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Contents: This white paper describes the transfer and evaluation of 16-bit images from 3D cameras or 3D or 2.5D height or distance sensors in NeuroCheck 6.2.

Notes: This document is not part of the official product documentation of the NeuroCheck software.

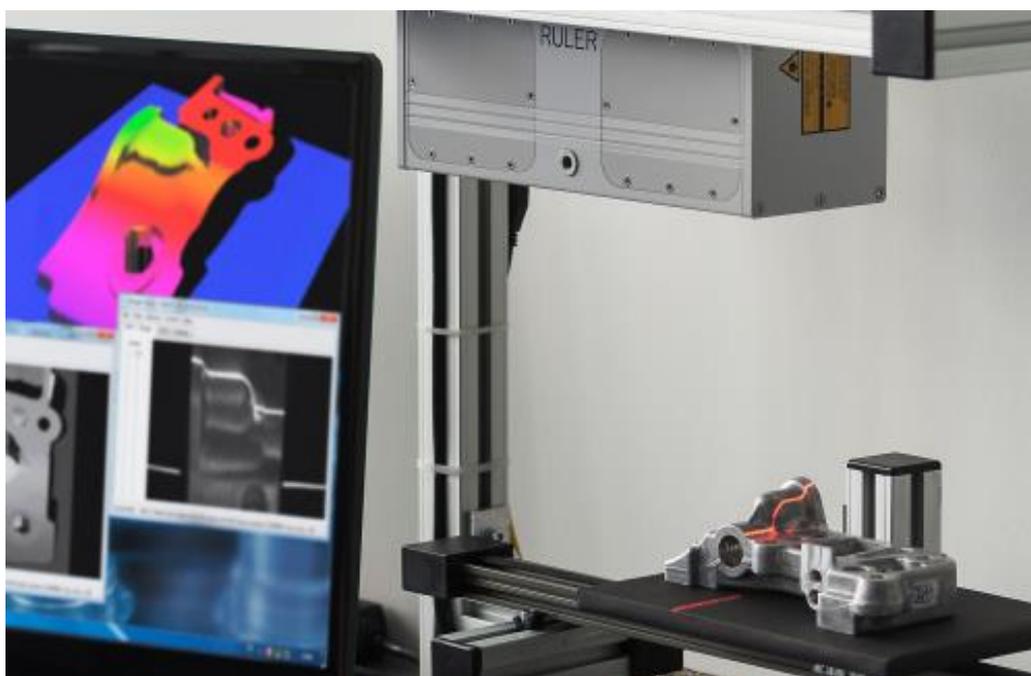


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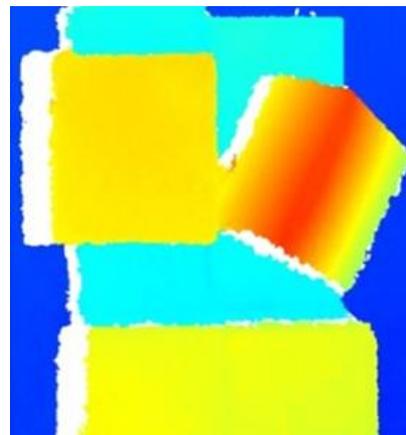
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1. Introduction

3D cameras are becoming suitable for industrial use and thus of relevance for industrial image processing.

Many 3D sensors create height or distance information with 16-bit data depth. So theoretically a vertical range of 600mm can be resolved in 0.01mm steps.

This document will describe the recommended procedure for using NeuroCheck version 6.2 to transfer, process and evaluate 16-bit images.



2. Available 3D cameras

There are several device drivers for 3D cameras than can be integrated into NeuroCheck, more are being developed.

Please ask NeuroCheck GmbH or the device manufacturer for what manufacturers and models drivers are available.

What sensor is suitable for what task has to be decided individually.

The kind of technology used by the sensor to gather data (e.g. laser scanner, sheet-of-light projection, time-of-flight, photogrammetric processes,) is principally irrelevant for the evaluation in NeuroCheck. What is important is the data interface described in the following.

Please note that depending on the driver implementation, the functionality described in the following may be limited.

3. Prerequisites for evaluating sensor data with NeuroCheck

- The 3D camera resp. 3D sensor creates a rectangular 2.5D height or distance image (no 3D point cloud).
- The sensor provides a gray-value image encoding 16-bit height information.
- To integrate the 3D camera into NeuroCheck 6.2 a device driver of type "3D camera" has been developed.
- Use NeuroCheck 6.2 at a license level that enables integrating the device.
- You'll probably need the plug-in DLL "PI_Bit16ImageTools.NET.dll" for NeuroCheck 6.2 (available from NeuroCheck Support).
- With some restrictions this document may also be used for normal 2D area cameras if their drivers provide a 16-bit/12-bit intensity image.

4. Processing 16-bit images in NeuroCheck

- Set up the 3D camera as a device of type "3D cameras" in the NeuroCheck Device Manager.
- Use the standard check functions "Capture Image" and "Transfer Image". Given that the device driver has been implemented correctly, the 16-bit image information will remain intact.
- A false color visualization may help you to better analyze the images visually. Use this button  to switch to false color visualization mode.
- NeuroCheck software is able to load, save, manage and process 16-bit images like 8-bit images.
- When processing 16-bit images using check functions like "Filter Image", "Combine Images", "Determine Threshold", "Template Matching", "Create Edges", "Compute Features" please be aware that parameter setting is not done in the range [0...255] but in the range [0...65536].

5. Advanced evaluation processes

5.1. Dynamic selection of a height interval

In some applications you may need to identify a distance/height area first and then evaluate this in detail.

For instance you can determine the medium gray value of an image area by check function "Compute Features". This value gives the distance in a 2.5D distance image. Let NeuroCheck write this value into a data register at run-time.

Use the check function "Convert 16-bit Image to 8-bit" from the plug-in DLL "PI_Bit16ImageTools.NET.dll". This check function reduces the data depth of the image from 16 bit to 8 bit in a controlled fashion. In the check function's parameter dialog you may set the transformation algorithm and extract the height area you're interested in. Please also refer to the detailed help file concerning this plug-in check function. Here you have the option to convert to a linear range/height area using dynamical values from data registers.

The height image thus reduced to 8-bit data depth can then be evaluated using the NeuroCheck standard check functions such as "Determine Threshold", "Template Matching", "Create Edges", "Compute Features".

Please note though that at this state only reduced precision and a reduced range of values is at your disposal.

5.2. Evaluating a height image at various levels of resolution

Example:

Your sensor has an evaluation range of 600mm and provides a theoretical resolution of 0.01mm. This can be depicted with 16-bit data depth.

An object the size of 20mm lies within the evaluation area that needs to be found first and then evaluated with a resolution of 0.5mm.

Principle:

For an initial object evaluation reduce the sensor image in rough steps to 8-bit and subsequently reduce the identical original image in a section of the distance/height area in fine steps to 8-bit for the final evaluation.

An example:

After capturing the sensor provides a 16-bit image which is transferred to NeuroCheck. Reduce this to 8-bit by evaluating the 8 most significant bits. Within the evaluation range of 600mm you'll obtain a resolution of 2.4mm so the searched-for object ranges over approximately 8 gray-value levels which makes it possible to detect it.

In the second step, take the original image of the sensor and reduce it to 8-bit by doing a bit shift of 4 thus eliminating the 4 most significant bits and the 4 least significant bits. The remaining 8 bit provide you with an effective value range of 37mm with a resolution of 0.15mm so an evaluation can take place.

As evaluation area in the reduced second image you may take the ROI where you found the object in the first reduced image.

5.3. Additional intensity image

Some 3D sensors do not only provide a height image but also an intensity image that equals a common gray-value image. The drivers of some sensors provide this image to NeuroCheck.

Capturing and transferring the image may then be done using the following check functions:

1. Check function "Capture Image".
2. Check function "Control Device": Selection of height image for next transfer.
3. Check function "Transfer Image". Height image.
4. Check function "Control Device": Selection of intensity image for next transfer.
5. Check function "Transfer Image". Intensity image.

When both sensor images are identically geometrically rectified, the information from both images may be combined. For example, one could search for an ROI in the height image and do an evaluation within this ROI in the intensity image or vice versa depending on the application.

In any case, an intensity image is quite helpful for visually interpreting the 2.5D height image. Given there is a suitable driver implementation, the intensity image can be used for viewing in NeuroCheck Live Image.

5.4. Additional quality image

It's an inherent characteristic of 3D sensors that there are no complete, reliable and exact measuring values for the entire image. Some 3D sensors also provide a quality or reliability image besides the height image which the driver can provide for NeuroCheck.

Capturing and transferring the image may then be done using the following check functions:

1. Check function "Capture Image".
2. Check function "Control Device": Selection of height image for next transfer.
3. Check function "Transfer Image". Height image.
4. Check function "Control Device": Selection of quality image for next transfer.
5. Check function "Transfer Image". Quality image.

When both sensor images are identically geometrically rectified, the information from both images may be combined. If the quality image defines, for example, the value of 65535 for "Measurement OK" and the value of 0 for "No measurement", it lends itself to use the standard check function "Combine Images" in "Minimum" mode to mask out missing image areas. Please also refer to the information provided by the manufacturer of the driver.