6 DoF Pose Estimation for Wide baseline Stereo Camera

Jay Patravali, Dr. Stephen Nuske | Carnegie Mellon University

MOTIVATION AND OBJECTIVE

- We use robots for automated visual yield mapping.
- Current system utilizes an expensive GPS to geotag raw stereo images. Accuracy is within a meter range.
- Overlaps between consecutive frames can lead to inaccurate output yield estimates or over counting.
- Develop a new visual odometry pipeline to robustly estimate the 6 DoF camera pose for a wide baseline stereo camera that logs high resolution images at low frame rates.
- Improve the accuracy of yield estimates by establishing a pose relation between individual image frames.

DATASET COLLECTION AND HARDWARE SETUP

Hardware: Pointgrey Flea3 Stereo Camera | Trimble GPS

- Sorghum Fields, SC
- Grape Vineyards, CA

POSE ESTIMATION PIPELINE

- The proposed sampling scheme is wrapped into our pose estimation pipeline. Implemented visual odometry method similar to Libviso2 [1].

RESULTS

F-矩阵估计

<table>
<thead>
<tr>
<th>Image Pair</th>
<th>Statistic</th>
<th>RANSAC</th>
<th>Lo RANSAC</th>
<th>BEEM</th>
<th>UniSAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vineyard</td>
<td>Correspondences</td>
<td>301</td>
<td>301</td>
<td>301</td>
<td>301</td>
</tr>
<tr>
<td>Data</td>
<td>Inliers</td>
<td>20</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Time (s)</td>
<td>0.124</td>
<td>0.68</td>
<td>0.61</td>
<td>0.61</td>
</tr>
<tr>
<td>Office</td>
<td>Correspondences</td>
<td>306</td>
<td>306</td>
<td>306</td>
<td>306</td>
</tr>
<tr>
<td></td>
<td>Inliers</td>
<td>56</td>
<td>78</td>
<td>86</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>Time (s)</td>
<td>0.129</td>
<td>0.61</td>
<td>0.83</td>
<td>0.82</td>
</tr>
</tbody>
</table>

DESIGN AND OPTIMIZATION

- We observe that the fraction of inliers from a set of matched correspondence is very small (~10%). Many false matches can pass the inlier test causing bad solutions to appear as good solutions.
- Uniqueness Sampling and Consensus (UniSAC) utilizes the feature quality to evaluate geometry solutions.

Algorithm

$$\text{Feature } f_i \rightarrow \text{sample } K \text{ times} \rightarrow \text{M-dim sub-features} \rightarrow \text{quantize } K \text{ integers}$$

Feature quantization:

$$q(v, p, z) = [v^2]$$

Feature Uniqueness score is used for sampling correspondences

$$U_f = \sum_{k=0}^{K} \frac{1 - C(D_k)}{C_{MAX}}$$

- Inliers plotted follow a heat-map color scheme, where red is a unique feature and blue is a frequently occurring feature.
- Lot of blue/green points indicate that the plant dataset consists of images that have repetitive features.

REFERENCES


FUTURE WORK

- ROS Package and systems integration for future field tests.
- Experiment with different feature descriptors to obtain best possible results.

ACKNOWLEDGEMENT

- Special thanks to Dr. Stephen Nuske for this opportunity and guidance, Zania Pothen and Omeed Mirbod for their help.
- Thanks to Rachel Burcin, Mikana Maeda and the RISS team.