Use of stereoscopic cameras to extract information on individual fish

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**Objectives**

Fish size measurement is an important and frequent operation for aquaculture or market purposes. Monitoring the size distribution of female fish can provide important insights into the overall health and sustainability of the population. The objectives of this paper are:

- Propose a stereoscopic fisheye cameras method by OpenCV to measure the fish size
- Evaluate the suitability and accuracy of this method

**Experiments**

- Cameras: (a) Dual fisheye cameras ELP-960P2CAM-LC1100 with 6cm baseline; (b) Images are captured from video
- Experiments: (a) Test objects: a blue carton, a red Cola can bottle and an artificial fish; (b) Environment: cameras were mounted on the glass in Rolex; (c) Placing distance: 15-20, 20-25, 25-30 cm away from the lens

**Methodology**

1. Calibration and rectification: obtain the cameras parameter and correct distortion.
2. Stereo matching: find keypoints of the target objects by ORB (select) and SIFT.
3. Triangulation: obtain the object depth.
4. Outliers Rejection: identify target objects
5. Size measurement: find the the maximum and minimum values of keypoints in the x-axis direction
6. Accuracy evaluation: calibration and size measurement

**Results**

**Calibration and rectification**

- **Intrinsic parameters**

<table>
<thead>
<tr>
<th>Camera</th>
<th>Matrix (mm,x,y)</th>
<th>Distortion coefficients(D)[0]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>650.84 -1.21</td>
<td>602.82</td>
</tr>
<tr>
<td>Right</td>
<td>422.20 -1.19</td>
<td>686.08</td>
</tr>
</tbody>
</table>

- **Extrinsic parameters**

<table>
<thead>
<tr>
<th>Rotation matrix[R]</th>
<th>Translation vector[T]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000 -0.003 0.004</td>
<td>-0.015</td>
</tr>
<tr>
<td>0.007 1.000 0.004</td>
<td>0.055</td>
</tr>
</tbody>
</table>

- **Reprojection error**

<table>
<thead>
<tr>
<th></th>
<th>Left camera</th>
<th>Right camera</th>
<th>Stereo system</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS(pixel)</td>
<td>0.59</td>
<td>0.60</td>
<td>0.61</td>
</tr>
</tbody>
</table>

**Size measurement**

- **Stereo matching**

  Cubic and cola have satisfactory accuracy, while the accuracy of fish was unexpected.

- **Calculated size and errors**

**Conclusion**

A method for object size measurement using stereoscopic cameras is proposed.

- Reprojection errors of the stereo camera system are satisfied with all RMSE lower than 1 pixel
- The accuracy of height measurement is greater than length measurement
- The cube and cola size measurements are more accurate
- There is a large error in the measurement of the length and height of the fish model, where the mean error values are 25% and 18% respectively
- The inaccuracy of fish size measurement may originate from the unrecognized keypoints of the target object and incorrect match during stereo matching process.