Illuminating the Frame

Enhancing Flash Control in V4L2 @ FOSDEM'26

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disclaimer

This presentation...

- is covering LED flashes only
- is condensed to the most important topics
- uses "strobe" and "flash" mostly interchangeable

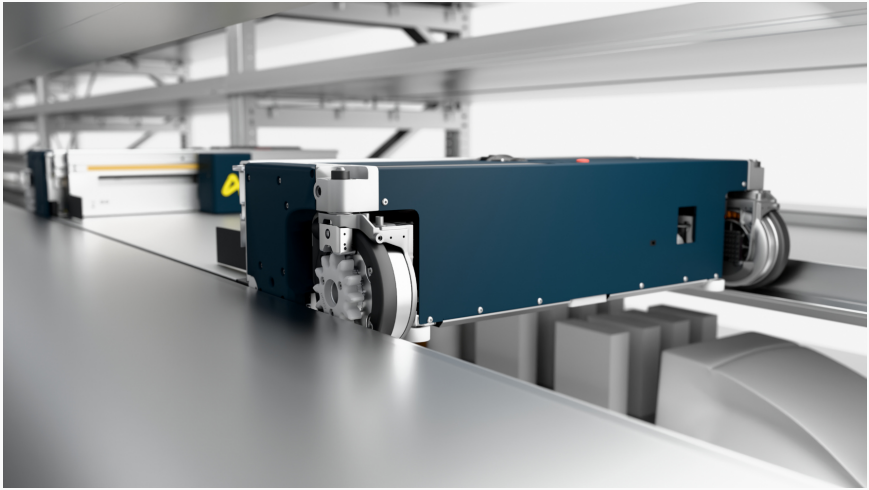
The opinions expressed here are solely my own and do not represent the views of my employer.

The use case

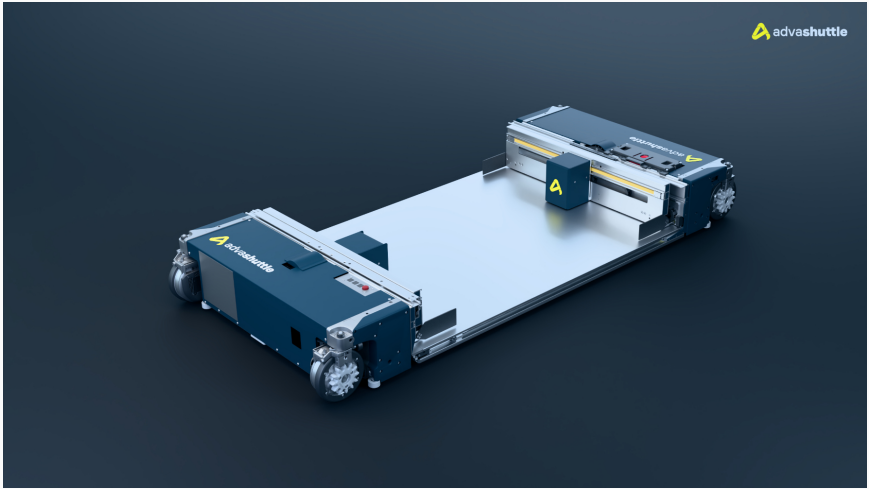
[use-case] advastore shuttle

Localization and positioning of an autonomous logistics shuttle driving on multi-level rails in "dark warehouse".

[use-case] advastore shuttle



[use-case] advastore shuttle



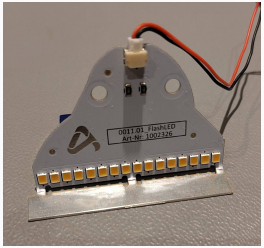
[use-case] advastore shuttle

- localization/positioning is done via 2D barcodes engraved in the rails
- 2 global shutter cameras running at 120fps with LED flashes attached
- shuttle is moving at 2.5 m/s, therefore need to keep exposure time low
- using a Linux v6.18 based OS (YoctoProject v5.3)

Flash basics

[basics] what's a flash/strobe?

a light-emitting unit connected to or used with a camera



[basics] flash control components

Logical components relevant for flash control:

imaging sensor takes the actual image. From a linux point of view behind a microprocessor which controls various aspects as e.g. the exposure time.

strobe source generates trigger for initiating a flash (sequence).

flash controller consumes the signal from the strobe source and controls the flash device.

flash device actually emits light as configured by the flash controller.

[basics] flash timing 1

Matching exposure and flash time. This is basically the default for rolling shutter cameras when using flashes.

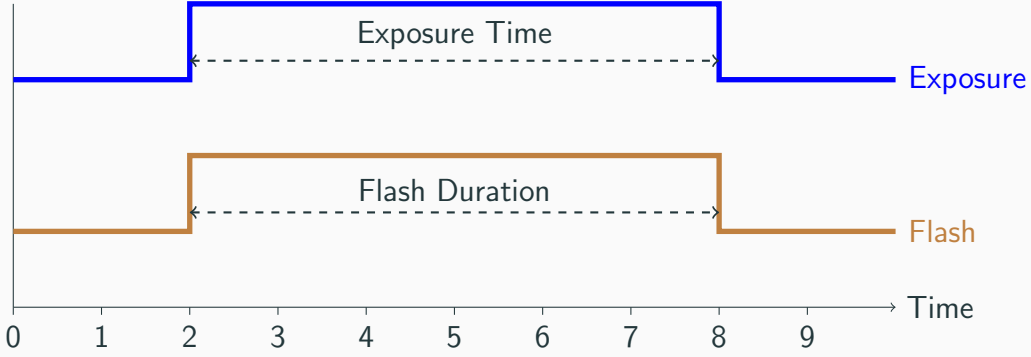


Figure 1: Matching flash and exposure time

[basics] flash timing 2

Negative flash offset to fire the flash already before the sensor starts exposing.
May be used to compensate delays until the flash device emits light.

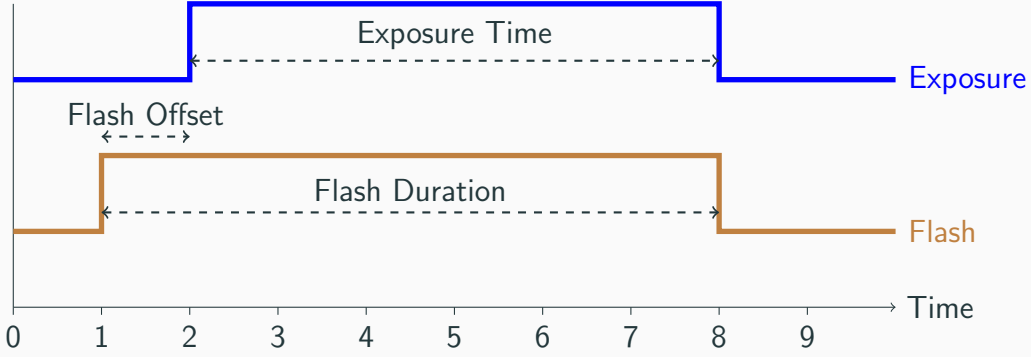


Figure 2: Early flash for full exposure time

[basics] flash timing 3

Short flash duration for reducing lightness in global shutter cameras when exposure is already at minimum.

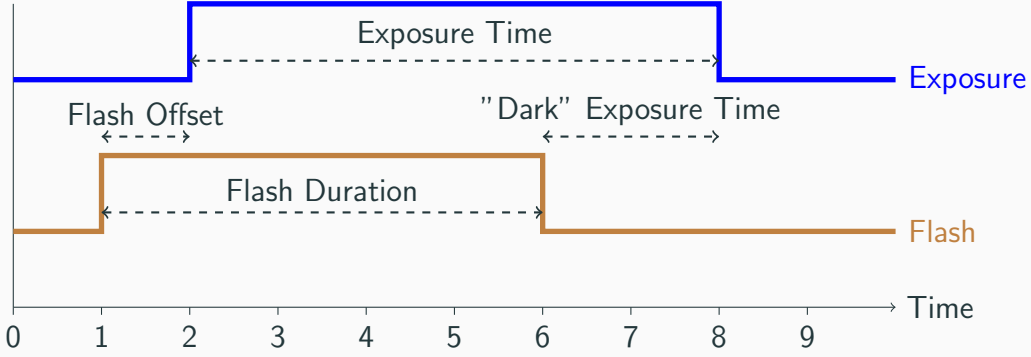


Figure 3: Early and short flash timing

flash control in Linux v6.19

[v4l2-in-6.19] flash mode and source configuration

V4L2_CID_FLASH_LED_MODE: Defines the mode of the flash LED.
For flashing use V4L2_FLASH_LED_MODE_FLASH

V4L2_CID_FLASH_STROBE_SOURCE: The source of the strobe signal.
V4L2_FLASH_STROBE_SOURCE_SOFTWARE: unsynchronized flash
V4L2_FLASH_STROBE_SOURCE_EXTERNAL: synchronized flash

[v4l2-in-6.19] unsynchronized flash control

Software/unsynchronized flash control:

`V4L2_CID_FLASH_STROBE`: Strobe the flash.

`V4L2_CID_FLASH_STROBE_STOP`: Stop flash strobe immediately.

[v4l2-in-6.19] flash controller config

`V4L2_CID_FLASH_TIMEOUT`: Hardware timeout for flash. The flash strobe is stopped after this period of time has passed from the start of the strobe.

`V4L2_CID_FLASH_INTENSITY`: Intensity of the flash strobe when the flash LED is in flash mode in mA.

There are a bunch more controls for reading status, fault handling, etc which are not relevant for this presentation.

V4L2 flash control proposal

[v4l2-proposal] V4L2_CID_FLASH_STROBE_OE

V4L2_CID_FLASH_STROBE_OE: Allows the strobe source to output a hardware strobe signal when needed. (This does not trigger a flash signal.)

Implemented by: strobe source (typically a camera sensor)

Used for: synchronized flash (V4L2_FLASH_STROBE_SOURCE_EXTERNAL)

[v4l2-proposal] V4L2_CID_FLASH_DURATION

V4L2_CID_FLASH_DURATION: Duration of the flash strobe pulse generated by the strobe source. May be "overridden" by the flash controller using V4L2_CID_FLASH_TIMEOUT.

Implemented by: strobe source (typically a camera sensor)

Used for: synchronized flash (V4L2_FLASH_STROBE_SOURCE_EXTERNAL)

[v4l2-proposal] V4L2_CID_FLASH_OFFSET

V4L2_CID_FLASH_OFFSET: Positive or negative offset between the start of the exposure time and the generated strobe pulse.

Implemented by: strobe source or flash controller

Used for: synchronized flash (V4L2_FLASH_STROBE_SOURCE_EXTERNAL)

[v4l2-proposal] timing

Figure 4: V4L2 flash duration and offset CID timing

[v4l2-proposal] upstream status

V4L2_CID_FLASH_STROBE_OE & V4L2_CID_FLASH_DURATION: submitted. In maintainers (Sakari Ailus) branch. Likely merged in 6.20/7.0.

V4L2_CID_FLASH_OFFSET: in development. To be submitted to ML after the merge window.

Conclusions

[conclusions]

- use the interface if it fits your needs
- enhance/improve the interface if it doesn't fit your needs (yet)
- flash control was also recently discussed on libcamera-devel[1]

[1] see lists.libcamera.org

So Long, and Thanks for All the Fish

Questions? Suggestions? Feedback?

Please feel free to reach out via:

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Codeberg	`https://codeberg.org/g0hl1n`
Signal	`g0hl1n.11`

So Long, and Thanks for All the Fish

btw: happy second *digitial independence day*!

`#diday #didit #dutgemacht`

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References

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