SWIFTflow
Sparsely Weighted SIFT matches based Optical Flow
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Optical Flow: Applications & Methods

Optical flow captures the motion of scene features relative to the camera

\[ I(x, y, t) = I(x + \Delta x, y + \Delta y, t + \Delta t) \]
Approach

- Extract SIFT features from Harris corner interest points.
- RANSAC to remove outliers.
Iterative Algorithm

● Prediction step
  ○ Compute k-nearest matches for each pixel
  ○ Compute flow for the pixel as a weighted mean of the k-nearest neighbors
Iterative Algorithm

- Correction/Update step
  - Pixel-wise comparison between generated image from the flow and second image
  - Pixels which match get added to the seed set
Evaluation

- Average Angular Error

\[
\arccos \left( \frac{f_x f_x^e + f_y f_y^e + 1}{\sqrt{((f_x)^2 + (f_y)^2 + 1)((f_x^e)^2 + (f_y^e)^2 + 1)}} \right)
\]

- Results on Middlebury Dataset

<table>
<thead>
<tr>
<th>IMAGE SET</th>
<th>LUCAS-KANADE</th>
<th>SIFT-FLOW</th>
<th>SWIFT-FLOW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimetrodon</td>
<td>30.12° ± 3.69°</td>
<td>9.991° ± 2.42°</td>
<td>11.88° ± 2.72°</td>
</tr>
<tr>
<td>Groove2</td>
<td>17.72° ± 4.71°</td>
<td>8.671° ± 5.84°</td>
<td>10.33° ± 5.67°</td>
</tr>
<tr>
<td>Groove3</td>
<td>21.87° ± 5.67°</td>
<td>15.80° ± 7.91°</td>
<td>15.53° ± 8.13°</td>
</tr>
<tr>
<td>Hydrangea</td>
<td>18.99° ± 5.00°</td>
<td>12.76° ± 10.1°</td>
<td>12.92° ± 10.2°</td>
</tr>
<tr>
<td>RubberWhale</td>
<td>25.19° ± 5.04°</td>
<td>20.59° ± 8.27°</td>
<td>23.28° ± 7.22°</td>
</tr>
<tr>
<td>Urban2</td>
<td>35.03° ± 12.9°</td>
<td>31.15° ± 15.8°</td>
<td>32.15° ± 16.8°</td>
</tr>
<tr>
<td>Urban3</td>
<td>27.80° ± 9.94°</td>
<td>17.39° ± 22.1°</td>
<td>13.94° ± 16.5°</td>
</tr>
<tr>
<td>Venus</td>
<td>23.55° ± 8.83°</td>
<td>5.808° ± 10.7°</td>
<td>11.32° ± 7.67°</td>
</tr>
</tbody>
</table>
Evaluation

- AAE with different number of seed features
Lessons Learned and Road Ahead

- SIFT-flow > SWIFT-flow > LK in terms of AAE
- More SIFT matches imply better accuracy
  - a small number of matches is enough to obtain best possible performance
- Caveats and potential workarounds:
  - dense flow is estimated solely on the basis of pixel-intensity => low robustness
  - Heavily dependent of RANSAC SIFT matching
Lessons Learned and Road Ahead

- Caveats and potential workarounds:
  - dense flow is estimated solely on the basis of pixel-intensity => low robustness
  - Heavily dependent of RANSAC SIFT matching
    - Use some form of regularization at prediction
  - Computationally expensive since the prediction step is performed for all pixels (still faster than SIFT-flow)
    - Incorporate the multi-resolution approach