

Technical Note

Spatial compensation adjustment for trilinear cameras

Spatial Compensation

Summary:

A trilinear line scan camera uses three sensor lines to capture an image. Color filters are placed on the pixels so that each line captures a different primary color - R, G, or B. The physical spacing of the sensor lines means that each line on the sensor has a slightly different optical angle to the target. As a result, during simultaneous exposure, each line on the sensor captures a slightly different position on the target. Simply combining these captured sensor lines into an RGB representation results in non-precise color reproduction and/or blur. To remedy this, a Spatial Compensation function is used to compensate for the different line positions. Typically, this involves introducing delay factors that stagger the exposure sequence of the three lines so that they each capture the same point on the target. A buffer holds each line image until the third line is captured and the combined RGB data can be output. Modern Spatial Compensation functions can make sub-pixel adjustments as small as 0.01 pixels to account for the timing relationship between the camera's scan rate and the speed of the web.

1. Trilinear sensor layout: JAI's Sweep Series SW-4000TL trilinear camera has two lines dedicated to each color. This is so that vertical binning can be performed if needed. The layout of the sensor is as follows:

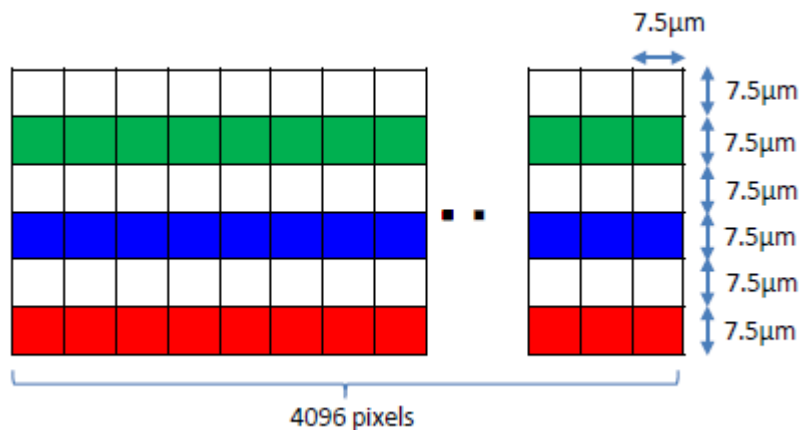


Fig. 1 Layout of trilinear sensor (Binning Vertical = Off)



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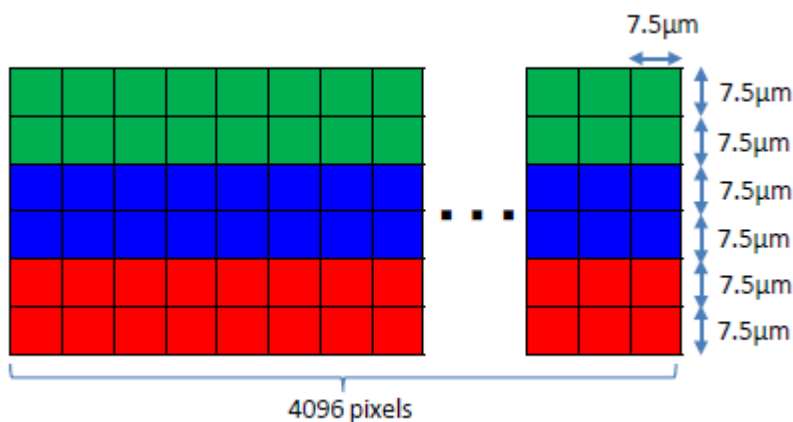


Fig. 2 Layout of trilinear sensor (Binning Vertical = On)

As shown in Fig. 1 and 2, the order of the color channels on the sensor is G/B/R, and whether vertical binning is off or on, the distance from the vertical center of one color channel to the next color channel is 15 μm . As a result, the images for each color channel will have a spatial offset on the target. This difference can be compensated by using the camera function called Spatial Compensation.

2. Method of Spatial Compensation

This section describes the function and method of Spatial Compensation in the SW-4000TL camera. Setting parameters are grouped in JAICustomControllmagingSetup in the Control Tool GUI.

2.1 Definition of each parameter

2.1.1 SpatialCompensationMode:

Two modes are supported; Auto and Manual. Detailed descriptions can be found in the camera's manual.

2.1.2 Spatial Compensation Selector and Spatial Compensation Value:

These settings are for Manual mode. Select the color channel by using the Spatial Compensation Selector and specify the compensation value (delay value) in the Spatial Compensation Value parameter.

The units and range of the Spatial Compensation Value parameter are as follows:

Range: 0 - 80 (integer), Unit: 0.1 pixels (SW-4000TL-PMCL, Device Version 0.1.1.5 or older)

Range: 0 - 800 (integer), Unit: 0.01 pixels (SW-4000TL-PMCL, Device Version 0.1.1.6 or later)

If you are using ASCII Commands - supported by the Camera Link model (SW-4000TL-PMCL) only, the commands and values are as follows:

Command: SPCR/SPCG/SPCB, Range: 0 - 80, Unit: 0.1 pixels

Command: SPCR16/SPCG16/SPCB16, Range: 0 - 800, Unit: 0.01 pixels.



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2.1.3 SpatialCompensationDistance:

This setting is for use with Auto mode. It specifies the distance moved by the web or target (in number of pixels) during one trigger interval.

Range: 0.5 - 2 (Ifloat), Unit: 1 pixel (increment = 0.1 pixel)

If you are using ASCII Commands - supported by the Camera Link model (SW-4000TL-PMCL) only, the commands and values are as follows:

Command: SPCD, Range: 5 - 20, Unit: 0.1 pixels

Command: SPCD16, Range: 50 - 200, Unit: 0.01 pixels.

Note:

On SW-4000TL-PMCL, ASCII Commands of SPCR16/ SPCG16/ SPCB16/ SPCD16 are supported by Device Version 0.1.1.6 or later.

2.2 Manual Compensation Mode

In manual mode, the camera compensates images using the values of SpatialCompensationR, SpatialCompensationG, and SpatialCompensationB. The value specifies the compensation delay distance (in number of pixels) for that line. The units and range of values is defined in section 2.1.2.

Depending on the direction of movement relative to the orientation of the camera, the parameters to be set should be different:

When the G channel (top of the sensor) points in the direction of movement (either the target or the camera are moving in this direction), compensation values (delays) need to be applied to the B and R channels using SpatialCompensationB and SpatialCompensationR.

On the other hand, if the R channel (bottom of the sensor) points in the direction of movement (either the target or the camera are moving in this direction), compensation values (delays) need to be applied to the B and G channels using SpatialCompensationB and SpatialCompensationG.

The adjusting process might be done as follows: check a captured image and find an edge whose chromatic shift is large in the scan direction. Then, measure (or count) the distance (pixel counts) of the chromatic aberration and put the distance into SpatialCompensationR / SpatialCompensationG / SpatialCompensationB. The parameters to be adjusted depend on the scan direction as described above. In most cases, the value needed for SpatialCompensationB (the middle of the three lines) will be half the value of SpatialCompensationG or SpatialCompensationR, depending on the direction.

Note:

When making compensation adjustments, the first 14 lines should be discarded as "dummy lines" to ensure that a consistent timing relationship has been established between the camera and target.



