THE VIALAB CALIBRATION CHALLENGE

STUTTGART - 09/11/2011

www.progetti.t3lab.it/vialab
SUMMARY

- General definition
- Challenge description
- Dataset and ground truth
- OpenCV results (preliminary)
- Open issues
Camera calibration is the process of finding the true parameters of the camera that produced a given photograph or video [1].


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GENERAL DEFINITION

Camera parameters

INTRINSIC PARAMETERS

\[ A = \begin{bmatrix} \alpha_x & \gamma & u_0 \\ 0 & \alpha_y & v_0 \\ 0 & 0 & 1 \end{bmatrix} \quad k[ ] \quad p[ ] \]

Camera matrix \quad Radial distortion coefficients \quad Tangential distortion coefficients

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GENERAL DEFINITION

Camera parameters

EXTRINSIC PARAMETERS

\[ P_C = R \cdot P_W + T \]

\[ P_W = R^{-1} \cdot (P_C - T) \]
CHALLENGE DESCRIPTION

Component tasks

IMAGE BASED CALIBRATION (CP1)

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CHALLENGE DESCRIPTION

Component tasks

POINT BASED CALIBRATION (CP2)
Main parameters

NUMBER OF CALIBRATION IMAGES
Main parameters

CAMERA CHARACTERISTICS

<table>
<thead>
<tr>
<th>ID</th>
<th>CAMERA</th>
<th>RESOLUTION</th>
<th>OPTIC</th>
<th>mm/pix (1 meter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dalsa Genie M640-1/2</td>
<td>VGA</td>
<td>8 mm</td>
<td>1.24</td>
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<tr>
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<tr>
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<td>9 mm</td>
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<tr>
<td>6</td>
<td>Dalsa Genie M1600-1/1.8</td>
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<td>6 mm</td>
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<tr>
<td>7</td>
<td>IDS UI-1480SE-M</td>
<td>5 Mp</td>
<td>8 mm</td>
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<tr>
<td>8</td>
<td>Basler Ace</td>
<td>5 Mp</td>
<td>6 mm</td>
<td>0.37</td>
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</tbody>
</table>
CHALLENGE DESCRIPTION

Main parameters

TARGET QUALITY

HQ:
- acquired by vendors or provided by VIALAB
- certified or measured real world coordinates

LQ:
- printed by VIALAB on a common laser printer
- nominal real world coordinates

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CHALLENGE DESCRIPTION

Evaluation metrics

VERIFICATION IMAGES

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CHALLENGE DESCRIPTION

Evaluation metrics

BACK PROJECTION ERROR (pix)

✓ Undistort verification images
  ▪ Localize verification points (mean of 20 frames)
✓ Back project known 3d points into image
  ▪ Find back projection error (Euclidean distance)

✓ Toolkit
  ▪ VIALAB

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**CHALLENGE DESCRIPTION**

**Evaluation metrics**

**FORWARD PROJECTION ERROR (mm)**

- ✓ Undistort verification images
  - ▪ Localize verification points (mean of 20 frames)
  - ▪ Find Z coordinate of each point (in camera reference system)
- ✓ Forward project image points to WRF
  - ▪ Find forward projection error (Euclidean distance)

- ✓ Toolkit
  - ▪ VIALAB

[Website Link: www.progetti.t3lab.it/vialab]
Evaluation metrics

FORWARD PROJECTION ERROR USING IMAGES (mm)

✓ Undistort verification images
✓ Localize verification points (mean of 20 frames)
  ▪ Find Z coordinate of each point (in camera reference system)
✓ Forward project image points to WRF
  ▪ Find forward projection error (Euclidean distance)

✓ Toolkit
  ▪ VIALAB
DATASET – GROUND TRUTH

Used benches

SETUP

CAMERAS

CALIBRATION / VERIFICATION POINTS

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DATASET – GROUND TRUTH

Used benches

MECHANICAL MEASUREMENTS

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DATASET – GROUND TRUTH

Used benches

OPTICAL MEASUREMENTS

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OPENCV RESULTS

Preliminary results

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OPEN ISSUES

Localization in real world

IRREGULAR PHYSICAL EDGES

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OPEN ISSUES

Localization in real world

INK-SHRINK / INK-SPREAD PHENOMENA
OPEN ISSUES

Localization in images

CORNER DETECTOR REPEATABILITY TEST

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## OPEN ISSUES

### Localization in images

#### CORNER DETECTOR REPEATABILITY TEST

<table>
<thead>
<tr>
<th>ID</th>
<th>CAMERA</th>
<th>RESOLUTION</th>
<th>OPTIC</th>
<th>Area (pixel(^2))</th>
<th>Area (mm(^2)) (1 meter)</th>
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<tbody>
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<td>0.0294</td>
<td>0.0040</td>
</tr>
</tbody>
</table>
OPEN ISSUES

Evaluation metrics

BACK PROJECTION ON CALIBRATION IMAGES

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THANKS A LOT FOR YOUR ATTENTION

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