CenturyArks Co., Ltd.

Guideline of Hot Pixels
SilkyEvCam HD (EvC4A)
equipped Sony's sensor
## Event-based Vision Camera

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1.   What Hot Pixels are…

Hot Pixels is one of false reactions defined by the Event-based vision sensor produced by Sony, and SilkyEvCam® HD (IMX636) send out event pixels which are more than 100 event/sec. even if events (contrast changes) do not occur. False reaction pixel is inspected to ensure that is less than and equal to the standard number of pixels prior to the shipment.
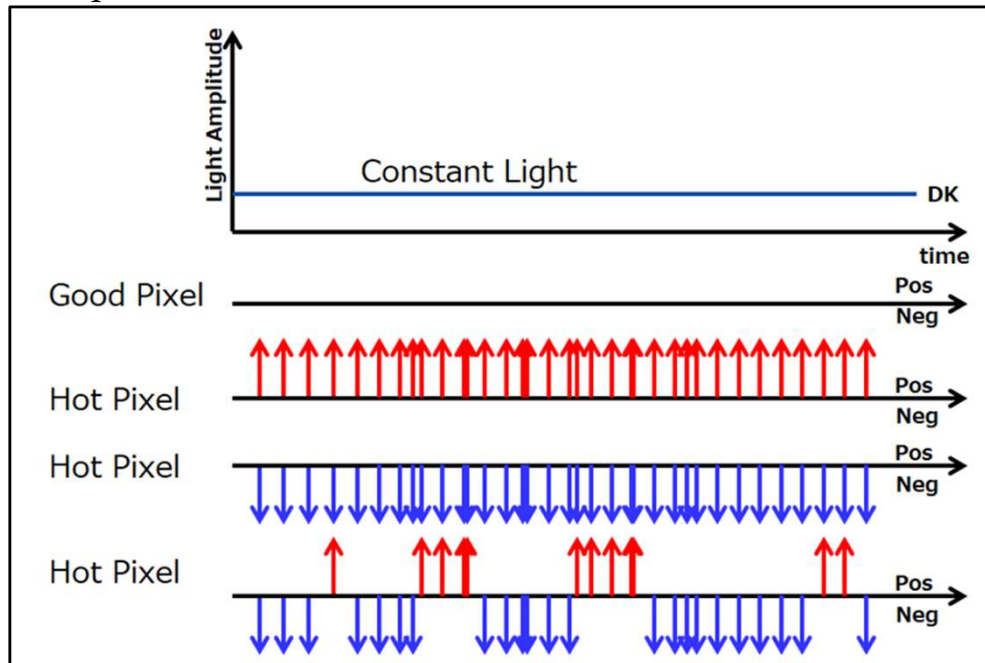
Overview of Hot Pixels

31. Error / Non-response Pixel Specifications

(VADD = 3.3 V, $VDDD_1$ = 1.98 V, $VDDD_2$ = 1.21 V, Tj = 60 °C)

Item	Min.	Typ.	Max.	Unit	Measurement method	Remarks
Hot pixel	—	—	80	pixel	32.1	Zone: Full pixels, BGR > 100 Hz, LC = 1000 lx
Cold pixel	—	—			32.2	Zone: Full pixels, LC = 1000 lx
Frozen pixel	—	—	3000	pixel	32.3	Zone: Full pixels, LC = 1000 lx
Cluster	—	—	0	cluster	32.4	Zone: Full pixels

Citation: IMX636-AAMR-C   Datasheet
Publisher: Sony Semiconductor Solutions Corporation

【Influence we are concerned】
As the number of events increase, data volume and data of processing load may increase.
Depending on your applications/usages, this may affect results of performance expected.

2. Hot Pixels features

The following dependencies have been identified for Hot Pixels' generation.

●Environmental dependence
 ―Illuminance
   Hot Pixels get worse in low light level.

 ―Temperature
   Hot Pixels changes by temperature change.
   There are two types of pixel which are prone to Hot Pixels at low temperatures and hot temperatures respectively.

   However the number of Hot Pixels does not exceed the number of specified in the sensor (IMX636) specifications within the guaranteed sensor performance range.
   【Guaranteed sensor performance range】
    Minimum Illuminance 5lux
    Temperature   -10°C～60°C ＊0°C～50°C for SilkyEvCam® HD

●Others
  Hot Pixels also vary by camera's bias (sensitivity) setting value.

3. How to avoid Hot Pixels

【Workaround of Hot Pixels】
The target pixel can be set to mask (disable any response).

・The maximum number of pixels that can be set is 64, and the target pixels are stored in the memory of the camera (SilkyEvCam HD).
・The amount of useless event data is reduced by this setting, but there is no event output of the target pixel.
・Please make your own decision on whether or not to use this setting after careful consideration of your intended use.
・SilkyEvCam HD (EvC4A) is masked against Hot Pixels detected at room temperature (approx. 25°C) and in low-light conditions (with a lens cap attached to the camera) at the time of shipment.

【 SilkyEvCam HD (EvC4A) responses to Hot Pixels 】
When the product is shipped, masking (disabling any response*2) is applied to Hot Pixels*1.
This setting is automatically made when the camera is started up, so there is no need to do anything. However, if you wish to set the mask setting to match your operating environment due to the above-mentioned dependency, please refer to the next section and set the mask setting by yourself.   *Due to the features of Hot Pixels, it is not possible to mask all Hot Pixels with this setting.

*1 Detected at room temperature (approx. 25°C) and in a low-light environment (with a lens cap attached to the camera).
*2 The mask setting at the time of shipment is for Serial No. 00213 or later.
For products with Serial No. 00xxx or earlier, please refer to the next section to make your own settings.

Next page:
We will explain how to check for Hot Pixels, set masks, and cancel them.

4. How to confirm the presence/absence of Hot Pixels

【Preparation】
✔ **Please download (free of charge) the Hot Pixels detection application (silkyevcam_mask_pixel_util, hotpixel_detector.py) from our website below.**
Windows: https://centuryarks.com/wp-content/uploads/2023/11/SilkyEvCam_Mask_Pixel_for_win64_v4.4.0.zip
Ubuntu: https://centuryarks.com/wp-content/uploads/2023/11/SilkyEvCam_Mask_Pixel_for_ubuntu_v4.4.0.zip

✔ **To hotpixel_detector.py, Metavision SDK and Python must be installed on the PC to be used.**

4-1.Confirming mask setting information of your camera to be used

1. How to run the application

```
Windows> silkyevcam_mask_pixel_util -l
 Ubuntu$    silkyevcam_mask_pixel_util -l
```

【Result of the application execution】
a. Output when no mask pixels are set for the camera
> silkyevcam_mask_pixel_util -l
Current Valid mask pixel: 0 pixel(s)

b. Output when mask pixels are set for the camera
> silkyevcam_mask_pixel_util -l
 Mask [0] x: 179 , y: 674
 Mask [1] x: 1155 , y: 89
 Mask [2] x: 1215 , y: 321

Current Valid mask pixel: 3 pixel(s)

4. How to confirm the presence/absence of Hot Pixels

4-2. Procedure of confirmation of Hot Pixels on target camera

1. Connect SilkyEvCam HD to your PC via USB cable.
2. Set the camera to your operating environment (illumination, bias settings, etc.).
3. Clear the mask pixel setting information on the camera (only if the mask pixel setting has already been made).
   Windows> silkyevcam_mask_pixel_util -r
   Ubuntu$ silkyevcam_mask_pixel_util -r
4. Execute the Hot Pixels pixel detection application (hotpixel_detector.py).
   Basic usage (see p. 7 for details on execution)
   Windows> python hotpixel_detector.py
   Ubuntu$ python3 hotpixel_detector.py
5. Check the Hot Pixels from the output information.
   Refer to the next page (output example) for an image of the output information.

【Hot Pixels detection application】

a. Name of the application：silkyevcam_mask_pixel_util
        Outputs the mask pixel information set in the camera, cancels the mask setting, and sets the mask by specifying pixel coordinates.
   Optoins
   -h   Help
   -s   Mask setting
   -r   Cancel mask setting
   -l   Output mask setting information
   -x   X coordinate specification when setting mask (setting in combination with -s)
   -y   Y coordinate specification when setting mask (setting in combination with -s)

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b. Name of the application：hotpixel_detector.py

Counts the number of events for each pixels in one second, waiting for the specified number of seconds (default 10) after application starts.

Outputs the coordinates of pixels for which the number of events exceeds the threshold (default 100).

Options

-h　Help

-ot Output types

　　0:　Output only the result of Hot Pixels detection (default)

　　1:　Output file for mask settings for silkyevcam_mask_pixel_util

--bias-diff　　　Bias value diff Setting　　　：Integer value（Default：0）

--bias-diff-off　　Bias value diff-off Setting　：Integer value（Default：0）

--bias-diff-on　　Bias value diff-on Setting　：Integer value（Default：0）

--bias-fo　　　Bias value fo Setting　　：Integer value（Default：0）

--bias-hpf　　　Bias value hpf Setting　　：Integer value（Default：0）

--bias-refr　　　Bias value refr Setting　　：Integer value（Default：0）

-t　threshold　　Threshold for number of events to output：Integer value（Default：100）

--start　　　　Start measurement seconds Seconds to start measurement　　：Integer value（Default：10）

--max-pixels　　Maximum number of pixel information to output：Integer value（Default：64）

Result of Hot Pixels detection	File output for mask setting
$ python3 hotpixel_detector.py -ot 0	**$ python3 hotpixel_detector.py -ot 1**
【出力例】 # Bias Set Information: #　diff: 0, diff_on: 0, diff_off: 0 #　fo: 0,　hpf: 0,　refr: 0 # Output is Only Result. # No.1 cnt:2014344(x, y):(11,507) # No.2 cnt:2014343(x, y):(1101,359) # No.3 cnt:2014343(x, y):(512,360) # No.4 cnt:2014251(x, y):(738,277) # No.5 cnt:1035260(x, y):(160,19) # ... Since the data after this is smaller than threshold value (100). # Confirm mask pixel setting. silkyevcam_mask_pixel_util -l	【出力例】 # Bias Set Information: #　diff: 0, diff_on: 0, diff_off: 0 #　fo: 0,　hpf: 0,　refr: 0 # Output Append Pixel. # No.1 cnt:2013178(x, y):(1101,359) silkyevcam_mask_pixel_util -s -x 1101 -y 359 # No.2 cnt:2013177(x, y):(11,507) silkyevcam_mask_pixel_util -s -x 11 -y 507 # No.3 cnt:2013177(x, y):(512,360) silkyevcam_mask_pixel_util -s -x 512 -y 360 # No.4 cnt:2013177(x, y):(738,277) silkyevcam_mask_pixel_util -s -x 738 -y 277 # No.5 cnt:1035801(x, y):(160,19) silkyevcam_mask_pixel_util -s -x 160 -y 19 # ... Since the data after this is smaller than threshold value (100). # Confirm mask pixel setting. silkyevcam_mask_pixel_util -l
【Note】 The silkyevcam_mask_pixel_util command is not output for information output only.	

5. How to set the mask for Hot Pixels

Detected Hot Pixels can be masked (disabled from reacting at all) by the following method.

5-1. Set mask for Hot Pixels on target camera

（The set mask pixels are stored in memory and will be set automatically when the power is turned on again, even if the power is turned off.）

1. Connect SilkyEvCam HD to your PC via USB cable.
2. Set the camera to your operating environment (illumination, bias settings, etc.).
3. Clear the mask pixel setting information on the camera (only if the mask pixel setting has already been made).
   Windows> silkyevcam_mask_pixel_util -r
   Ubuntu$ silkyevcam_mask_pixel_util -r
4. Run the Hot Pixels detection application (hotpixel_detector.py).
   Basic usage (see p. 7 for details on execution）
   Windows> python hotpixel_detector.py -ot 1 <Option> > [Configuration File Name]
   Ubuntu$ python3 hotpixel_detector.py -ot 1 < Option > > [Configuration File Name]
5. Take the following actions for the [setting file name] created in the previous section 4.
   Windows：Change (add) the extension to .bat for [Configuration File Name] and create [Configuration File Name].bat.
   Ubuntu：   Add execute permission to [config file name]. (chmod +x [config file name])
6. Mask is set by executing [setting file name]. For details on how to check the settings, refer to section 4-1.
   Windows：[Configuration File Name].bat
   Ubuntu：   [Configuration File Name]

5-2. Cancel mask for Hot Pixels on target camera

Execute the following command. After the cancel, the settings can be checked and re-configured by executing 4-1. and 5-1.
   Windows> silkyevcam_mask_pixel_util -r
   Ubuntu$ silkyevcam_mask_pixel_util -r

Thank you!