits better computer vision and scientific use, but anyway a triplet is needed. Cameras equipped with a single sensor chip can only see color if a matrix of colored filters is added in front of the sensor’s pixels. The most used matrix for industrial cameras is called “RGB Bayer array”.

The sensor itself can still deliver only one piece of information per pixel, Red, Green or Blue, but 3 are needed in order to display it in full color. A computation must therefore take place, using the information of the **adjacent pixels** (which are filtered in different colors), to simulate the 2 missing piece of information per pixel.
This computation creates of course additional data:

- that are not related fully to the reality, because the information of adjacent pixels is used;
- that will depend on the computation algorithm used, and none is perfect;
- that will increase the total amount of data to transfer, although no more information is coming from the sensor compared to a monochrome camera.

a. Cameras with encoded color output

When the **color computation takes place inside the camera**, camera is said to have encoded color output modes (RGB or YUV). Image data streamed out of the camera correspond to a picture that can be directly displayed, but at the cost of a higher bandwidth used for transmission.

b. Camera with RAW color output

When the **color computation takes place outside the camera**, camera just needs to stream a single data per pixel like a monochrome model. The only difference is the presence of the color filter array in front of the sensor. Color reconstruction is left to the application program. Advantages/disadvantages:

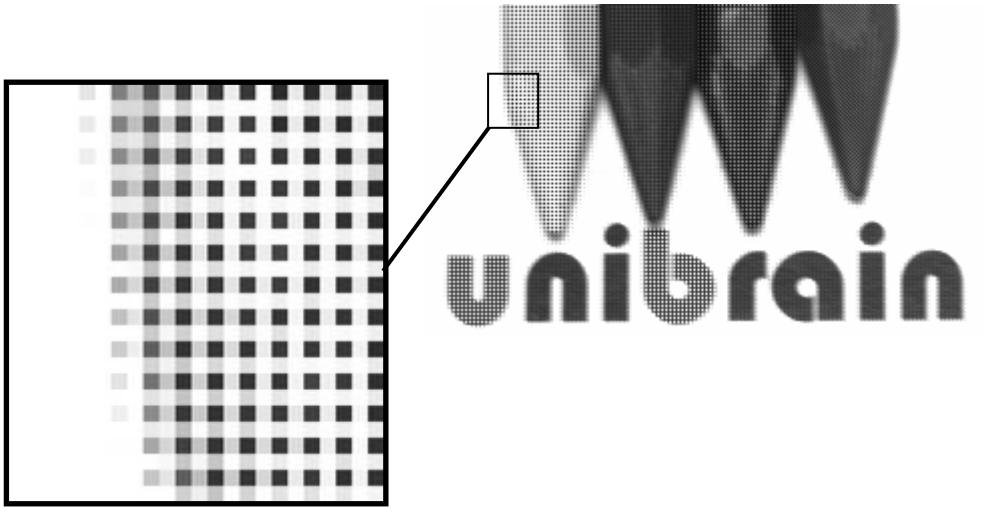
+ Picture transmission uses the less possible FireWire bandwidth: it is therefore possible, using the same FireWire network, to transmit more cameras, higher resolutions and/or higher frame rates;
+ Computation algorithm can be freely selected by the user depending on his specific needs, and not pre-decided by the camera manufacturer: this is a major requirement in high end image processing applications;
- Transmitted picture can only be displayed in color after processing by the application, at the cost of a higher use of computer resources.
  Therefore, customers wanting to use a RAW color camera for visual monitoring in color must be aware of the need a powerful computer to get a fluent display.

c. RAW color handling by the Fire-i™ 3.0 & Fire-iAPI™ 3.0

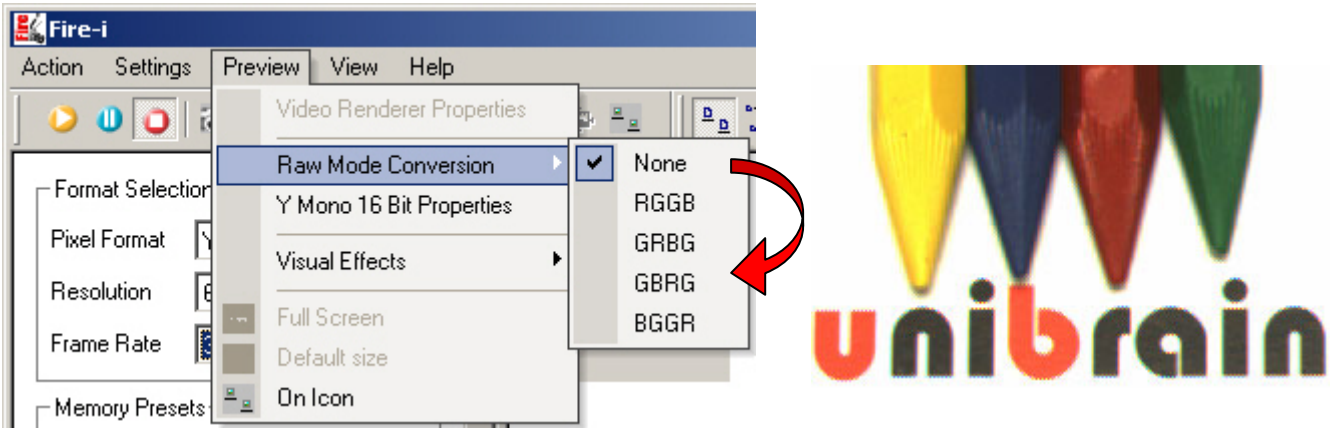
By default, a RAW color mode camera will appear as a monochrome.

It will display a black and white image showing a “grid” effect. This is the result of the modulation of the light level introduced by the Bayer color filter.

A portion of such image is shown here.



Fire-i™ 3.0 Software offers a menu option to switch on the color conversion by the computer. Fire-i yuv decompressor can be used by Fire-iAPI™ 3.0 developers to do a similar conversion.



Please note that a correct display of the colors may only be achieved knowing the geometrical offset of the Bayer filter above the first pixel of the sensor. The corresponding option for conversion must be selected accordingly (RGGB, GRBG, GBRG, BGGR).