MIPI CCS camera sensor driver

The MIPI CCS camera sensor driver is a generic driver for MIPI CCS compliant camera sensors. It exposes three sub-devices representing the pixel array, the binner and the scaler.

As the capabilities of individual devices vary, the driver exposes interfaces based on the capabilities that exist in hardware.

Pixel Array sub-device

The pixel array sub-device represents the camera sensor's pixel matrix, as well as analogue crop functionality present in many compliant devices. The analogue crop is configured using the `V4L2_SEL_TGT_CROP` on the source pad (0) of the entity. The size of the pixel matrix can be obtained by getting the `V4L2_SEL_TGT_NATIVE_SIZE` target.

Binner

The binner sub-device represents the binning functionality on the sensor. For that purpose, selection target `V4L2_SEL_TGT_COMPOSE` is supported on the sink pad (0).

Additionally, if a device has no scaler or digital crop functionality, the source pad (1) expses another digital crop selection rectangle that can only crop at the end of the lines and frames.

Scaler

The scaler sub-device represents the digital crop and scaling functionality of the sensor. The V4L2 selection target `V4L2_SEL_TGT_CROP` is used to configure the digital crop on the sink pad (0) when digital crop is supported. Scaling is configured using selection target `V4L2_SEL_TGT_COMPOSE` on the sink pad (0) as well.

Additionally, if the scaler sub-device exists, its source pad (1) exposes another digital crop selection rectangle that can only crop at the end of the lines and frames.

Digital and analogue crop

Digital crop functionality is referred to as cropping that effectively works by dropping some data on the floor. Analogue crop, on the other hand, means that the cropped information is never retrieved. In case of camera sensors, the analogue data is never read from the pixel matrix that are outside the configured selection rectangle that designates crop. The difference has an effect in device timing and likely also in power consumption.

Private controls

The MIPI CCS driver implements a number of private controls under `V4L2_CID_USER_BASE_CCS` to control the MIPI CCS compliant camera sensors.

Analogue gain model

The CCS defines an analogue gain model where the gain can be calculated using the following formula:

gain = m0 * x + c0 / (m1 * x + c1)

Either m0 or c0 will be zero. The constants that are device specific, can be obtained from the following controls:

V4L2_CID_CCS_ANALOGUE_GAIN_M0 V4L2_CID_CCS_ANALOGUE_GAIN_M1
V4L2_CID_CCS_ANALOGUE_GAIN_C0 V4L2_CID_CCS_ANALOGUE_GAIN_C1

The analogue gain (`x` in the formula) is controlled through `V4L2_CID_ANALOGUE_GAIN` in this case.

Alternate analogue gain model

The CCS defines another analogue gain model called alternate analogue gain. In this case, the formula to calculate actual gain consists of linear and exponential parts:

gain = linear * 2 ^ exponent

The `linear` and `exponent` factors can be set using the `V4L2_CID_CCS_ANALOGUE_LINEAR_GAIN` and `V4L2_CID_CCS_ANALOGUE_EXPONENTIAL_GAIN` controls, respectively

Shading correction

The CCS standard supports lens shading correction. The feature can be controlled using `V4L2_CID_CCS_SHADING_CORRECTION`. Additionally, the luminance correction level may be changed using `V4L2_CID_CCS_LUMINANCE_CORRECTION_LEVEL`, where value 0 indicates no correction and 128 indicates correcting the luminance in corners to 10 % less than in the centre.

Shading correction needs to be enabled for luminance correction level to have an effect.