Computer vision

3D Stereo camera Bumblebee

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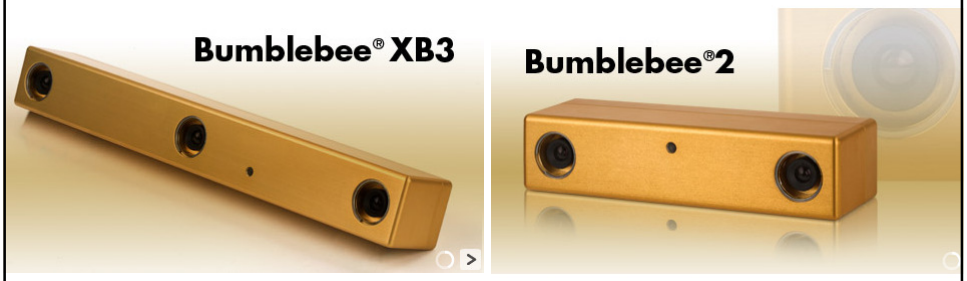
3D Stereo Camera Bumblebee

Overview:

- **Introduction to stereo vision**
- **Camera stereo parameters**
- **Accuracy with different baselengths**
- **Examples**
- **Advantages / Disadvantages**

Introduction to stereo vision



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Introduction to stereo vision

- **Stereo vision camera's are used to perform 3D measurements**
- **Stereo vision is based on the human eyes:**
  The camera takes two snapshots from different positions.
  When a certain object can be identified as a pixel location in one image and in the other image, then the distance can be calculated based on the translation of the object pixel
- **Some problems in stereo vision:**
  - **Identifying of pixels in multiple images for matching the same world coordinates**
  - **Correct calibration of both camera's, so the pixels can be correlated**
  - **Less accuracy on larger distances**

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Introduction to stereo vision

- **Identifying of pixels in multiple images for matching the same world coordinates:**

  This can be solved with stereo vision algorithms. There are many algorithms available. A stereo vision SDK is delivered with the BumbleBee camera's.

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Introduction to stereo vision

- **Correct calibration of both camera's, so the pixels can be correlated**

  A stereo rig is used to calibrate the camera's. The images have to be mapped to a pin-hole camera model. This image is called rectified.

Raw image with lens distortion

Rectified pin-hole image

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Introduction to stereo vision

- **Less accuracy on larger distances**

  The distance calculation is based on the following equation:

$$Dist_{(m)} = \frac{f_{(pix)} \cdot base_{(m)}}{Disp_{(pix)}}$$

  in this equation f is the focal length of the lens in pixels. The disparity is the difference in x-direction of the pixel coordinates in both images

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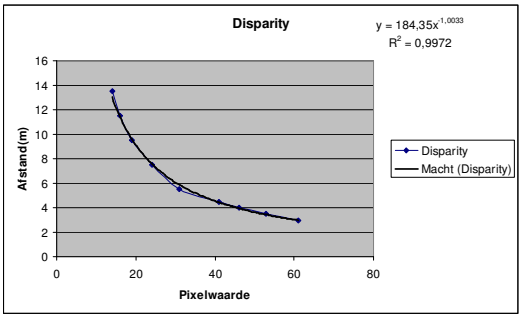
Introduction to stereo vision

- **Less accuracy on larger distances**

  When the distance according to each pixelvalue is plotted, the following graph will appear



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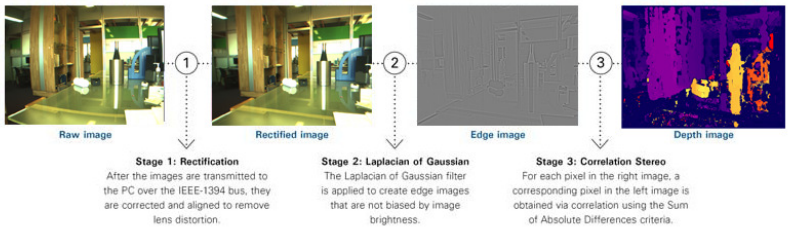
Introduction to stereo vision

To get a correct depth image, a few steps need to be taken:



Camera stereo parameters

- **Mode**
  The BumbleBee camera's have 7 different modes:
  1: Raw Image
  2: Rectified Color
  3: Rectified
  4: Disparity (this gives a depth image)
  5: Disparity Color (this gives a depth image in false colors)
  6: Disparity Validation (when certain area's are not volidated in the vision algorithm they get a certain color)
  7: Absolute (in this mode the absolute world coordinates are given)
- **Pan**
  With this parameter the user can choose witch camera's are used to perform stereo vision algorithm's

Camera stereo parameters

- **Disparity**
  The disparity range is the range of pixelvalues in wich the stereo algorithm searches for a best match. A disparity value of 0 means that an object is unlimited far away. A maximum disparity value means that this is the closest distance that an object can be measured
- **Disparity Mapping**
  With disparity mapping the user can define a pixel range in wich the result pixels will be shown. This is comparable with a contrast stretch.
- **Stereo Mask**
  The user can define the size of the mask that is used to correlate both images.
- **Edge Mask**
  The user can define the size of the edge mask that is used to correlate both images.

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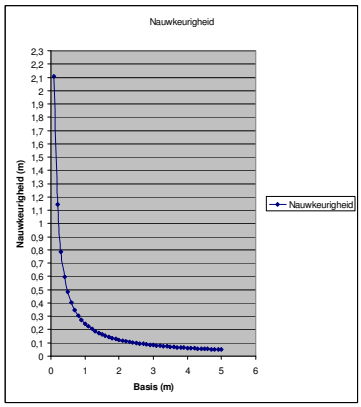
Accuracy with different baselengths

- **To achieve higher accuray a bigger baselength is needed. When measuring the same distance with the same stereo camera's on a bigger base. The accuracy will be like the following graph**



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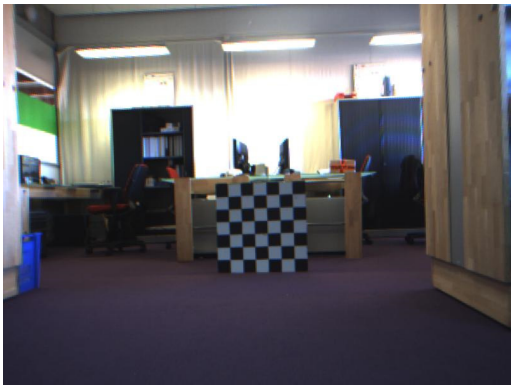
Examples

- **Rectified Color Image**



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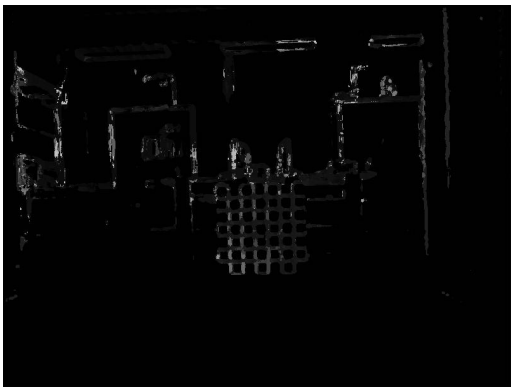
Examples

- **Disparity image (on 3m distance)**



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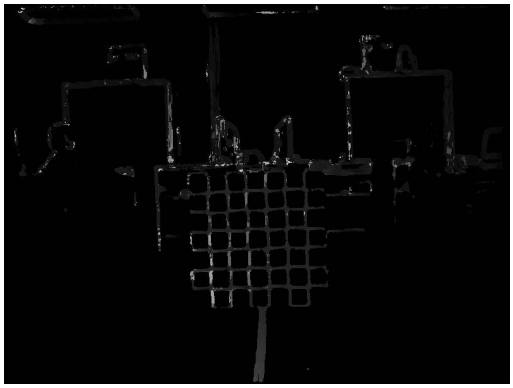
Examples

- **Disparity image (on 2m distance)**



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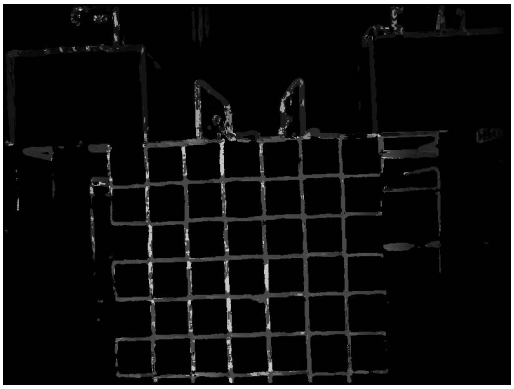
Examples

- **Disparity image (on 1m distance)**



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Advantages / Disadvantages

- **Advantages**
  - **High accuracy can be achieved by using the correct base**
  - **Accuracy on different distances can be calculated**
  - **When focal length of the lens is known, the needed base can be calculated for good accuracy**
- **Disadvantages**
  - **Not possible to calculate distance of every pixel in the image**
  - **Accuracy is not linear**

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