

# Modern features: advances, applications and software



- Why now?
- 2005 IJCV paper on “A comparison of affine region detectors”
  - What has happened since?
  - Improvements over the classics?
- Release of new software suites for feature detection
  - VLFeat
  - Also benchmarks

# Modern features: advances, applications and software



Programme:

2.30 - 2.45 Introduction

2.45 - 3.30 Feature detectors

3.30 - 4.15 Feature descriptors

4.15 - 4.30 Break

4.30 - 5.00 Software

5.00 - 5.30 Benchmarks

5.30 - 6.15 Hands-on software session

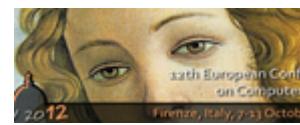
See webpage for this up to date programme

<https://sites.google.com/site/eccv12features/>

# Features Detector.

- **Definition:** A feature **detector** (extractor) is an algorithm taking an image as input and outputting a set of regions (“local features”).
- “Local Features” are **regions**, i.e. in principle arbitrary sets of pixels, not necessarily contiguous, which are at least :
  - **distinguishable** in an image regardless of viewpoint/illumination
  - **robust to occlusion** must be **local**
  - Must have a discriminative neighborhood: they are “**features**”
- Terminology has not stabilised:  
Local Feature = Interest “Point” = Keypoint =
  - = Feature “Point” = The “Patch”
  - = Distinguished Region = Features
  - = (Transformation) Covariant Region
- **Definition:** A **descriptor** is computed on an image region defined by a detector. The descriptor is a representation of the intensity (colour, ....) function on the region.

# Feature Detectors: Desiderata



- **Invariance** (or covariance) to a broad class of geometric and photometric transforms
- **Efficiency:** close to real-time performance
- **Quantity/Density** of features to cover small object/part of scenes
- **Robustness** to:
  - occlusion and clutter (requires *locality*)
  - to noise, blur, discretization, compression
- **Distinctiveness:** individual features can be matched to a large database of objects
- **Stability over time** (to support long-temporal-baseline matching)
- **Geometrically accuracy:** precise localization
- **Generalization** to similar objects
- Even coverage, complementarity, number of geometric constraints, ...

No detector dominates in all aspects, some properties are competing, e.g. level of invariance x speed

# Feature Descriptor.

- **Definition:** A descriptor is computed on an image region defined by a detector. The descriptor is a representation of the intensity (colour, ....) function on the region.

Desiderata for feature descriptors:

- Discriminability
- Robustness to misalignment, illumination, blur, compression, ...
- Efficiency: real-time often required
- Compactness: small memory footprint. Very significant on mobile large-scale applications

Note: The region on which a descriptor is computed is called a **measurement region**. This may be directly the feature detector output or any other function of it (eg. convex hull, triple area region..)

# Application Domains



- Methods based on “Local Features” are the state-of-the-art for number of computer vision problems (mostly those that require local correspondences).
- Suited to instance matching over change in viewpoint, scale, lighting, partial occlusion, region of interest ...
- Multiple views of the same scene, e.g.
  - Computing epipolar geometry or a homography
  - Photo Tourism
  - Panoramic mosaic
- Query by example search in large scale image datasets, e.g.
  - Google goggles
  - Where am I? Match to Streetview
  - Total recall
- Copy detection
- Re-acquisition in tracking
- Object category recognition

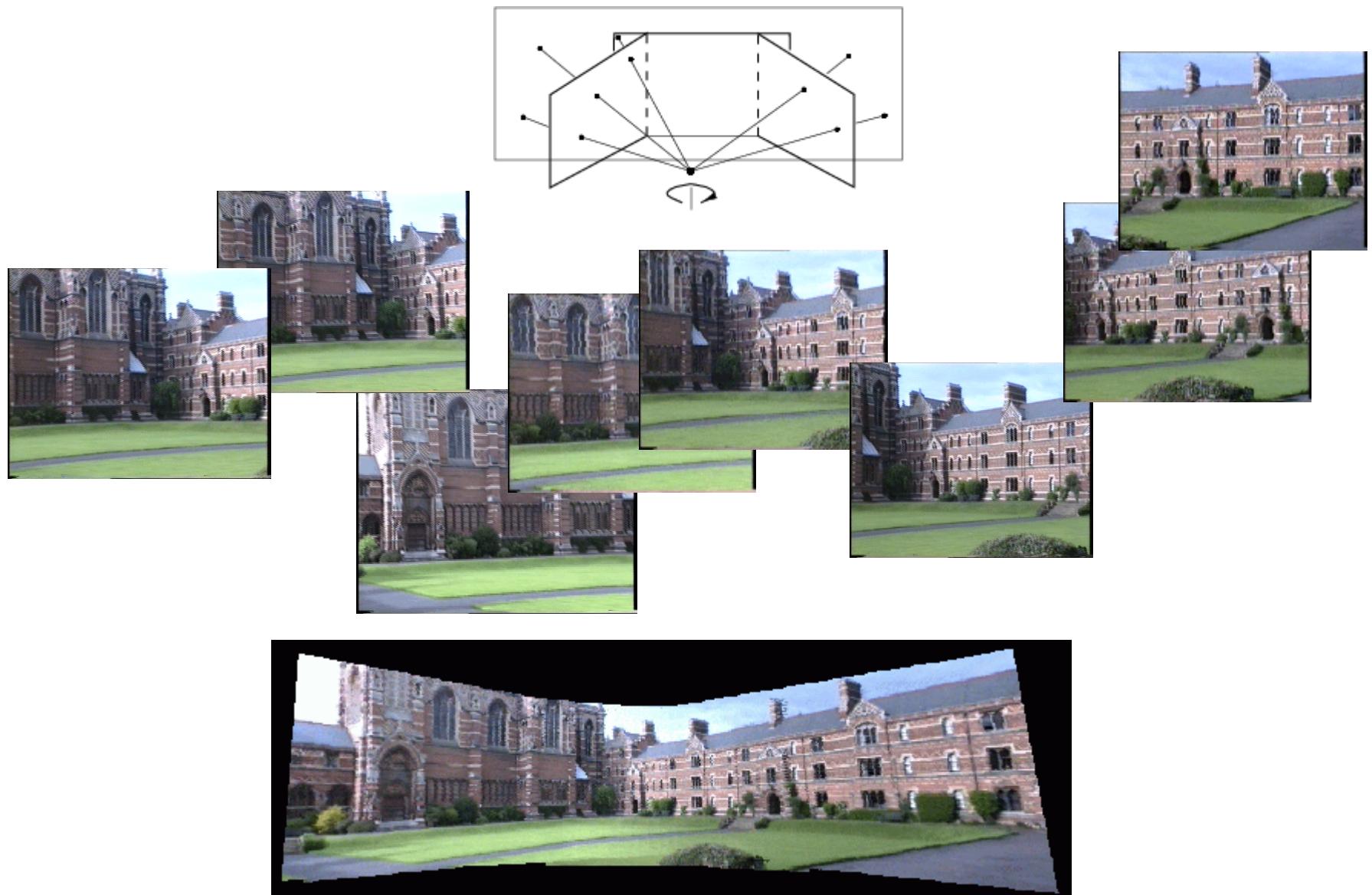
# Example 1: Wide baseline matching

- Establish correspondence between two (or more) images
- Useful in visual geometry: Camera calibration, 3D reconstruction, Structure and motion estimation, ...

Local transf: scale/affine – Detector: affine-Harris Descriptor: SIFT



# Example 2: Panoramic mosaic



# Example 2. Image Stitching: Building a Panorama



M. Brown and D. G. Lowe. Recognising Panoramas. ICCV 2003

# AutoStitch iPhone

[Home](#) [Usage](#) [Gallery](#) [FAQ](#) [Reviews](#) [Company](#) [News](#)



## Automatic Image Stitching for the iPhone

**AutoStitch iPhone** is a fully automatic image stitcher for the iPhone. This application unleashes the power of your iPhone's camera to create wide-angle views and panoramas with any arrangement of photos.

AutoStitch uses the most advanced stitching technology available today, but it's very simple to use. To see how it works on the iPhone/iPod Touch, see our [usage instructions](#) or [tutorial video](#).

AutoStitch iPhone brings together years of research and development experience into an amazing application that is available now on your iPhone at a very low price.

**\*\*\* Note:** If you recently upgraded to iOS4 or to version 3.0 and are having problems, please see the top of our [FAQ](#).

 Available on the iPhone  
**App Store**

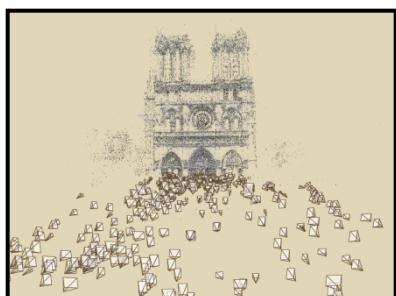
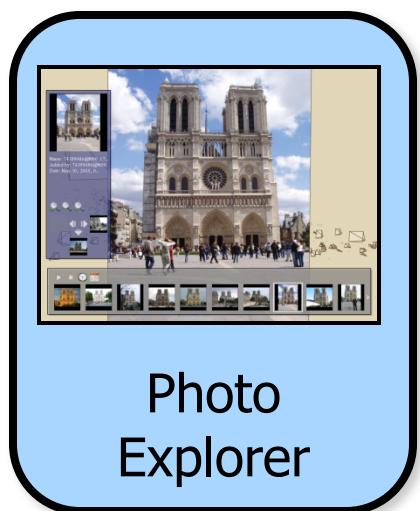
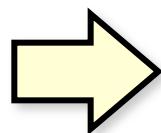
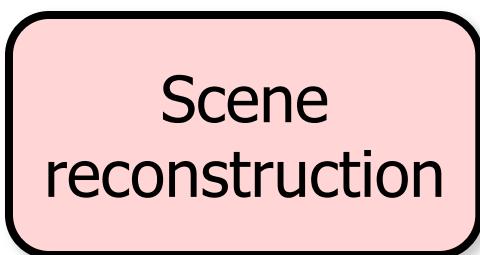
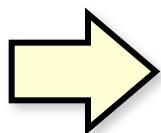
Buy AutoStitch from the App Store now for just \$2.99!

# Example 3: 3D reconstruction

- Photo Tourism overview



Input photographs



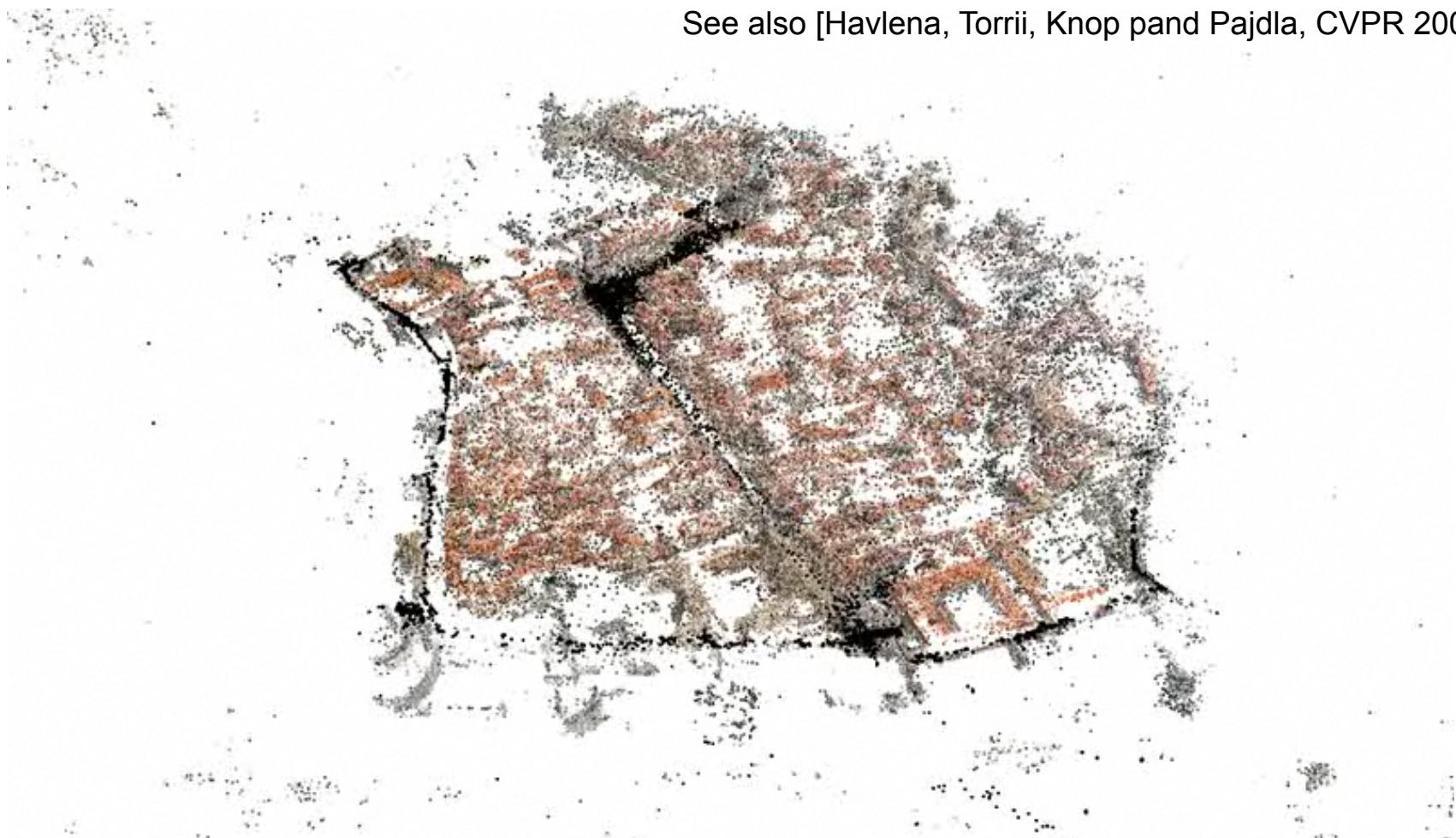
Relative camera  
positions and orientations  
Point cloud  
Sparse correspondence

# Example 3: 3D reconstruction

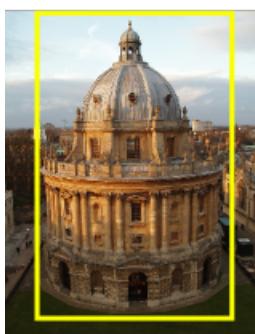
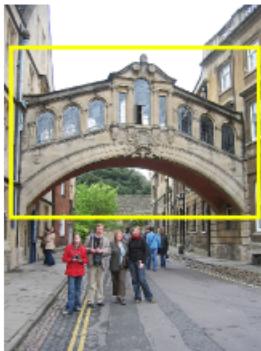
57,845 downloaded images, 11,868 registered images. This video: 4,619 images.

The Old City of Dubrovnik

[Building Rome in a Day](#), Agarwal, Snavely, Simon, Seitz,  
Szeliski, ICCV 2009  
See also [Havlena, Torii, Knop and Pajdla, CVPR 2009].



# Example 4: Query by example search in large scale image datasets

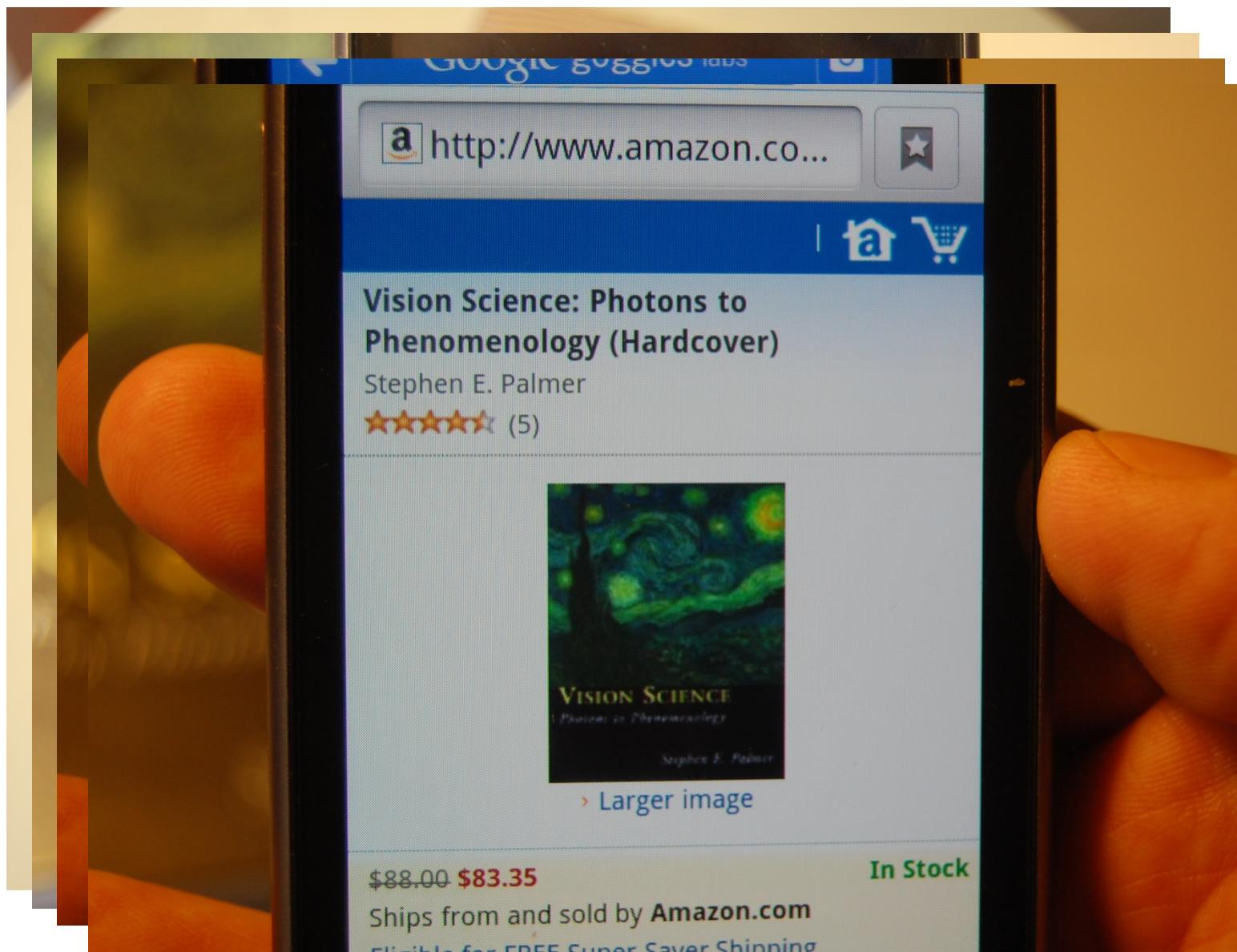


Find these objects

...in these images and 1M more

Search the web with a visual query ...

# Example 5: Google goggles





## kooaba Paperboy delivers digital extras for print

by kooabaChannel

### kooaba Paperboy delivers digital extras for print

by kooabaChannel

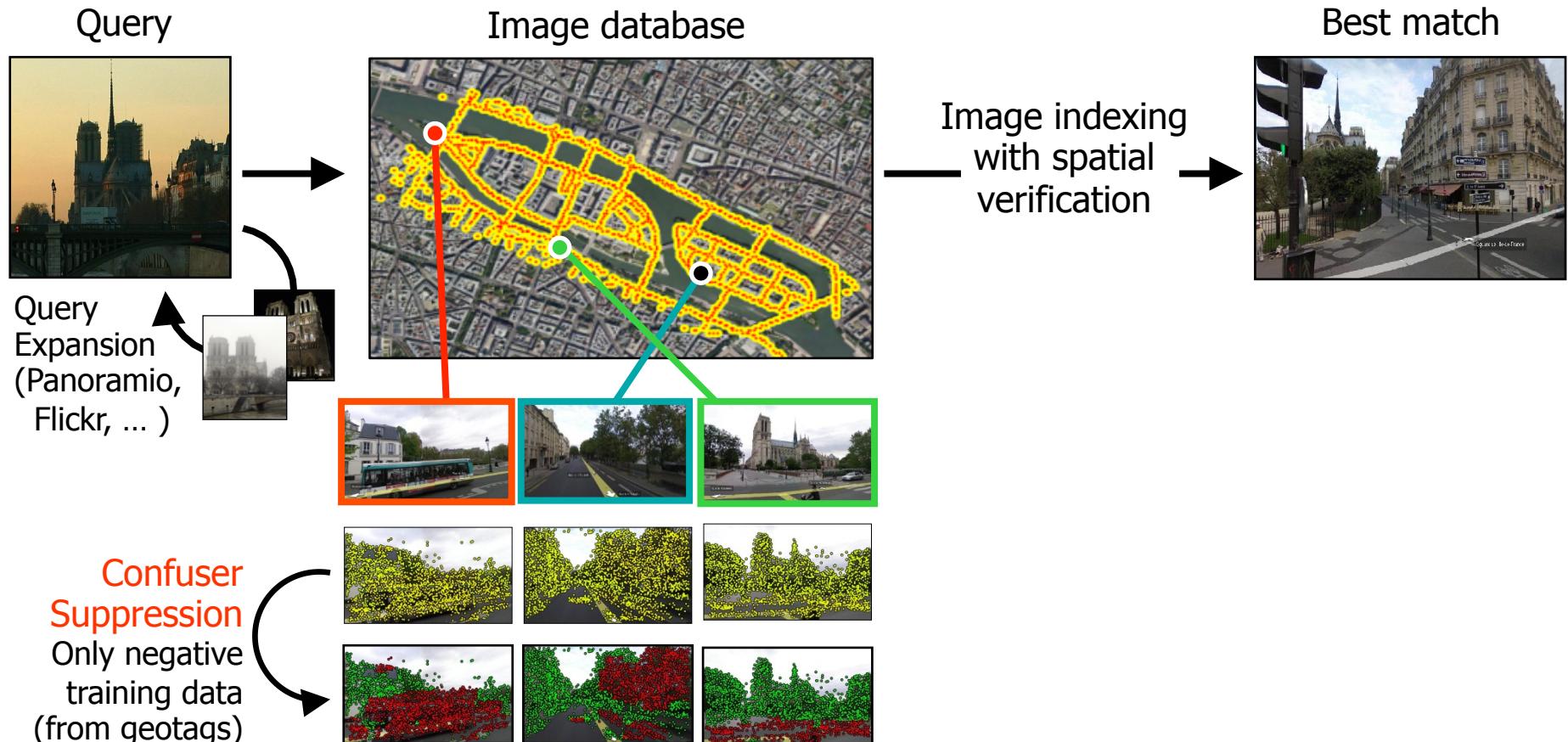


The smartphone screen shows a mobile application interface for a newspaper article. At the top, it says "SonntagsZeitung Ausgabe 13. Feb, Seite 1". Below that, there are social sharing buttons for Facebook, Twitter, and E-Mail. Further down, there are options to "Entdecken", "Seite anzeigen (480,6 KB)", "SoZ-Abo: 3 Monate für nur 30.-", and "Aufbewahren". The overall design is clean and modern, with a focus on digital interaction with print media.

You Tube

# Example 6: Where am I?

- Place recognition - retrieval in a structured (on a map) database

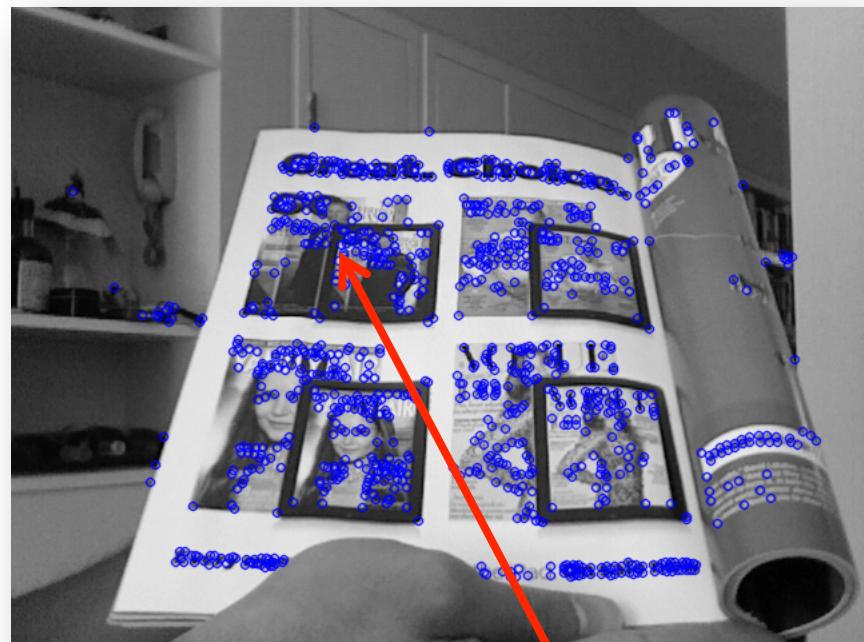


# Example 8: Re-acquisition in tracking

Tracking target



Input image



Weight vector  $w_i$  per keypoint

Descriptor  $d_j$  per keypoint

$$\text{Correspondence score: } s_{ij} = \langle w_i, d_j \rangle$$

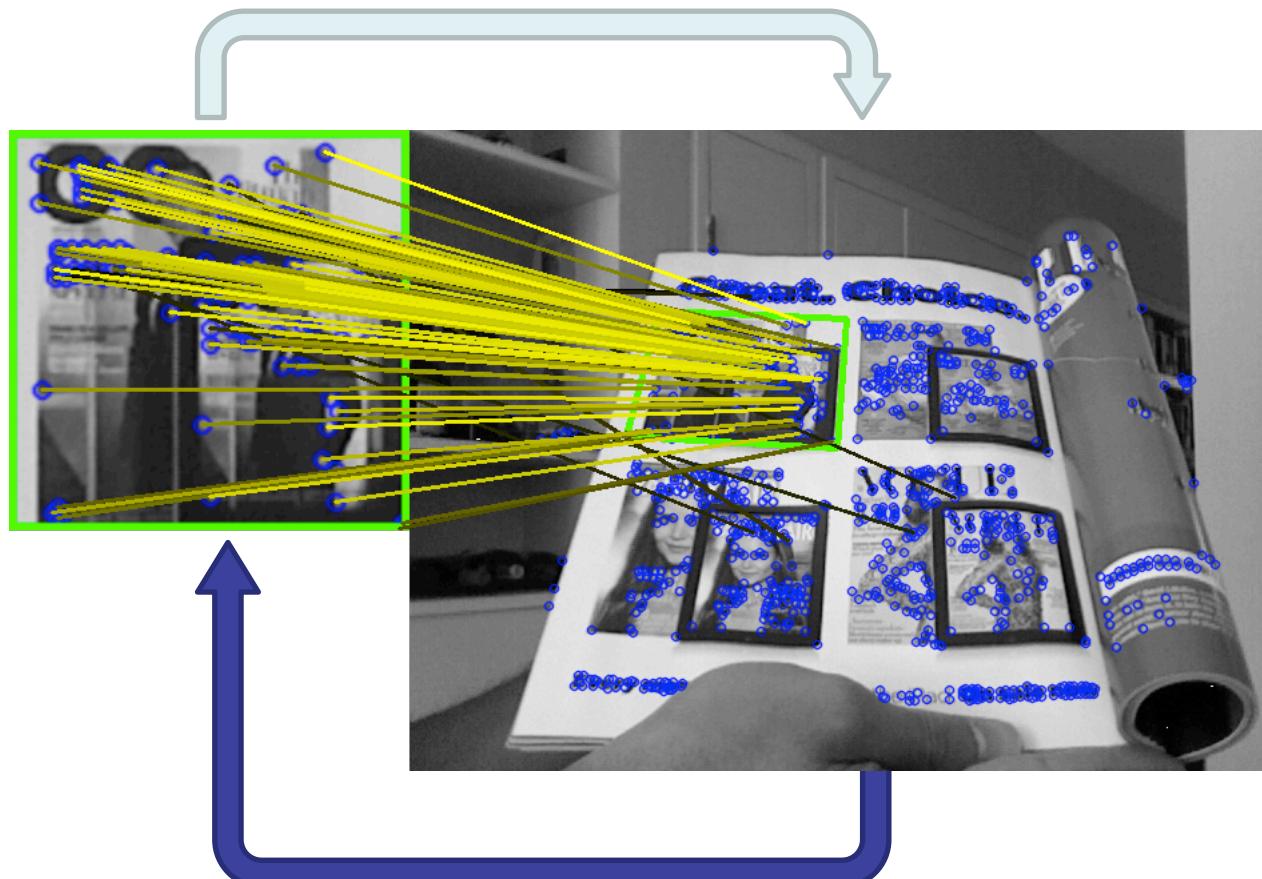
Hare, Amri, Torr, CVPR 2012

# Example 8: Re-acquisition in tracking

- Tracking Loop

Detect

Correspondence generation + PROSAC



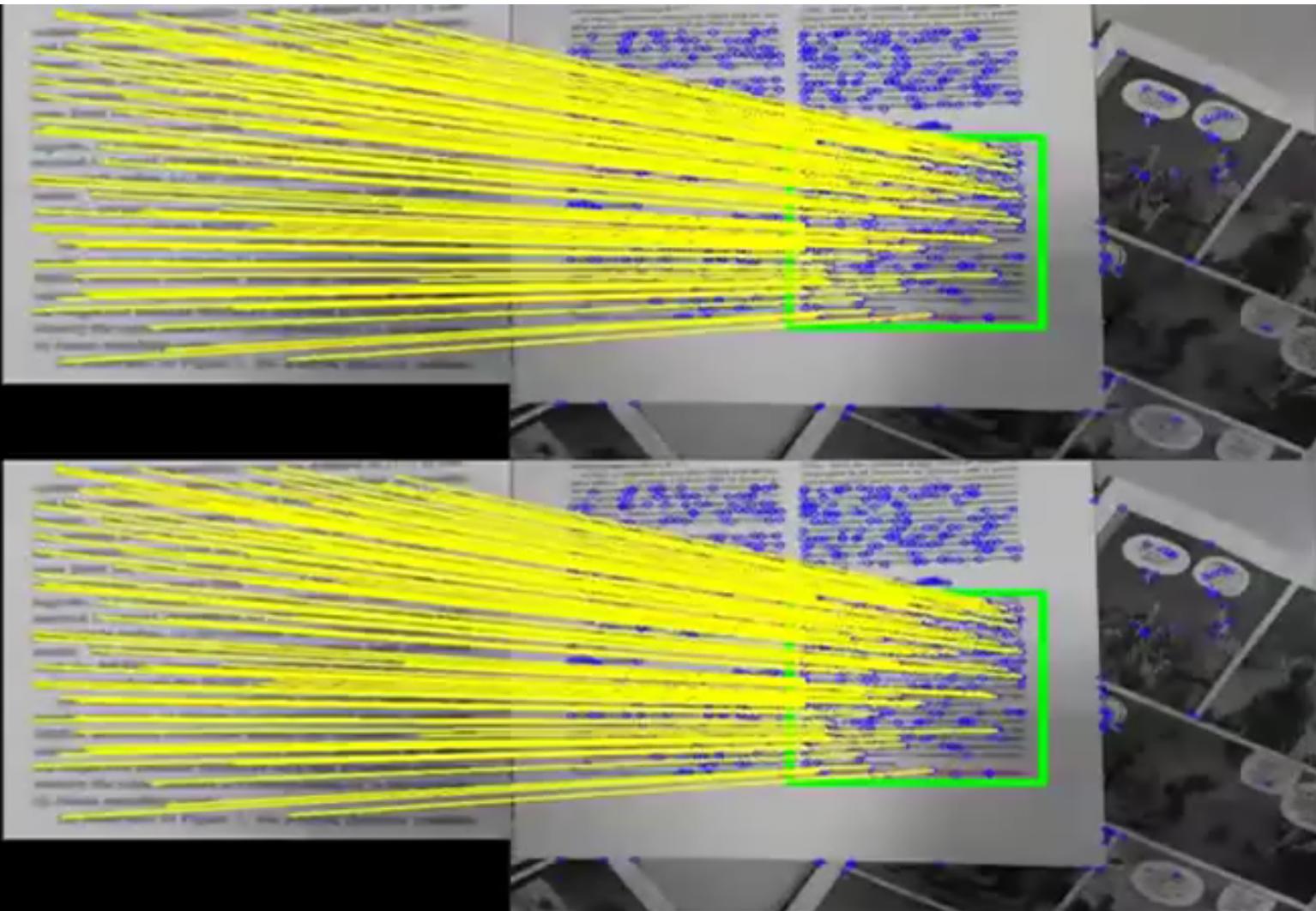
Hare, Amri, Torr,  
CVPR 2012

Update

Structured SVM +  
stochastic gradient descent

# Example 8: Re-acquisition in tracking

Static Model



*paper*

# Studierstube NFT v3 Sneak Preview

2009-07-30

[http://studierstube.org/handheld\\_ar](http://studierstube.org/handheld_ar)

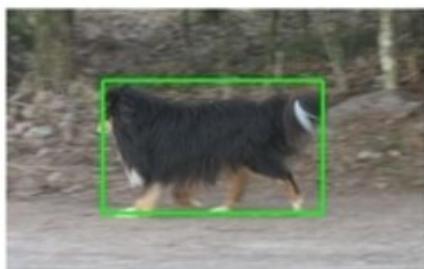
Courtesy of Graz University of Technology

# Example 8: Object category recognition

## Sliding window detector

- Classifier: SVM with linear kernel
- BOW representation for ROI

Example detections for dog



Lampert et al CVPR 08: Efficient branch and bound search over all windows