Feature Matching
Feature matching

Given a feature in $I_1$, how to find the best match in $I_2$?

1. Define distance function that compares two descriptors

2. Test all the features in $I_2$, find the one with min distance
Feature distance between $f_1$ and $f_2$

Simple approach is

$$SSD(f_1, f_2) = |f_1 - f_2|^2$$

Fails in ambiguous cases
Feature distance between $f_1$ and $f_2$

Better approach is

Ratio distance = $\frac{SSD(f_1, f_2)}{SSD(f_1, f_2')}$

- $f_2$ is best SSD match to $f_1$ in $I_2$
- $f_2'$ is 2nd best SSD match to $f_1$ in $I_2$
Feature distance between $f_1$ and $f_2$

Better approach is

Ratio distance = $\frac{SSD(f_1, f_2)}{SSD(f_1, f_2')}$

The value is in the range $[0, 1.0]$
Eliminating bad matches

Throw out features with distance > threshold

• How to choose the threshold?
True/false positives

Throw out features with distance > threshold

The threshold affects performance

- **True positives** = # of detected matches that are correct
  - Suppose we want to maximize these—how to choose threshold?
- **False positives** = # of detected matches that are incorrect
  - Suppose we want to minimize these—how to choose threshold?
## Evaluating the results

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[From Wikipedia]
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\[
\text{Precision} = \frac{TP}{TP + FN} \\
\text{Recall} = \frac{TP}{FP + TN}
\]
Evaluating the results

\[
\begin{align*}
\text{true positive rate} &= \frac{TP}{TP + FN} \\
\text{false positive rate} &= \frac{FP}{FP + TN}
\end{align*}
\]
Evaluating the results

With a loose threshold, where in the graph? (accept everything as a match)
Evaluating the results

With a tight threshold, where in the graph? (reject everything)
Evaluating the results

\[
\frac{TP}{TP + FN} \quad \frac{FP}{FP + TN}
\]

true positive rate
false positive rate

Where do you want the curve to go?
Evaluating the results

ROC Curves
• Want to maximize area under the curve (AUC)
• Useful for comparing different feature matching methods
• For more info: http://en.wikipedia.org/wiki/Receiver_operating_characteristic
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[ from wikipedia ]
Feature matching examples
SIFT Scale Invariance Results
SIFT Rotation Invariance Results
SIFT Lighting Invariance Results
SIFT Robustness to Clutter

[slide by Neeraj Kumar]
SIFT for 3D Objects?

[slide by Neeraj Kumar]
When does SIFT fail?

Patches SIFT thought were the same but aren’t:
SIFT References


[slide by Neeraj Kumar]
SIFT References


