Baumer
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Application Note

Shading Correction (Flat-Field Correction) with the Baumer GAPI SDK

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Description
The Baumer GAPI shading correction (flat-field correction) helps calibrating your vision system to drastically reduce effects of brightness differences introduced by a camera/lens-system or non-even light sources.

Products
Baumer cameras, Baumer GAPI SDK from v2.9.2

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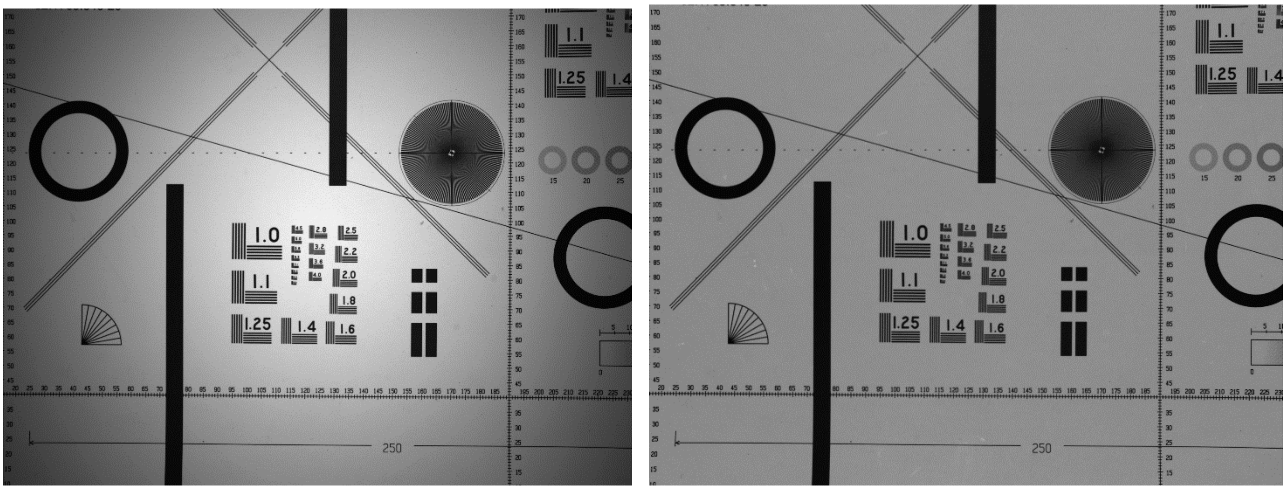
1 Introduction

It is not uncommon for vision systems to have variations in brightness over the full image frame for various reasons. These variations will negatively affect algorithms, like object detection or code reading, developed to enable the various tasks of a vision system.

"Flat-field correction is a technique used to improve quality in digital imaging. The goal is to remove artifacts from 2-D images that are caused by variations in the pixel-to-pixel sensitivity of the detector and/or by distortions in the optical path. It is a standard calibration procedure in everything from pocket digital cameras to giant telescopes.

Flat fielding refers to the process of compensating for different gains and dark currents in a detector. Once a detector has been appropriately flat-fielded, a uniform signal will create a uniform output (hence flat-field). This then means any further signal is due to the phenomenon being detected and not a systematic error."

Wikipedia: https://en.wikipedia.org/wiki/Flat-field_correction [05.06.2018]



Example: original and a corrected version

It is important to understand the limitations of the algorithm. If the difference in brightness in an image is greater than 25 % to 30 % we think that are issues with the choice of components and you might want to consider changing components of the system as the algorithm might not give the expected results.

2 Step 1: measuring the vision system

Notice

For best results the measurements should be taken in the real environment of the complete vision system setup.
It is important to understand that only static effects can be reduced. That means if you change the lens, aperture or light-sources you need to re-calibrate the system.

After setting up the Vision System and choosing the desired settings for aperture and light settings the example will guide you to create 2 data-sets, one for the darkest possible image (dark-field frame) and one for the lightest image (light frame).

The example will take several images for each set and build an average to reduce the influence of sensor-noise. Those averaged images are then used to calculate the necessary data to correct images taken by the vision system.

You need a clean and white target for the light reference, any artefacts (like dirt or even the texture of paper) might be visible after the calibration! The target must cover the whole surface you want to calibrate. Ideal would be a calibrated target but it is not strictly necessary.

2.1 Set-up of the vision system

1. Set-up your vision system including camera, lens and light sources for your intended use.
2. Configure exposure time, aperture, gain and intensity of the light sources as required for your application.
3. Configure a fixed exposure-time so that the image is not over-saturated. This can be done with the help of the *Baumer Camera Explorer* (Histogram-View, F7). Also ensure that the gain is set to the lowest possible value to reduce any noise in the image.

2.2 Acquire the dark field reference

This is an optional step to achieve full flat-field correction. If you require just a shading correction you can skip this step. The measurement is only necessary once for a specific camera.

1. Compile and start the example *016_FlatField_Calculation.cpp* at a convenient location.
2. To create the dark-field reference it is necessary to completely block out any light from the camera sensor. This is best done by covering the lens with the lens-cap or by removing the lens and attaching the protective cap which came with your camera.
3. Now press “D” to acquire the Dark Field Frame.
4. The example will take some images and store the calculated reference data as a Baumer Raw Image (dark_field_reference.brw) in the same folder as the example. Brw-Files can be viewed with the *Baumer Camera Explorer*.
5. The example will notify you when the measurement and calculations are successful. In case the example notifies you of issues please check your Vision System setup again and repeat the measurement.

2.3 Acquire the light reference

1. Now you need to set-up the system for the light-frame. So please go and remove the lens-cap or attach the lens again and switch on all configured light sources.
2. If your systems lighting shines towards the camera (e.g. to take the 2D-shape of an object), remove any object out of the view of the Vision System. Otherwise place a completely white sheet where the object will reside. Ensure the full view range is covered by the sheet!
3. Start the compiled example again and press “L” to acquire the Light Frame.
4. Again, the calculated reference data will be stored as a Baumer Raw Image (light_reference.brw) inside the folder of your example.
5. The example will notify you when the measurement and calculations are successful. In case the example notifies you of issues please check your setup again and repeat the measurement.
6. You now have everything ready to correct images taken by your system.

Notice

If a non-ideal target is used (e.g. Paper) it is possible that structures or dirt on the target are visible in the corrected image. In this case the Baumer GAPI box- and median-filters can help reduce the unwanted artefacts. The filters should only be used as a last resort as they will effect the shading-corection negatively.

Example how to use the filters:

```
bo_uint r    = m_pShading->GetFilter(BGAPI2::Ext::Sc::Shading::BoxFilter, true);
bo_uint rMin = m_pShading->GetFilterMin(BGAPI2::Ext::Sc::Shading::BoxFilter, true);
bo_uint rMax = m_pShading->GetFilterMax(BGAPI2::Ext::Sc::Shading::BoxFilter, true);

// Set median-filter radius for light reference
m_pShading->SetFilter(BGAPI2::Ext::Sc::Shading::MedianFilter, true, 1);

// Set box-filter radius for light reference
m_pShading->SetFilter(BGAPI2::Ext::Sc::Shading::BoxFilter, true, 2);
```

3 Step 2: correcting the vision systems images

The references taken in the measurement step can now be used to correct the images taken by your Vision System. Usually you want to include this correction in your application; the example will show you what to do.
The example can produce 2 different measurements, if you provide a dark field reference and a light reference a flat-field correction is calculated. If you only provide the light reference the calculation done is a shading correction.

1. Set up your Vision System as intended and place an object as required.
2. Compile and start the example *017_FlatField_Correction.cpp* at a convenient folder location.
3. Ensure the references dark_field_reference.brw and light_reference.brw do exist inside the folder of your example.
4. Press any key to start take an image.
5. The example will take one image and store and the corrected image inside the folder of your example the file will be named imageSample.brw. This brw-files can be opened and converted using the *Baumer Camera Explorer*.

4 Related topics

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5 Support

In the case of any questions or for troubleshooting please contact our support team.

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Baumer Group

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