

Robotics and
Embedded Systems



Applied Computer Vision for Robotics

23.4.2014

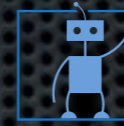
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Brian Jensen

Features

- ✦ Normally split into a detector and descriptor
- ✦ The detector only finds points of interests
- ✦ The descriptor is extracted around a keypoint to allow comparison and matching
- ✦ Usual feature pipeline:
 - ✦ Detect features
 - ✦ Build descriptor
 - ✦ Use descriptors for matching

Features



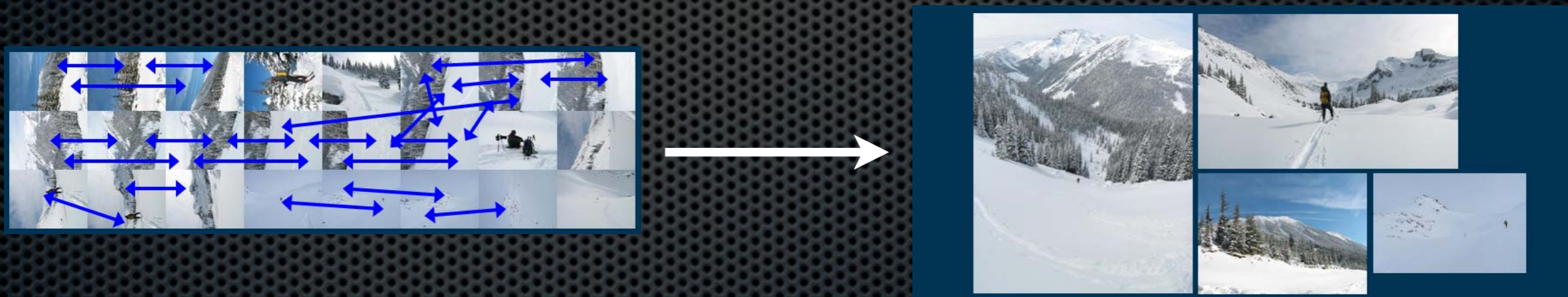
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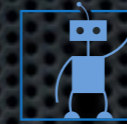
- Exemplary applications
 - Panorama stitching
 - Template tracking
 - Visual Odometry/SLAM

Features

- ✦ Panorama stitching:
 - ✦ Pure rotation of the camera assumed
 - ✦ Correspondences allow homography estimation



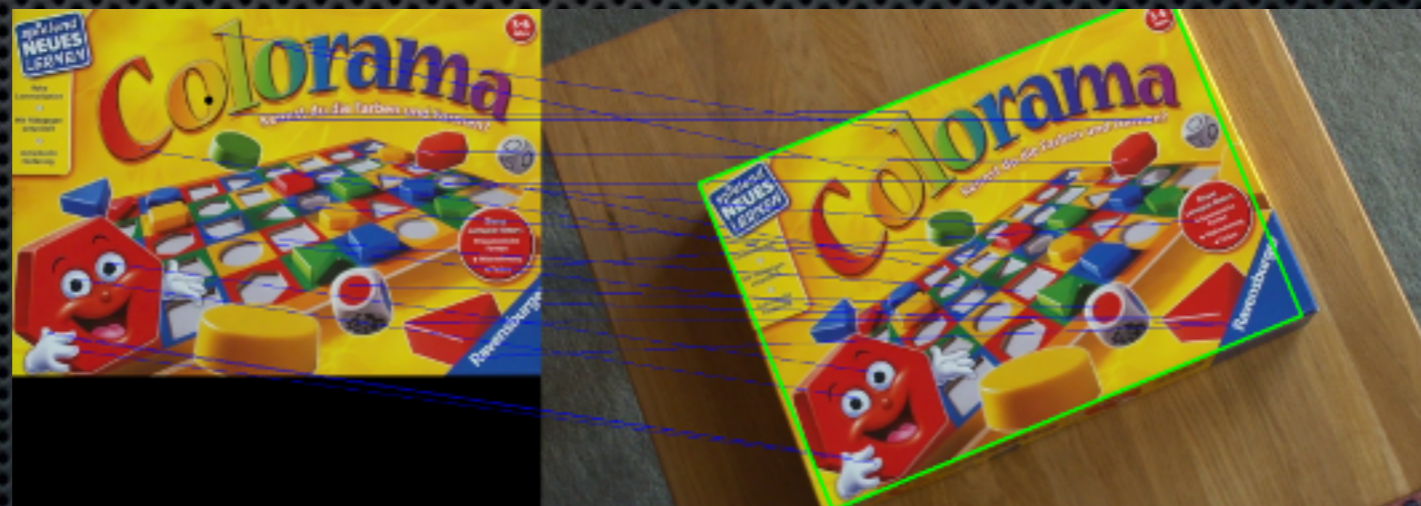
Features



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- Template tracking:
 - Features of a template are matched to features extracted from video stream
 - Use correspondences to estimate homography

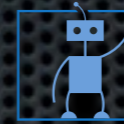


Features

- ✦ Visual Odometry/SLAM
 - ✦ use features to estimate relative movement between frames
 - ✦ build map of 3d features to locate yourself
 - ✦ more details in sheet 3



Sheet 2



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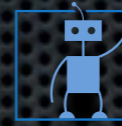
- Sheet 2 is mainly about descriptors
- Goal: find a way to describe the keypoint in order to compare it with other keypoints

MOPS

- ✦ Multi-Scale Oriented Patches
- ✦ Rotate the patch using the found orientation and on multiple scales
- ✦ We just use the smoothed intensities for comparison (original: haar coefficients)
- ✦ To compensate for brightness changes it is a good idea to normalize the patch



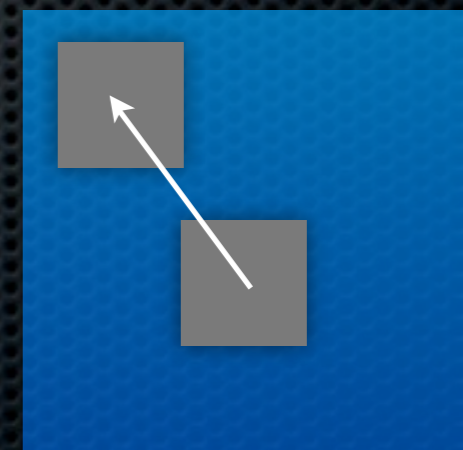
Binary descriptors



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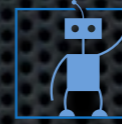


- ✦ Descriptor only contains the result of brightness comparisons of patch areas
- ✦ Many comparisons get combined and form a binary descriptor
- ✦ Distance measured using Hamming distance
- ✦ Orientation also useful to consider

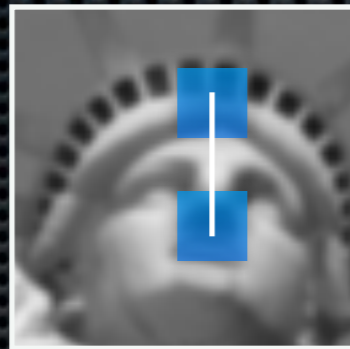


[1] M. Calonder, V. Lepetit, C. Strecha, and P. Fua, "BRIEF: binary robust independent elementary features," presented at the ECCV'10: Proceedings of the 11th European conference on Computer vision: Part IV, 2010.

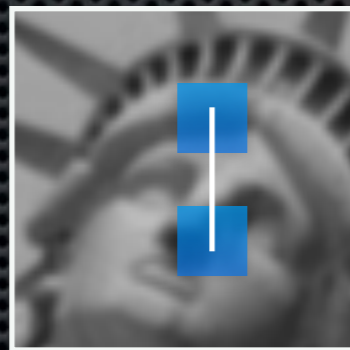
Binary descriptors



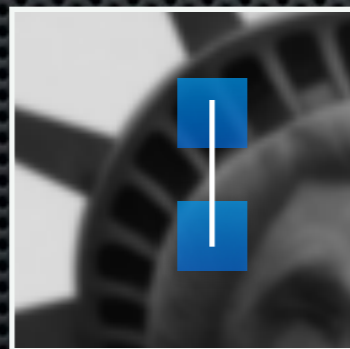
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$$\sum_a I(\mathbf{x}_a) < \sum_b I(\mathbf{x}_b) = 1$$

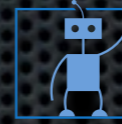


$$\sum_a I(\mathbf{x}_a) < \sum_b I(\mathbf{x}_b) = 1$$

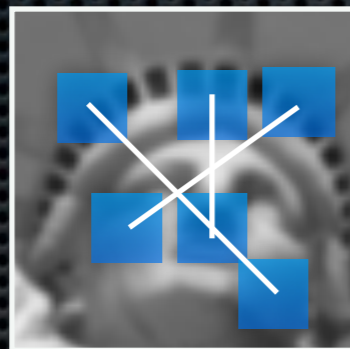


$$\sum_a I(\mathbf{x}_a) < \sum_b I(\mathbf{x}_b) = 0$$

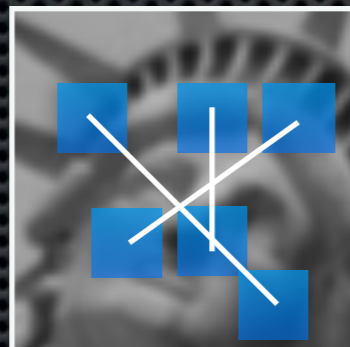
Binary descriptors



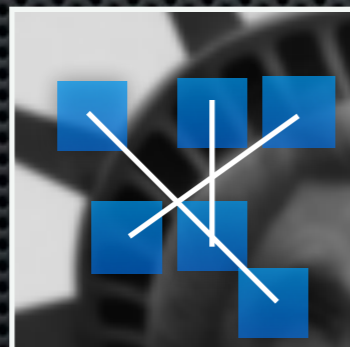
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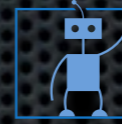


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Binary descriptors



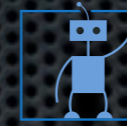
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- ✦ Bit string length depends on the number of tests (e.g. 64, 128, 256)
- ✦ Hamming distance expresses how many tests gave the same result and how many differed (depends only on the values and not their position)
- ✦ ORB extends BRIEF by choosing uncorrelated tests and rotating the whole pattern according to an estimated orientation

[1] E. Rublee, V. Rabaud, K. Konolige, and G. Bradski, “ORB: An efficient alternative to SIFT or SURF,” presented at the Computer Vision (ICCV), 2011 IEEE International Conference on, 2011, pp. 2564–2571.

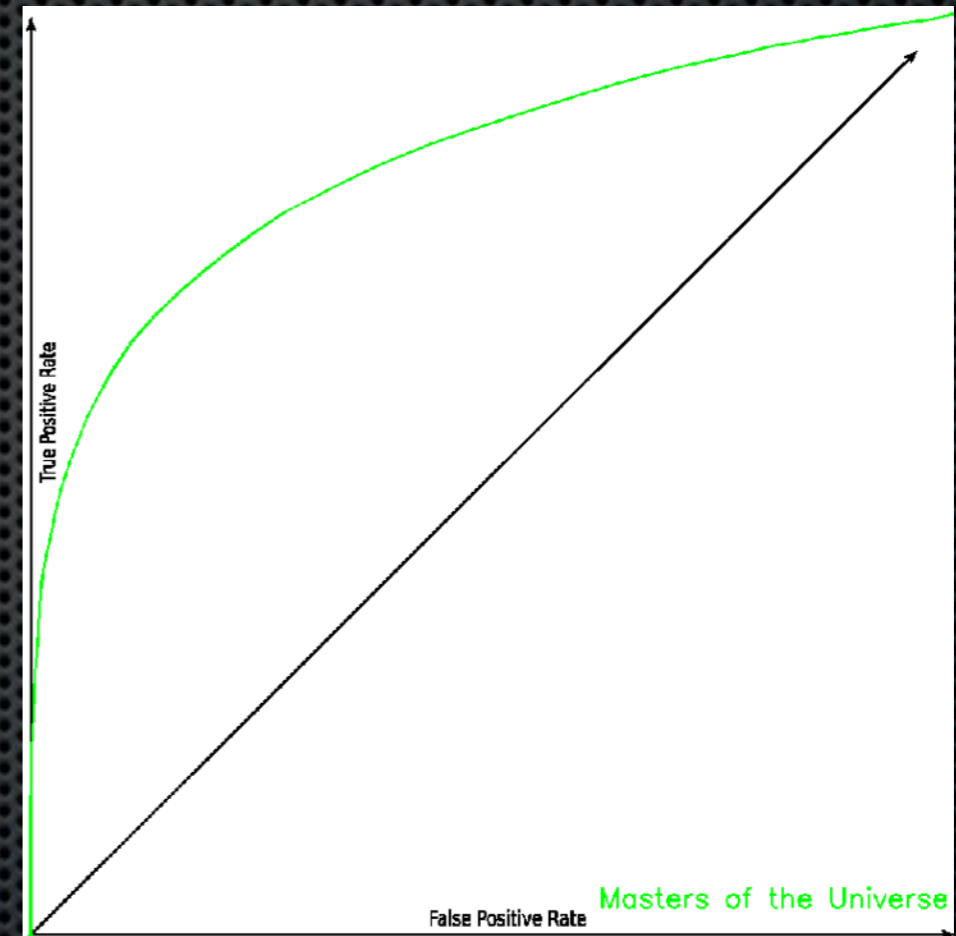
ROC Curve



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- ✦ is a graphical plot which illustrates the performance of a binary classifier system
- ✦ plot of the true positive rate against the false positive rate for increasing descriptor distance thresholds



ROC Challenge

- ✦ Competition between the teams
- ✦ Experiment to find best performing descriptor

