



# Local Feature Extraction and Description for

Wide-Baseline Matching, Object Recognition and  
Image Retrieval Methods, Stitching and more ...  
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Includes slides by:

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- Martin Urban, Stepan Obdrzalek, Ondra Chum Center for Machine Perception Prague
- Matthew Brown, David Lowe, University of British Columbia

# Lecture 1 outline

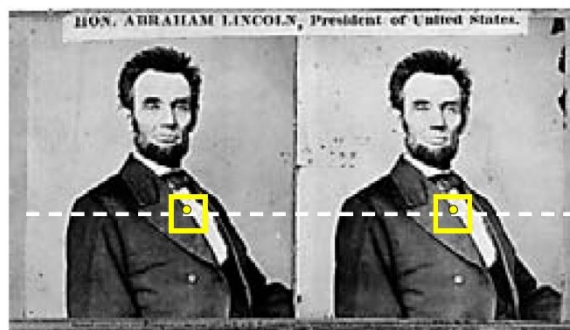
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- Local features: introduction, terminology
- Motivation: generalisation of local stereo to wide-baseline stereo
- Examples: retrieval, panorama, recognition

- Methods based on “Local Features” are the state-of-the-art for number of computer vision problems (often those, that require local correspondences).
- E.g.: Wide-baseline stereo, object recognition and image retrieval.
- Terminology is a mess:  
Local Feature = Interest “Point” = The “Patch” =  
= Feature “Point”  
= Distinguished Region  
= (Transformation) Covariant Region

# Motivation: Generalization of Local Stereo to WBS

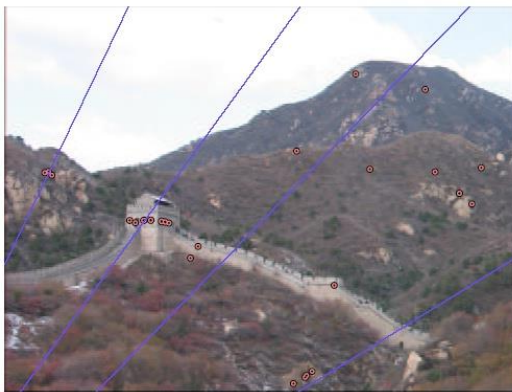
1. Local Feature (Region) = a rectangular “window”
  - robust to occlusion, translation invariant
  - windows matched by correlation, assuming small displacement
  - successful in stereo matching
2. Local Feature (Region) = a circle around an “interest point”
  - robust to occlusion, translation and rotation invariant
  - matching based on correlation or rotation invariants (*note that the set of circles of a fixed radius is closed under translation and rotation*).
  - successful in tracking and stereo matching



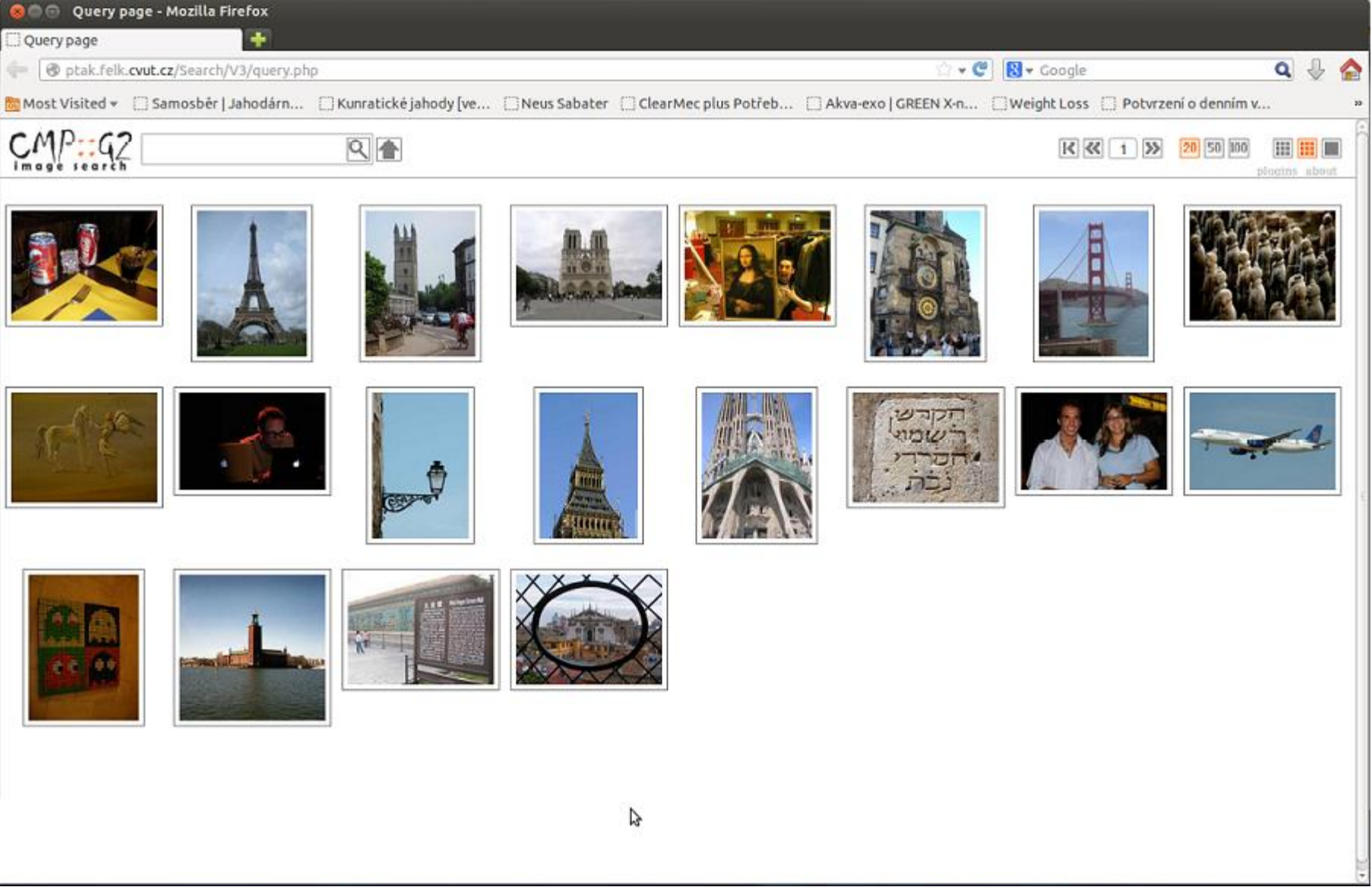
Hard Impossible for a Local feature based method?

## 3. Widening of baseline or zooming in/out

- local deformation is well modelled by affine or similarity transformations
- how can the “local feature” concept be generalised? *The set of ellipses is closed under affine tr., but it's too big to be tested*
- window scanning approach becomes computationally difficult.



# Local Features in Action (1): Image Retrieval



# Local Features in Action (1): Image Retrieval

Query page - Mozilla Firefox

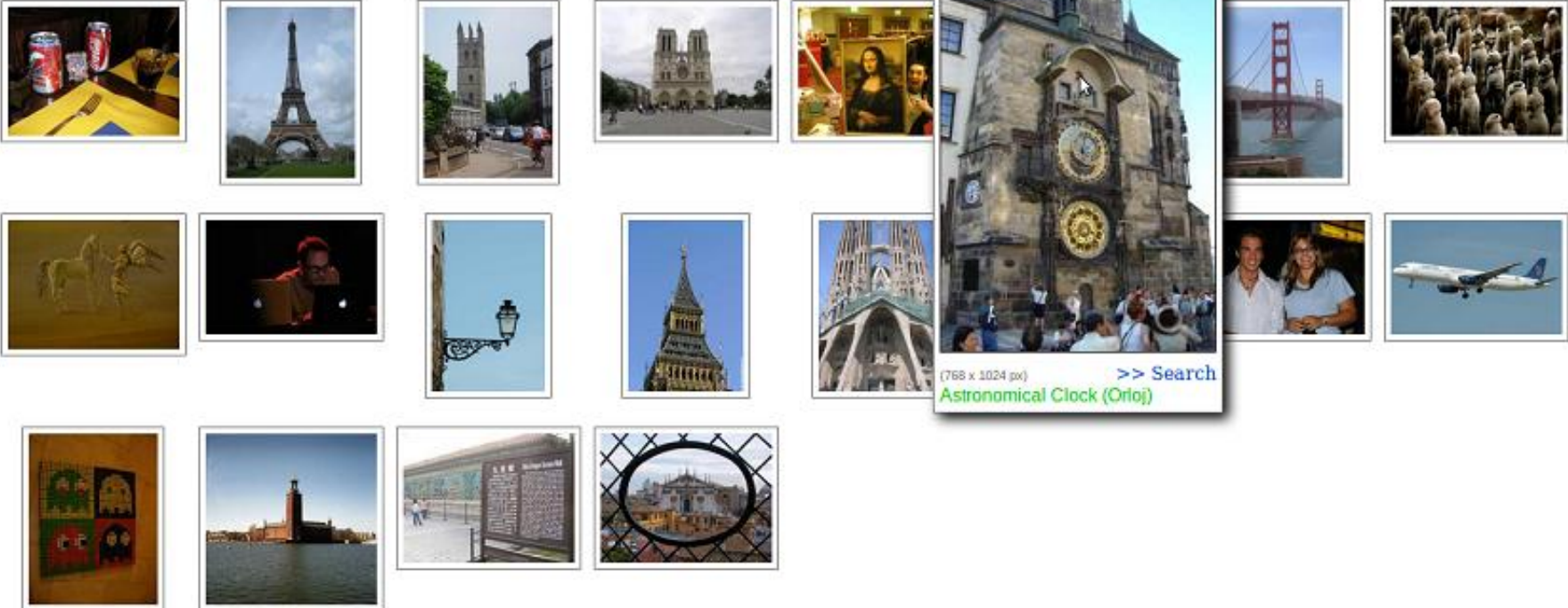
Query page

ptak.felk.cvut.cz/Search/V3/query.php

Most Visited Samosběr | Jahodárn... Kunratické jahody [ve... Neus Sabater ClearMec plus Potřeb... Akva-exo | GREEN X-n... Weight Loss Potvrzení o denním v...

CMP:G2 image search

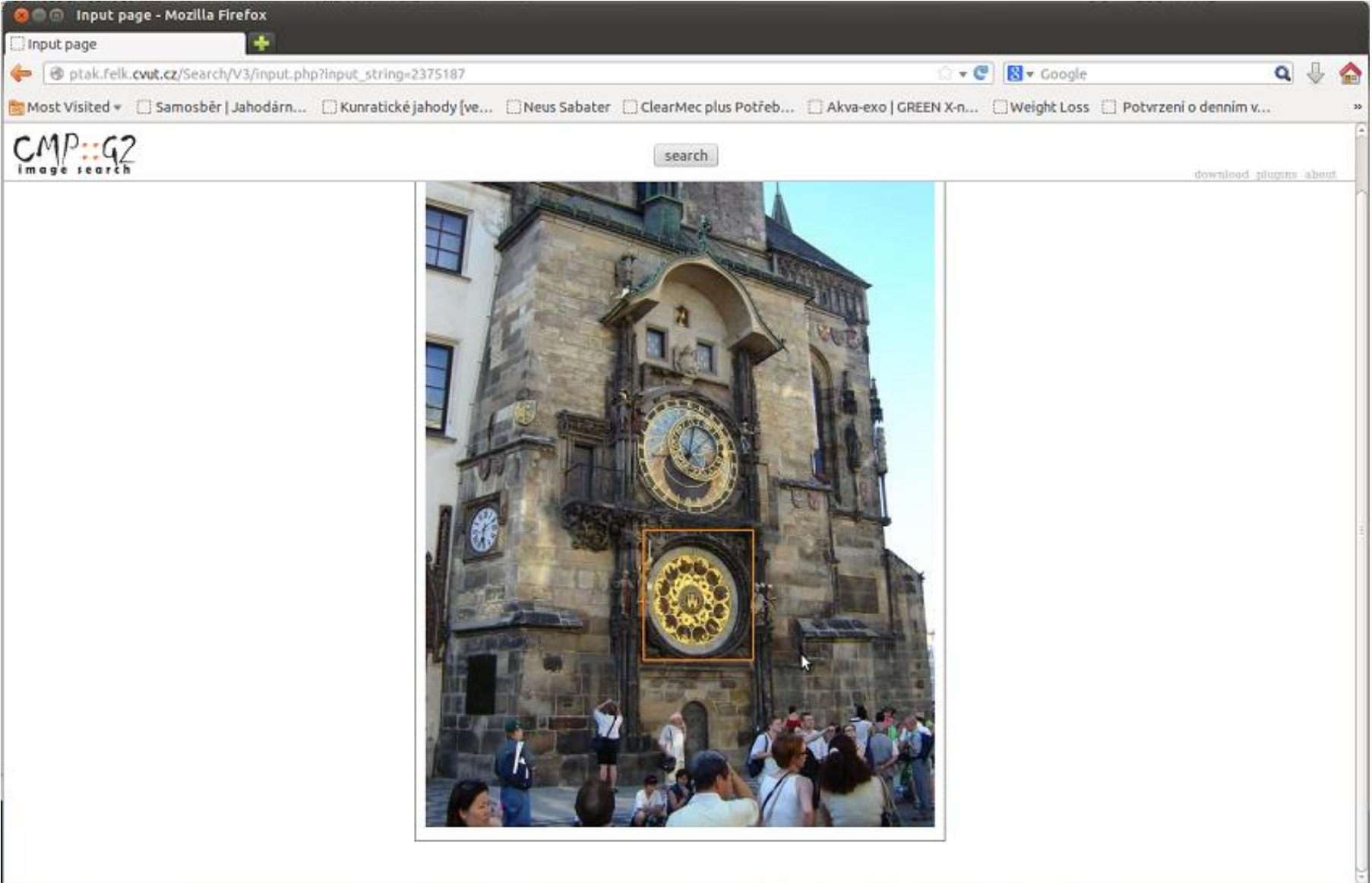
plugins about



(768 x 1024 px) >> Search  
Astronomical Clock (Orloj)

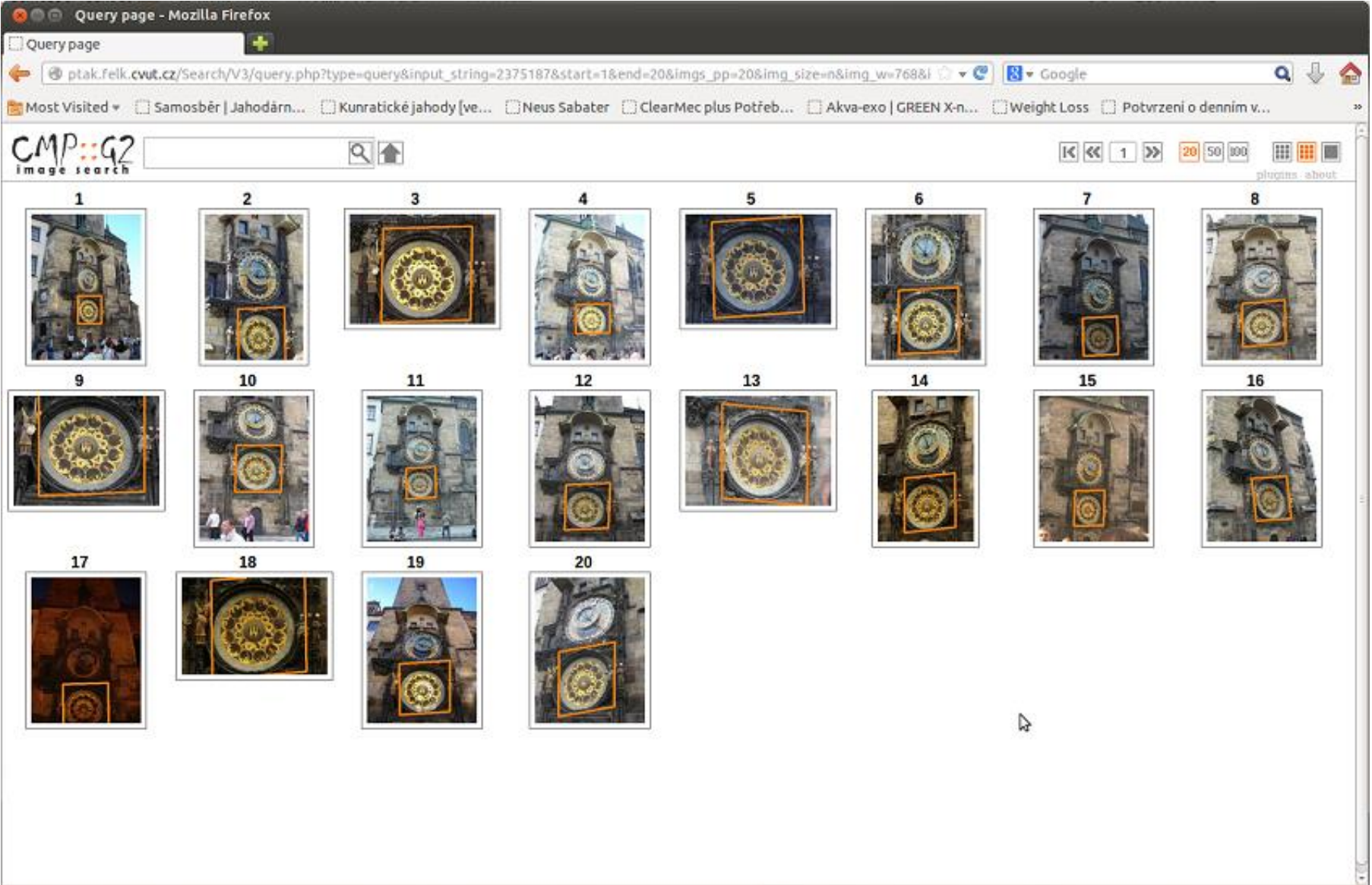
ptak.felk.cvut.cz/Search/V3/input.php?input\_string=2375187

# Local Features in Action (1): Image Retrieval





# Local Features in Action (1): Image Retrieval



# Local Features in Action (1): Image Retrieval

Query page - Mozilla Firefox

Query page

ptak.felk.cvut.cz/Search/V3/query.php?type=query&input\_string=2375187&start=1&end=20&imgs\_pp=20&img\_size=n&img\_w=

Most Visited Samosbér | Jahodárn... Kunratické jahody [ve... Neus Sabater ClearMec plus Potřeb... Akva-exo | GREEN X-n... Weight Loss Potvrzení o denním v...

CMP:G2 image search

1 2 3 4 5 6 7 8

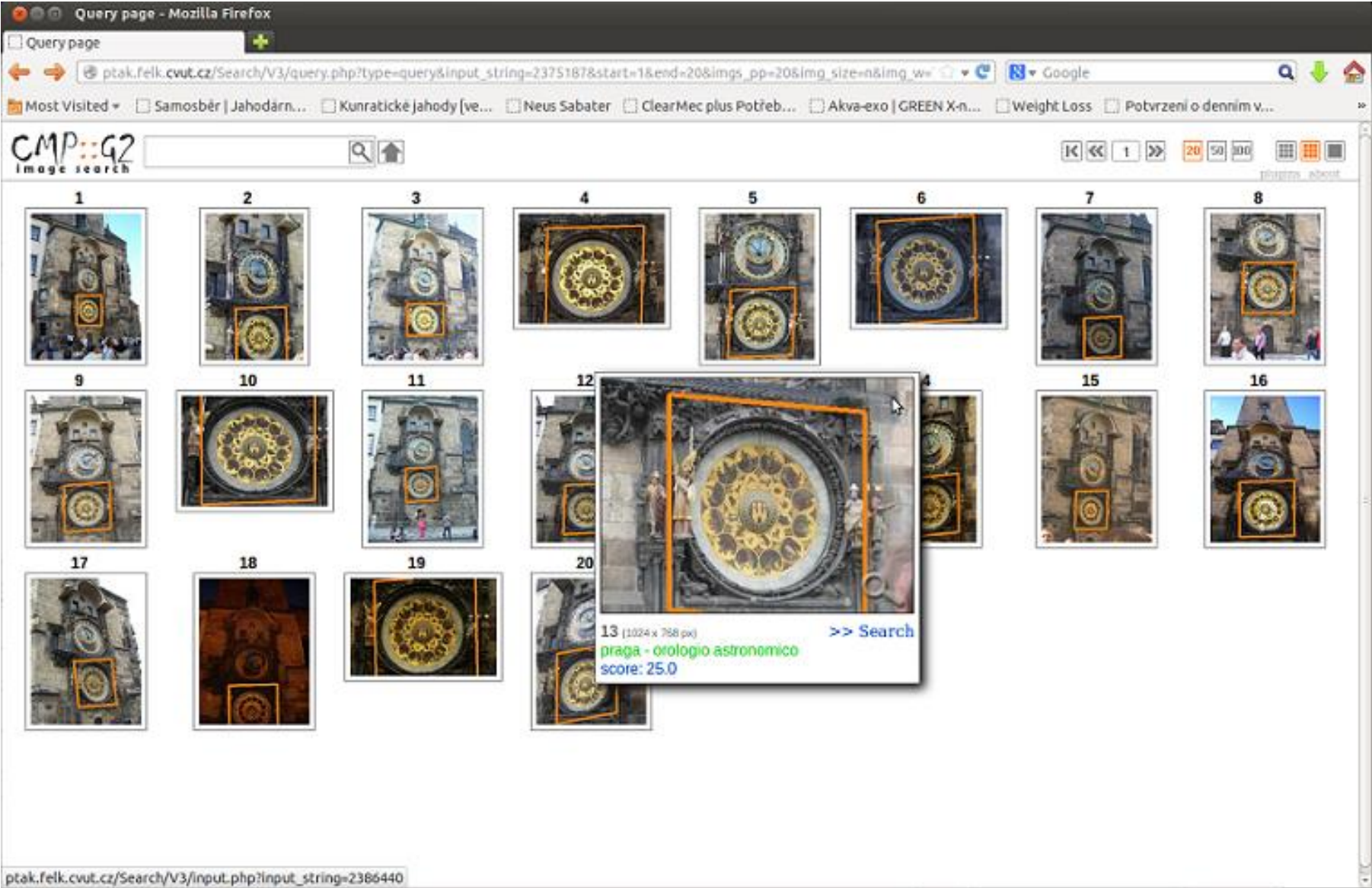
9 10 11 12 13 14 15 16

17 18 19 20

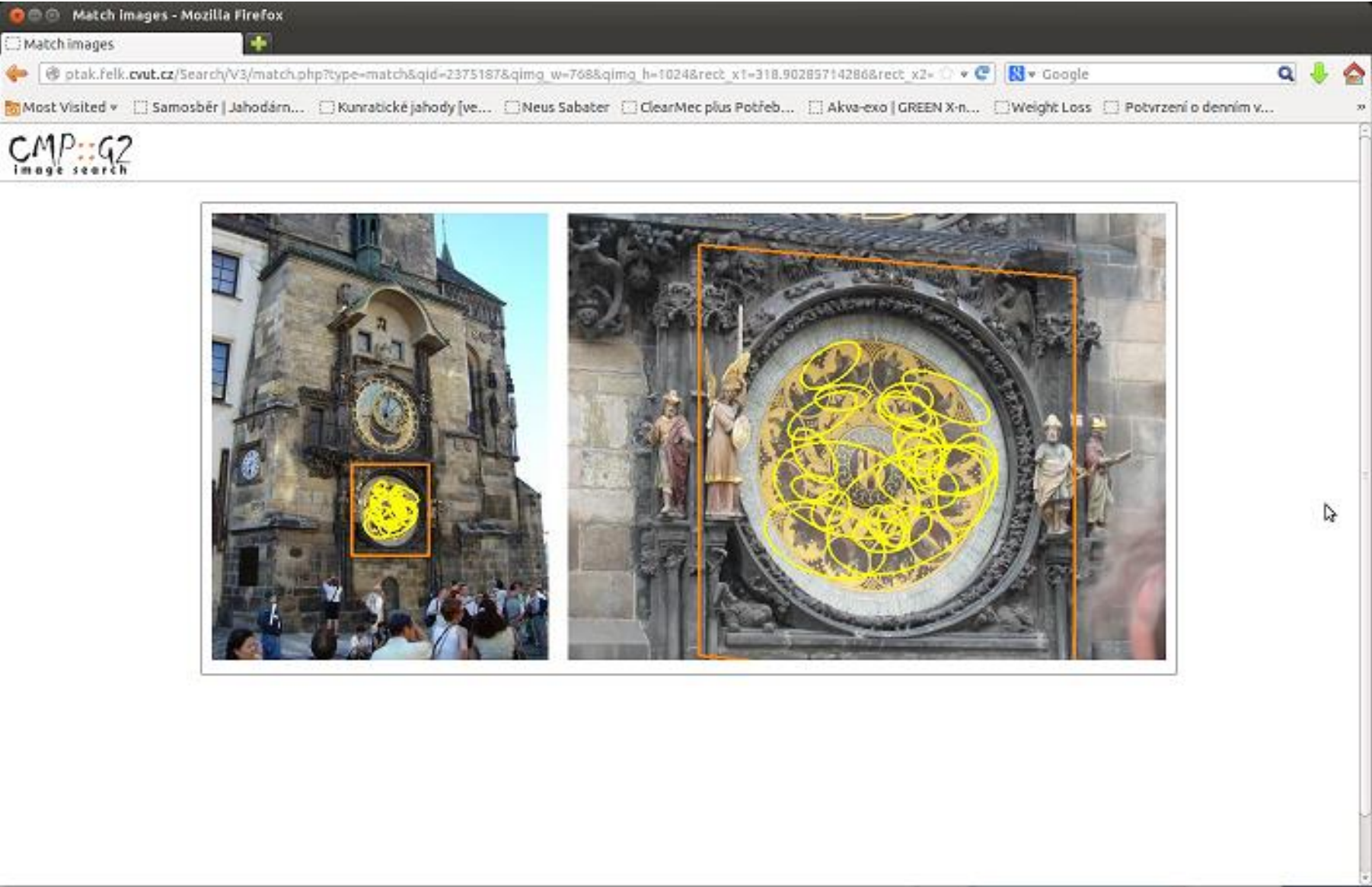
13 (1024 x 768 px)  
praga - orologio astronomico  
score: 25.0

>> Search

ptak.felk.cvut.cz/Search/V3/input.php?input\_string=2386440



# Local Features in Action (1): Image Retrieval



# Local Features in Action (2): Building a Panorama

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# Local Features in Action (2): Building a Panorama

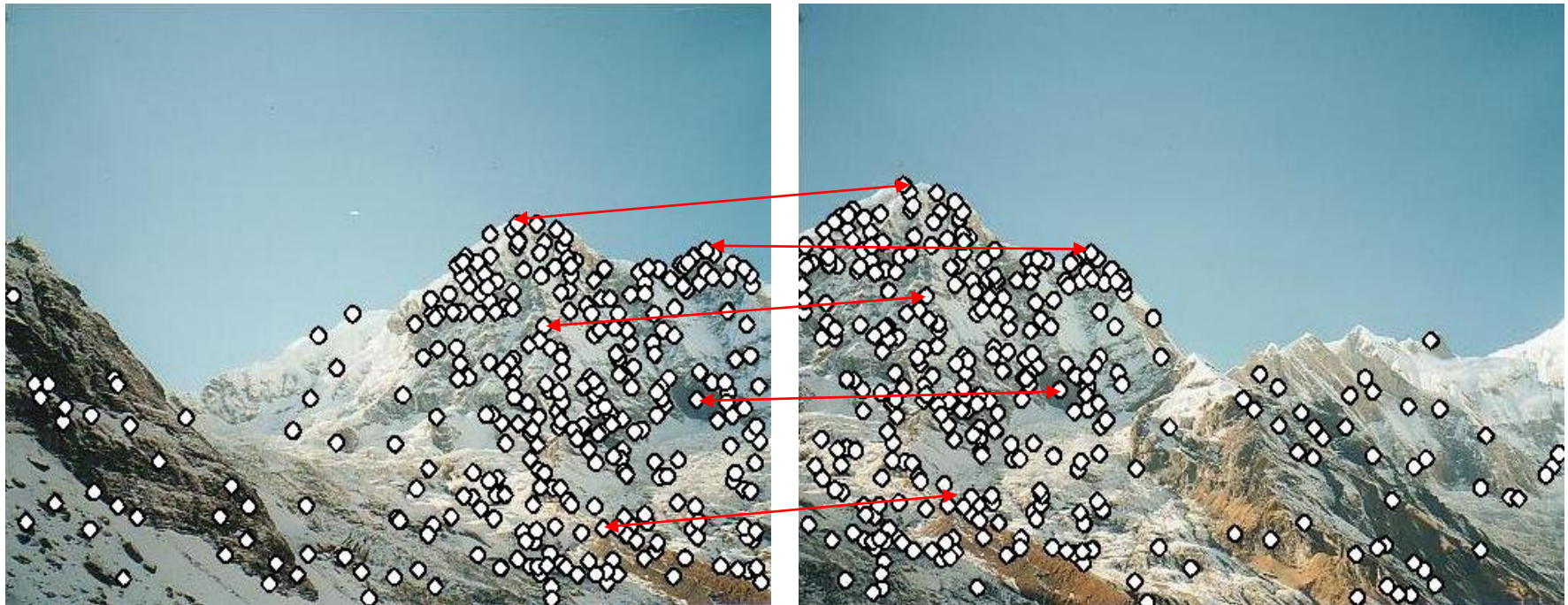
- We need to match (align) images = find (dense) correspondence
- (technically, this can be done only if both images taken from the same viewpoint)



# Local Features in Action (2): Building a Panorama

Possible approach:

1. Detect features in both images
2. Find corresponding pairs
3. Estimate transformations (Geometry and Photometry)
4. Put all images into one frame, blend.



## ■ Problem 1:

- Detect the *same* feature *independently* in both images\*
- Note that the set of “features” is rather sparse



no chance to match!

A repeatable detector needed.

\* Other methods exist that do not need independency

## ■ Problem 2:

- how to correctly recognize the corresponding features?



## Solution:

1. Find a discriminative and stable descriptor
2. Solve the matching problem



## Local Features in Action (2): Building a Panorama

- Detect feature points in both images
- Find corresponding pairs
- Use these pairs to align images

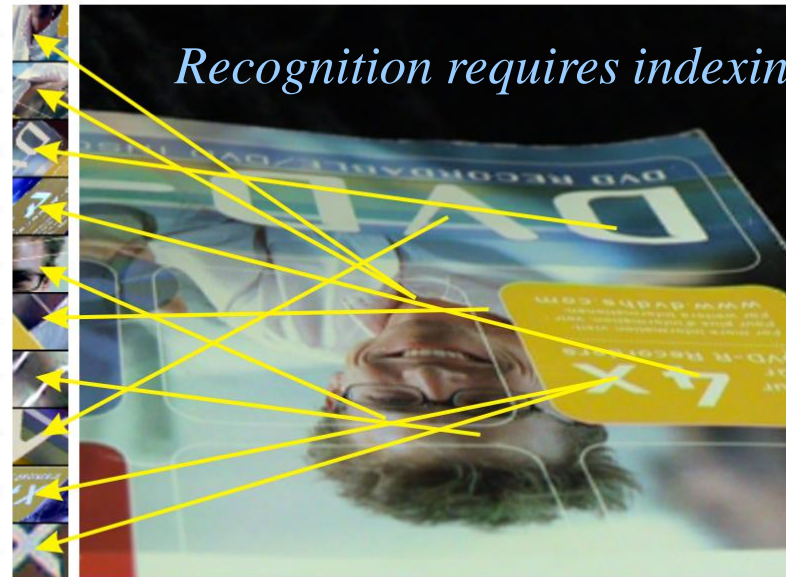
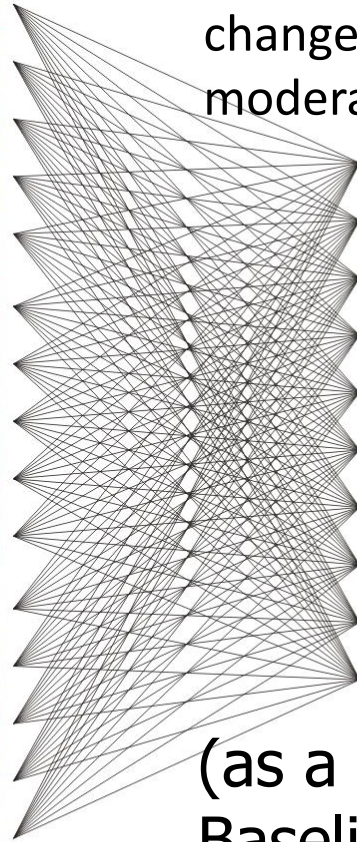
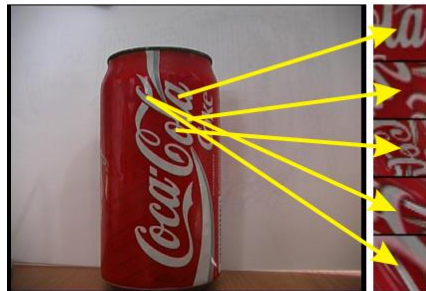
Any alternatives?



# Local Features in Action (4): “Recognition”

(as a Sequence of Wide-Baseline Matching Problems)

Properties: robust to occlusion, clutter, handles pose change, illumination but becomes unrealistic even for moderate number of objects.



(as a Sequence of Wide-Baseline Matching Problems)

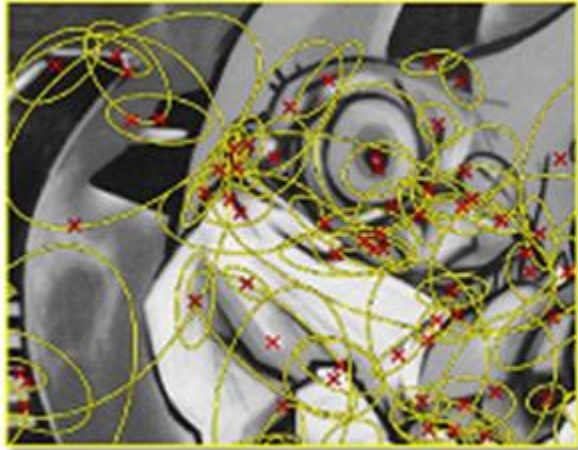
Database processing

Matching

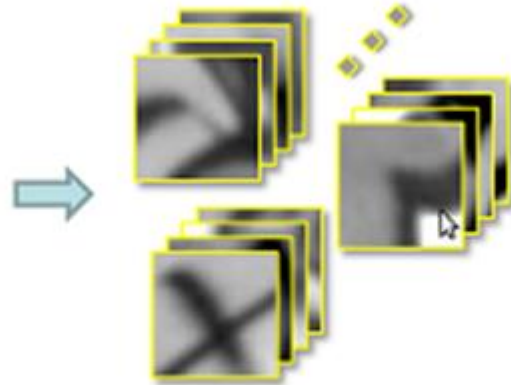
Query processing

# Local Features in Action (3): Object Retrieval

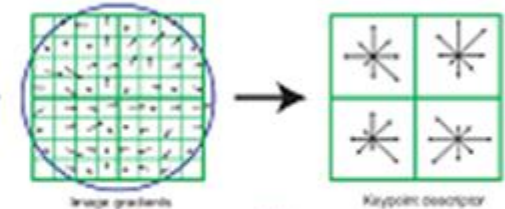
Features



Local Appearance



SIFT Description [Lowe'04]

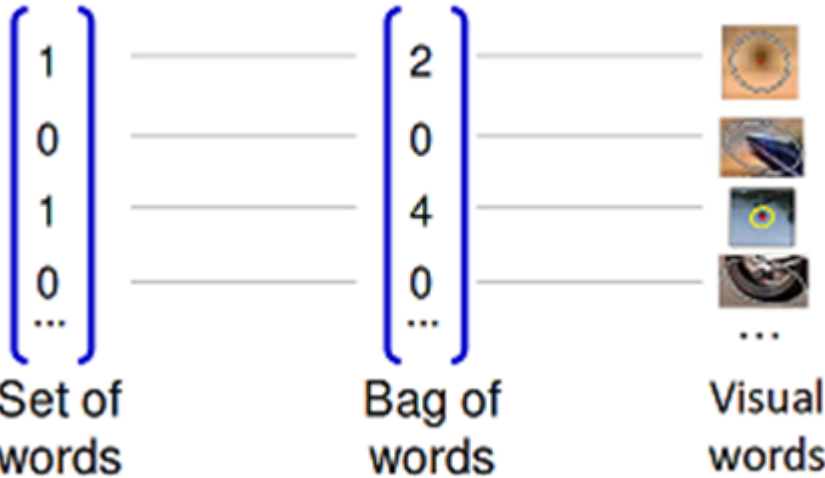


Vector quantization



Visual vocabulary

Image representation



Visual Words

word<sub>1</sub>, word<sub>2</sub>, word<sub>8</sub>, ...  
word<sub>948534</sub>, word<sub>998125</sub>  
**graffiti**



macros.tex  
sfmath.sty  
cmpitemize.tex

Thank you for your attention.

