Mathematics for Image Processing

Feature detection and description

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Overview

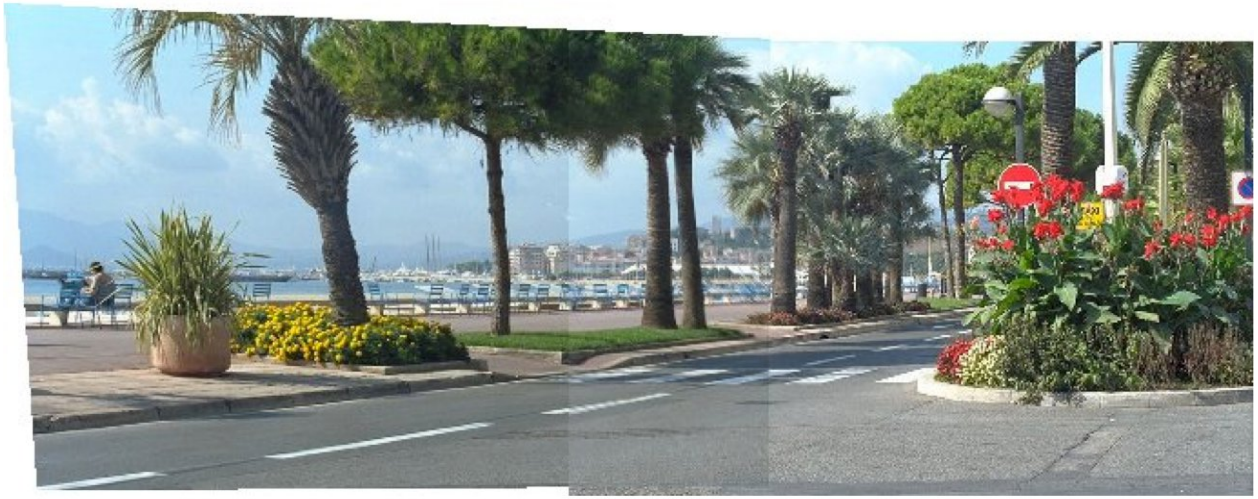
salient point = point saillant
feature point = point caractéristique
matching = mise en correspondance

- Motivation
  - uses of salient/common features in images
- Notions
  - feature detector, descriptor, matcher
  - mathematical tools for feature detection and description
- Illustration with emblematic features
  - Harris corner detector
  - SIFT detector and descriptor

Motivation
Problem 1: creating a panorama

- Select points visible in both images

- Map one to another and stitch into composite mosaic



Corresponding points

- Given images I and I' of the same scene (or similar)
- Given points p in I, p' in I', s.t. p same as p' "in reality"
- Problem:
  - How can we check that p and p' are corresponding points?

Corresponding points

image patch = imagette (ou patch)

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- Given points p in I, p' in I', s.t. p same as p' "in reality"
- Problem:
  - How can we check that p and p' are corresponding points?
    → Test photometric similarity around points (image patches)

Corresponding points

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- Question:
  - Are all points as easy to compare?

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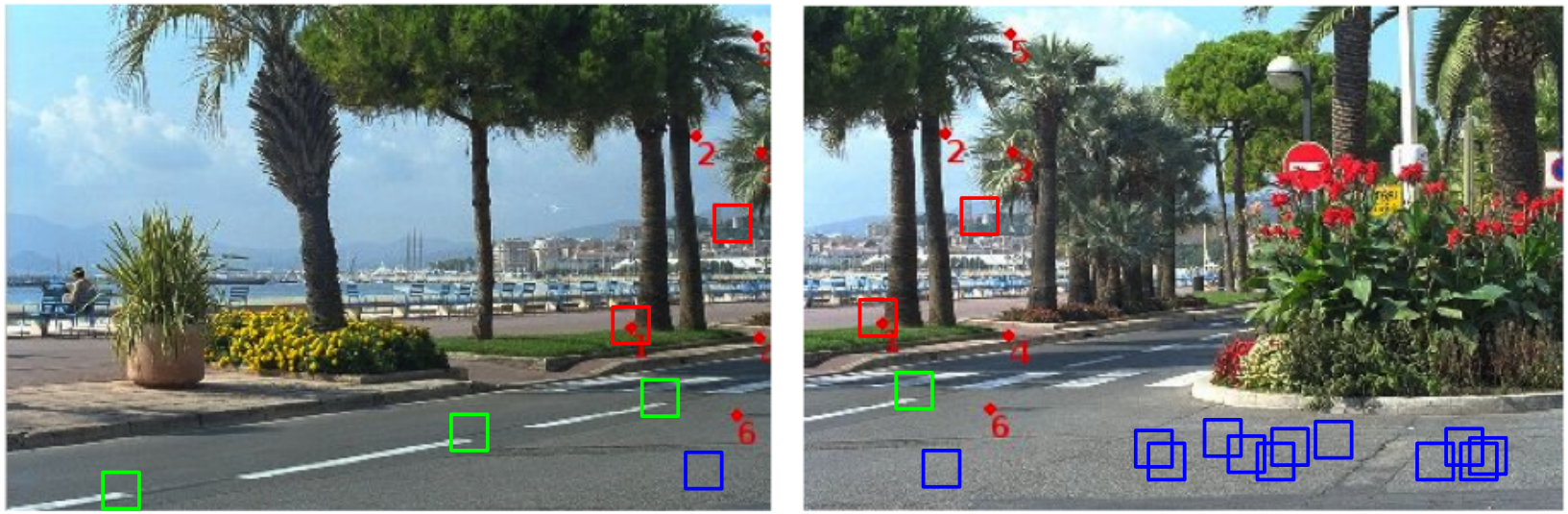
  - Are all points as easy to compare?
    → No. Patches with variations are better (but not perfect).



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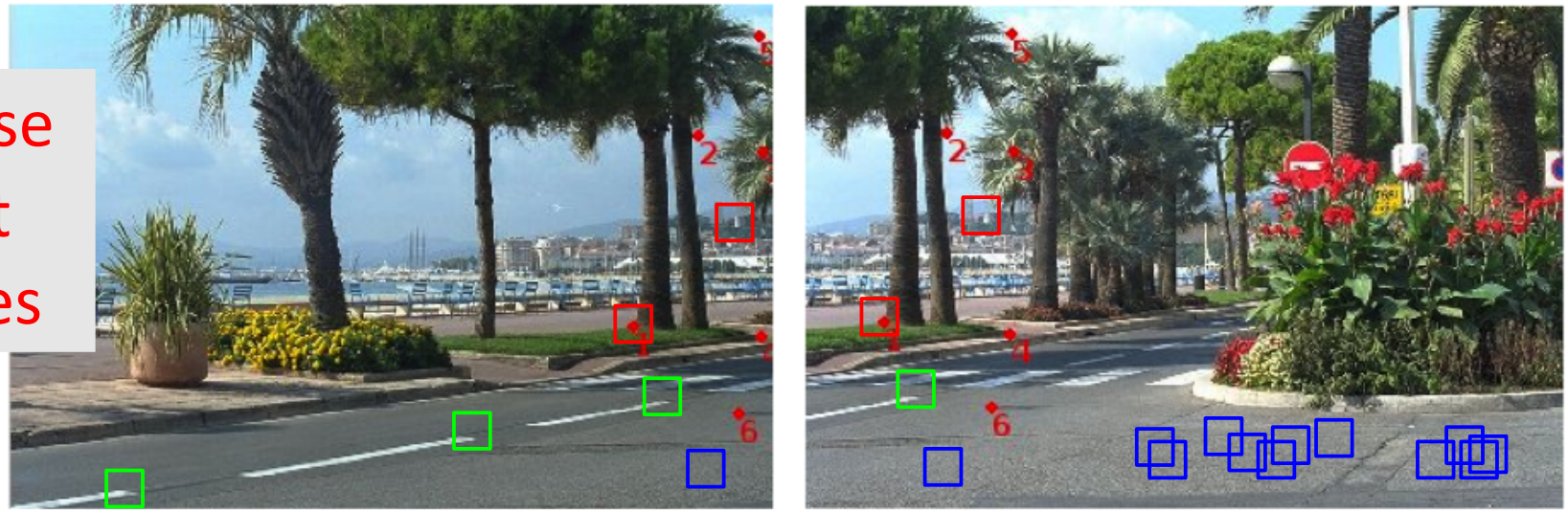
☛ choose salient features



Questions

What kind of salient points can you think of ?

What can be salient, other than points ?

Moulon 2011 © Mikros Image, ENPC

Common Salient Features

keypoint = point d'intérêt
corner = coin
edge = arête / bord

- Points (a.k.a. keypoints or interest points)
  - corners (e.g., building corners, mountain peaks)
- Edges
  - fragments (straight line segments, curves)
  - chains (boundary profiles)
- Regions
  - “blobs” (located at their center point)
  - particular set of connected pixels
    - e.g., maximally stable extremal regions (MSER)

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Common Salient Features

In the following:

keypoint = point d'intérêt
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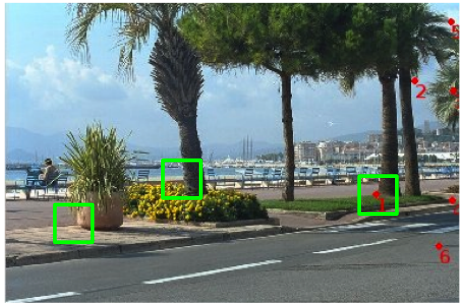
Salient points

- Problem:
  - Given image I
  - How can we select salient points?



Salient points

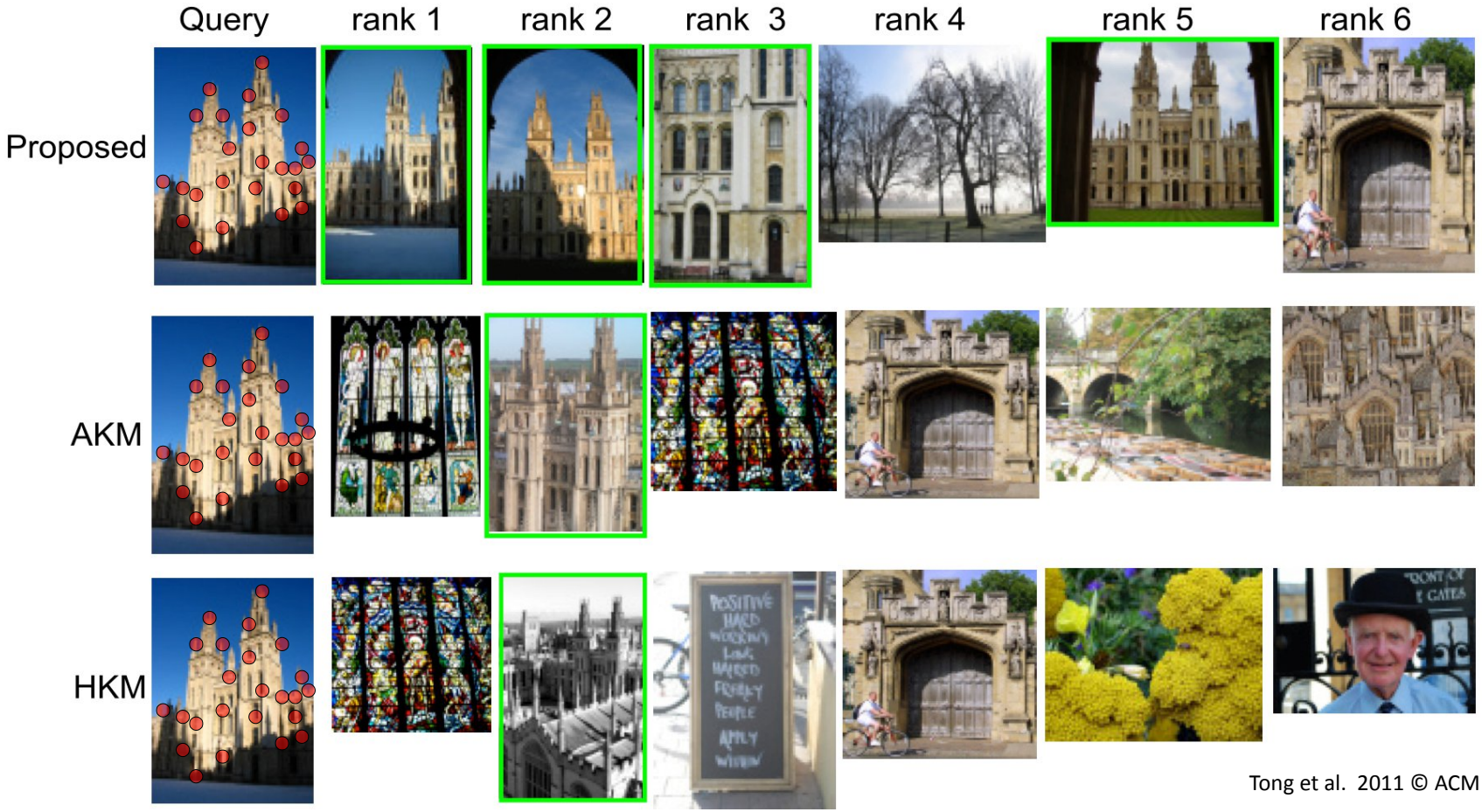
- Problem:
  - Given image I
  - How can we select salient points?

→ Use a specific detector of particular photometric patterns

content-based image retrieval
= recherche d'images basée sur le contenu

Motivation

Problem 2: content-based image retrieval



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- Identify salient points
- Look for images with similar salient points

Salient points

- Problem 1:
  - Given image I
  - How can we select salient points?
    → Use a specific detector of particular photometric patterns

- Problem 2:
  - Given images I and I' of the same scene (or similar scenes)
  - How can we efficiently match salient points? (quadratic!)

Salient points

- Problem 1:
  - Given image I
  - How can we select salient points?
    → Use a specific detector of particular photometric patterns

- Problem 2:
  - Given images I and I' of the same scene (or similar scenes)
  - How can we efficiently match salient points? (quadratic!)
    → Compare an abstraction of the patches (= descriptor)

Motivation
Problem 3: object recognition

geometrical consistency = cohérence géométrique

- Identify salient points
- Look for similar salient points in other image
- Check geometrical consistency

Problem 4: 3D model construction

remains of Cluny abbey (Burgundy)

camera pose = position et orientation des appareils photo

- Identify corresponding salient points
- Estimate camera pose
- 3D reconstruct by triangulation

Problem 4: 3D model construction (cont.)