Segmentation based features for wide-baseline multi-view reconstruction

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• Motivation

• Existing methods

• SFD: Segmentation based feature detector

• Results and Evaluation of feature detectors

• Application to sparse and dense reconstruction

• Conclusion
Applications

Object Recognition

Film

Broadcast

Surveillance
Key application

Sparse and Dense scene reconstruction

Multiview Capture → Feature detection & matching between pair of views → Camera calibration & Sparse scene reconstruction → Dense scene reconstruction
Key application

Sparse scene reconstruction

SIFT

SFD (Proposed)
Key application

Dense scene reconstruction

SIFT

SFD (Proposed)
Why SFD?

- Large number of features and matches
- Good scene coverage
- Improved accuracy
- Order of magnitude increase in reconstructed points.
SFD for dense reconstruction

Original images → Segmented images → Features

Dense reconstruction ← Sparse reconstruction ← Feature matches
SFD Algorithm

Over-segmentation:

Region boundaries represent lines corresponding to local maxima of the image function
SFD Algorithm

Feature Detection:

Odzemok segmented image

Feature Illustration

Feature examples
SFD Algorithm

Feature Detection:
Evaluation: Datasets

- Juggler (6 moving)
- Odzemok (6 static, 2 moving)
- Cathedral (8 static)
Evaluation: Datasets

Merton

Valbonne

Rossendale
Evaluation: Features and Matches

Outdoor - Dynamic

MSER  SIFT  SFD with Watershed  Matches
Evaluation: Features and Matches

Outdoor - Static

MSER  SIFT  SFD with Watershed  Matches
Evaluation: Sparse reconstruction

SIFT

Original

SFD

261

409

1884

4084

12385

7211
Some more results

Segmentation based feature detector for wide-baseline multi-view reconstruction

Paper ID: 4
Evaluation: Over-segmentation

SFD: Independent of segmentation technique
Evaluation: Over-segmentation

- Watershed
- Mean-shift
- SLIC

Detected features

Matches

Merton

Odzemok
Evaluation: Over-segmentation

- Watershed
- Mean-shift
- SLIC
- Watershed
- Mean-shift
- SLIC

Detected features

Matches

Valbonne

Juggler
Evaluation: Matches

![Bar chart showing the number of correct matches for various feature detection methods. The methods include FAST, HARRIS, MSER, ORB, SIFT, SURF, SFD-WA, SFD-MS, and SFD-SLIC. The x-axis represents the different methods, and the y-axis represents the number of correct matches. The chart indicates that SFD-SLIC has the highest number of correct matches, followed by SFD-WA and SFD-MS.](chart.png)
Evaluation: Matches

Number of correct matches

- Valbonne
- Juggler

Comparison of different feature detection methods:
- FAST
- HARRIS
- MSER
- ORB
- SIFT
- SURF
- SFD-WA
- SFD-MS
- SFD-SLIC
Evaluation: Time performance

The image shows a bar graph comparing the time performance of various feature detection algorithms, including FAST, HARRIS, MSER, ORB, SIFT, SURF, SFD-WA, SFD-MS, and SFD-SLIC. The x-axis represents the algorithms, and the y-axis represents the time performance in milliseconds (ms). The bars are color-coded to indicate different algorithms, with red bars representing Odzemok and yellow bars representing Merton. The graph visually compares the performance of these algorithms, with some algorithms performing significantly faster than others.
Evaluation: Time performance

- FAST
- HARRIS
- MSER
- ORB
- SIFT
- SURF
- SFD-WA
- SFD-MS
- SFD-SLIC

Time performance in ms

- Valbonne
- Juggler
Mean re-projection error (MRE) is calculated for Odzemok dataset for various detectors:

\[ MRE = \frac{\sum_{i=0}^{N} \sqrt{(x - x')^2 + (y - y')^2}}{N} \]

N is the number of feature matches.
## Accuracy (MRE) Evaluation of SFD

### Table: Feature Detector and Descriptor Comparisons

<table>
<thead>
<tr>
<th>Feature Detector</th>
<th>Descriptor</th>
<th>RC</th>
<th>MRE</th>
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<tbody>
<tr>
<td>SFD</td>
<td>SIFT</td>
<td>3717</td>
<td>1.351</td>
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<tr>
<td>SIFT</td>
<td>SIFT</td>
<td>1269</td>
<td>1.175</td>
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<td>MSER</td>
<td>SIFT</td>
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<td>FAST</td>
<td>BRIEF</td>
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<td>1.483</td>
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### Graph: Re-projection error of SIFT and SFD-WA for Odzemok

Re-projection error of SIFT and SFD-WA for Odzemok
Evaluation: Repeatability

Repeatability with camera 1 to all other views (15-120 degree baseline).
Conclusions

- Novel feature detector for wide-baseline matching
- A comprehensive performance evaluation for feature matching and time performance
- Ground truth accuracy evaluation
- Further plans include evaluating the utility of SFD features in applications such as camera tracking and object recognition.
Thank you!

Segmentation based feature detector for wide-baseline multi-view reconstruction

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Questions??
Accuracy Evaluation of SFD with Harris and Uniform Sampling

- Uniform grid sampling is performed by locating features at points of maximum gradient magnitude with a 13X13 grid
- Experimented on Odzemok dataset

<table>
<thead>
<tr>
<th>FD</th>
<th>Descriptor</th>
<th>Features</th>
<th>RC</th>
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<tbody>
<tr>
<td>SFD</td>
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<td>Uniform Sampling</td>
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<tr>
<td>Harris</td>
<td>SIFT</td>
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<td>145</td>
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</tbody>
</table>
Evaluation: Repeatability

Repeatability between adjacent views (15-30 degree baseline)