Examples of Computer-assisted Photo-identification of Individual Animals

Eric J. Pauwels,
Paul de Zeeuw, Elena Ranguelova, Adri Steenbeek

Centrum voor Wiskunde & Informatica
Amsterdam, The Netherlands

Sensor Webs in Ecology

- Currently, most ICT work within LifeWatch focuses on semantic mediation of existing data collection (e.g. taxonomic databases in musea);
- Rapid progress in ICT technologies is giving rise to new sets of data streams:
  - Sensors. abiotic conditions, GPS, RFID and camera, etc.
  - Citizen's science: large communities of amateur scientists, using mobile devices and internet to pool resources
- As a consequence, there's a growing need for computer-assisted methodologies to filter and process these data.

BioDivGrid08 (www.biodivgrid.org)

International Workshop on

Distributed Sensing and Collective Intelligence in Biodiversity Monitoring

Home | Keynote Speakers | Registration | Programme | Organisation

Workshop Goals

Global biodiversity is profoundly affected by both natural and man-made changes. Monitoring the resulting impact on the environment requires gathering and analysing large collection of data. The confluence of three technological trends promises to have a profound influence on this process:

1. Modern sensor and computer technology is furnishing researchers with increasingly sophisticated equipment to set up radio-linked **sensor networks,** tailor-made for the unsupervised monitoring of large and distributed biotopes.
2. The ubiquity of internet access provides experts with efficient means to tap into the combined **contributions and expertise of large crowds of web-connected people,** thus creating an enormous pool of resources ready to be harnessed.
3. Last but not least, emerging **semantic web technologies** are forging standards and tools that facilitate aggregation and analysis of, and access to, heterogeneous web-based databases.

Important Dates

10 Oct 08:
Abstract

20 Oct 08:
Decision

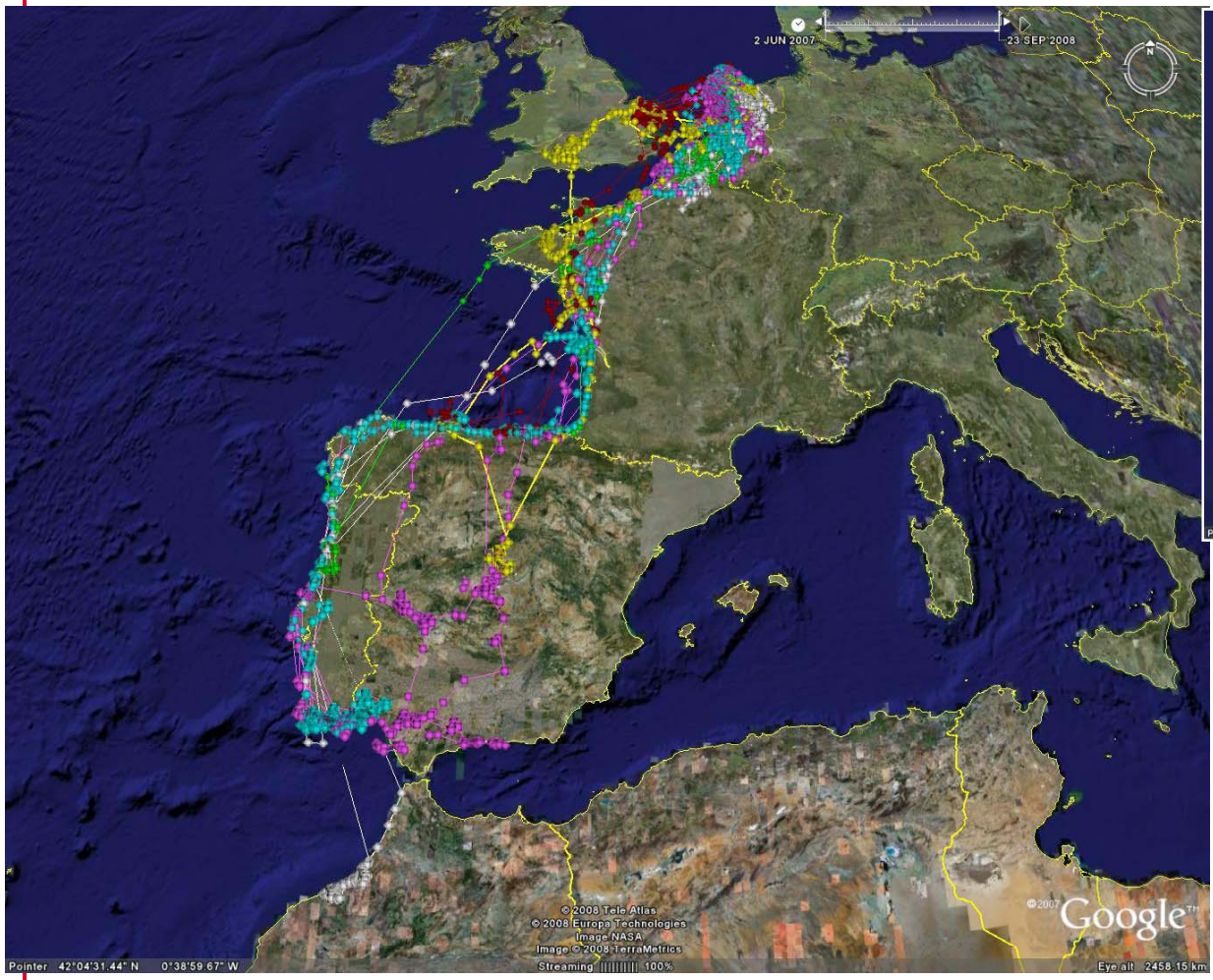
15 Nov 08:
Camera-ready

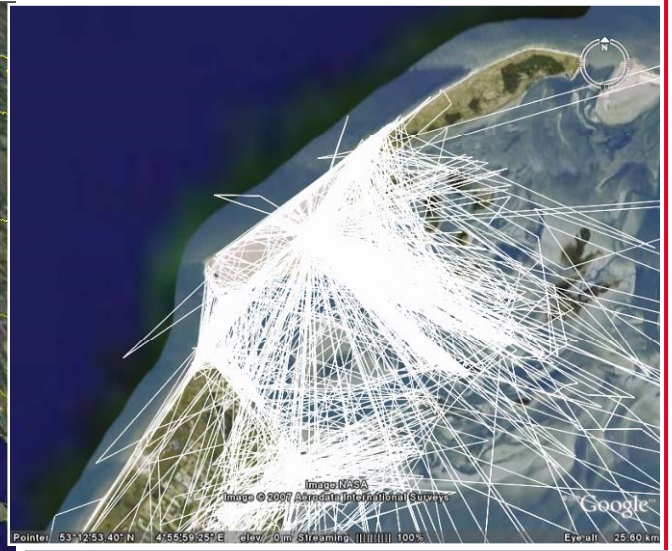
Useful Links

CWI
LifeWatch

GPS Sensing: Tracking birds from space

J. Shamoun-Baranes, Univ of Amsterdam

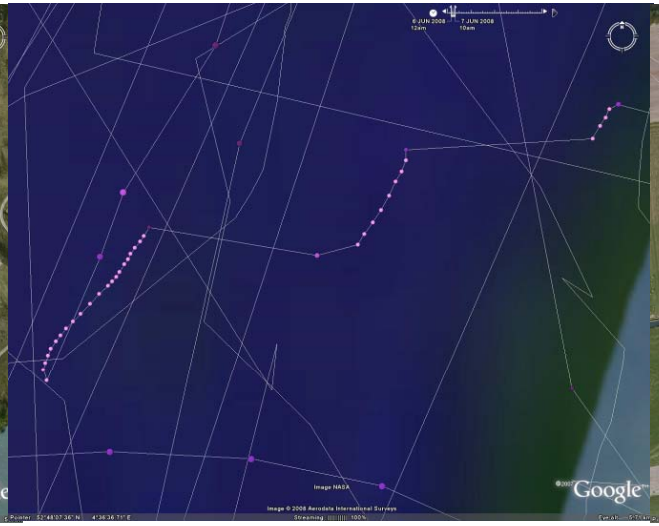




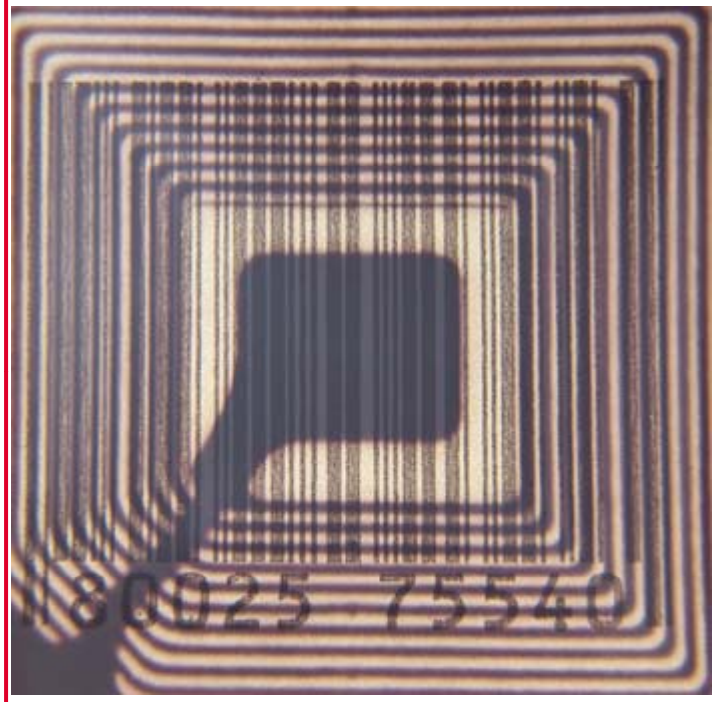
A day in the life of gull 52 ♀ FAJK

- June 6, 2008 6:15 – June 7, 2008 6:15
- 6:25 leaves nest, goes to North Sea
- 7:50 – 9:25 **hangs out on beach**
- 9:25-11:07 **follows fishing vessel**
- 11:07 – 11:53 flies back to Texel 20-40 km/hr (not nest)
- 11:53-13:04 mudflats & beach
- 13:04 – 21:15 nest
- 1:20 flies south over North Sea 30-50 km/hr then turns east over land
- 2:30 – 5:24 **rural areas/agricultural fields**
- Flies back to Texel over North Sea 30-50 km/hr, back at 6:10

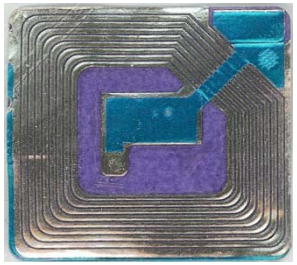
J. Shamoun-Baranes, Univ. Amsterdam

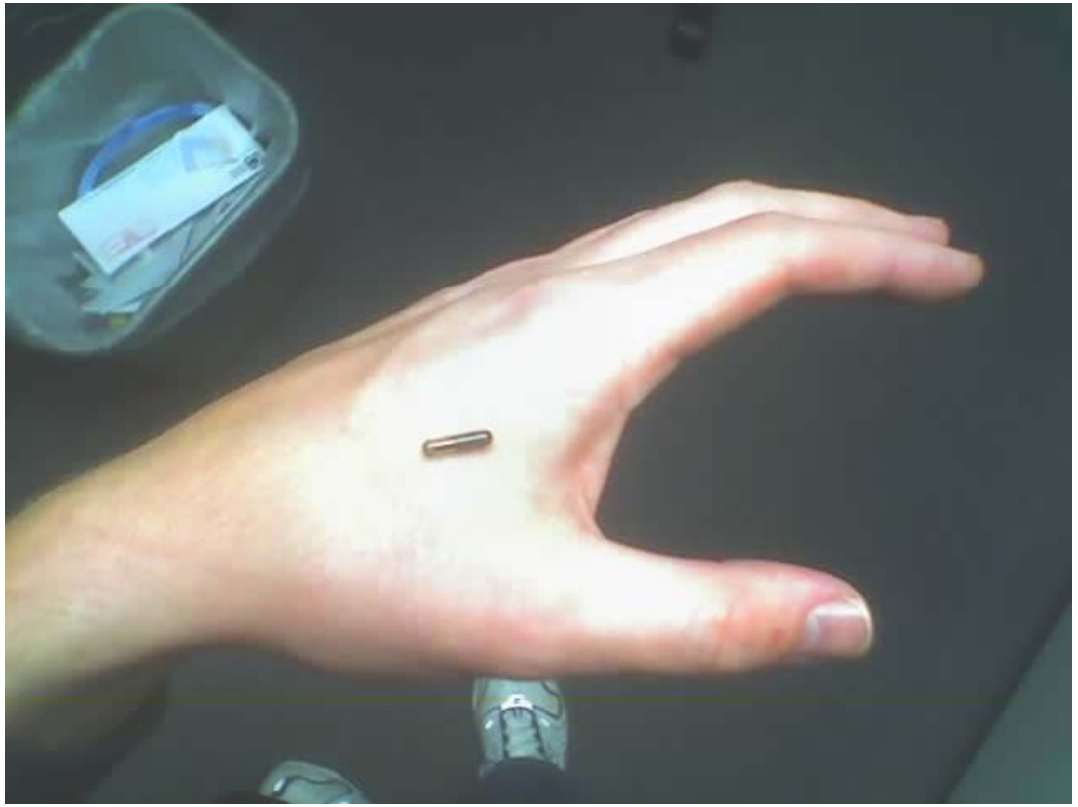


RFID-based sensing



RFID = Unique identifier!





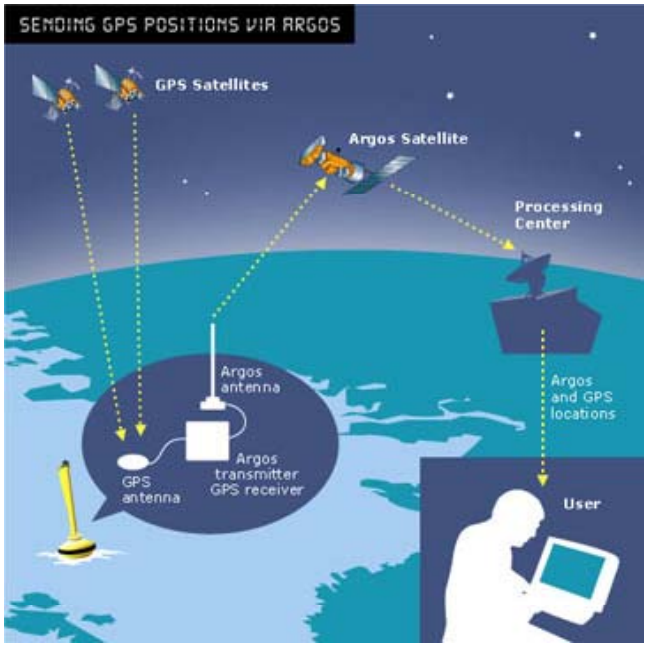
Insect RFID tags (Courtesy of N. Raine, QMUL)

Pet RFID tag

1 x 1.6 x 0.5mm/ 2.4 mg (13.56 MHz)

NB: Harder to add visual recognition marks as well

GPS-sensing: 24/7 location information on individuals



Drawbacks of GPS and RFID tagging

RFID en GPS sensing:

Although information obtained in this way is very detailed there are some drawbacks:

- Can only be used on small subset of population;
- Tagging animals often difficult and costly (esp. marine animals);
- Often very stressful for animal!

GPS Tagging of whales

GPS tagging of whale

GPS tagging of whale

Drawbacks of GPS and RFID tagging

RFID en GPS sensing:

Although information obtained in this way is very detailed there are some drawbacks:

- Can only be used on small subset of population;
- Tagging animals often difficult and costly (esp. marine animals);
- Often very stressful for animal!

QUESTION:

Could photo-identification be a viable alternative in some situations?

- Applicable to large populations
- Not stressful, (not for the animal anyway)
- CAMERA as sensor: Use naturally occurring markings as identifiers

Naturally occurring markings on ceteceans

scratches

patches

Fluke and dorsal fin profiles

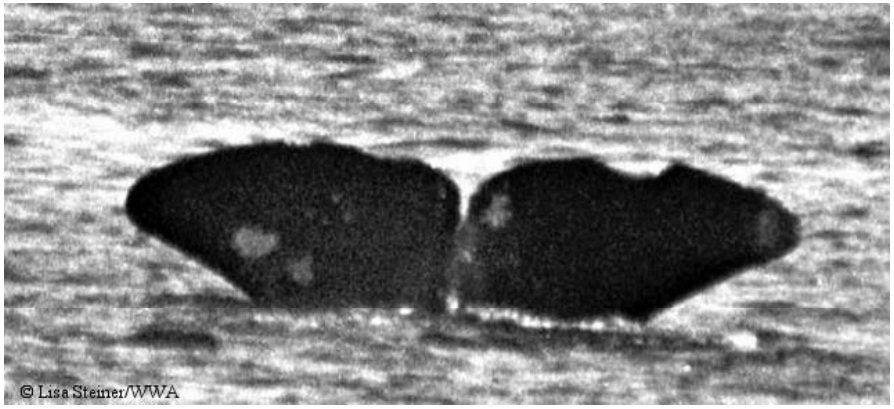
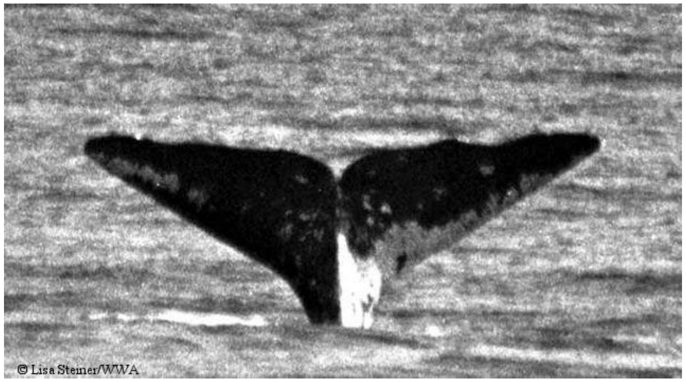
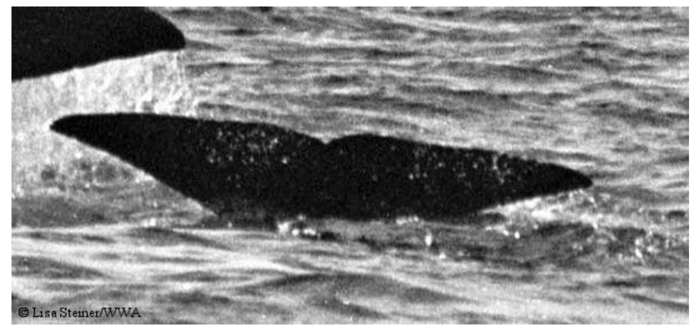


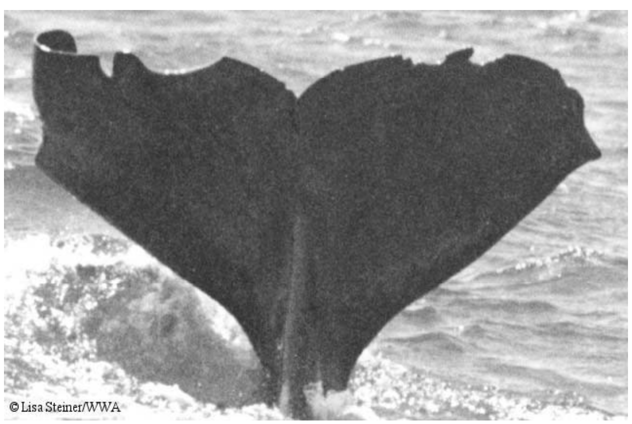
Photo-ID Example 1: Sperm whale

Fluke (tail) profile identifies individual animal

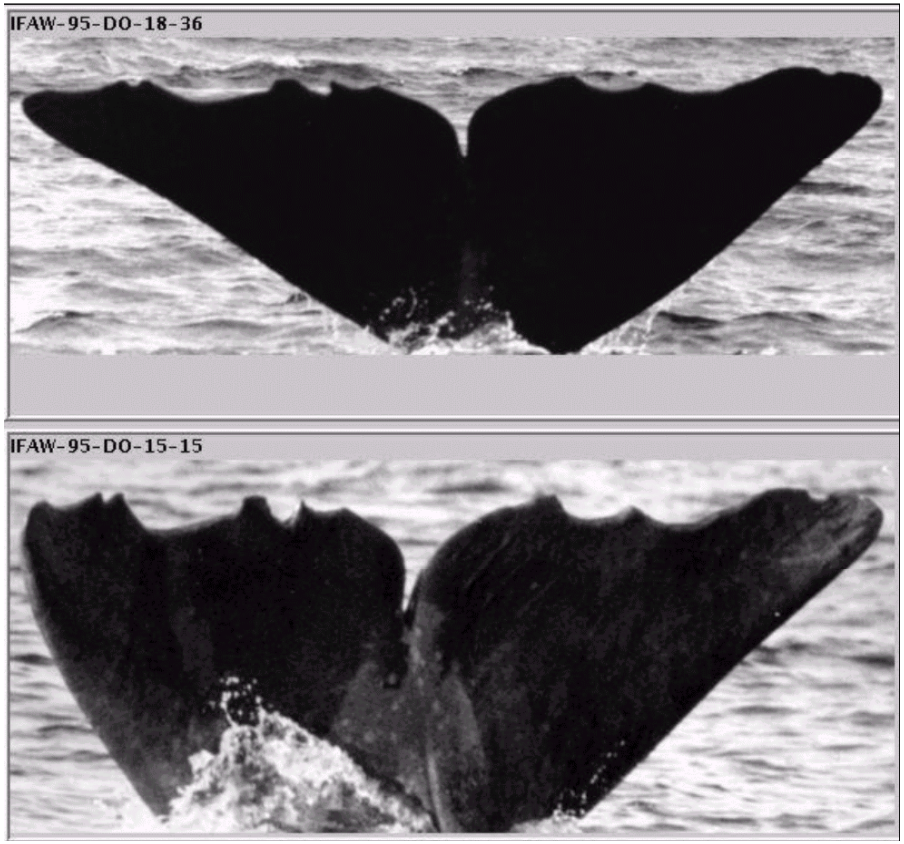
Lots of variation in fluke profiles







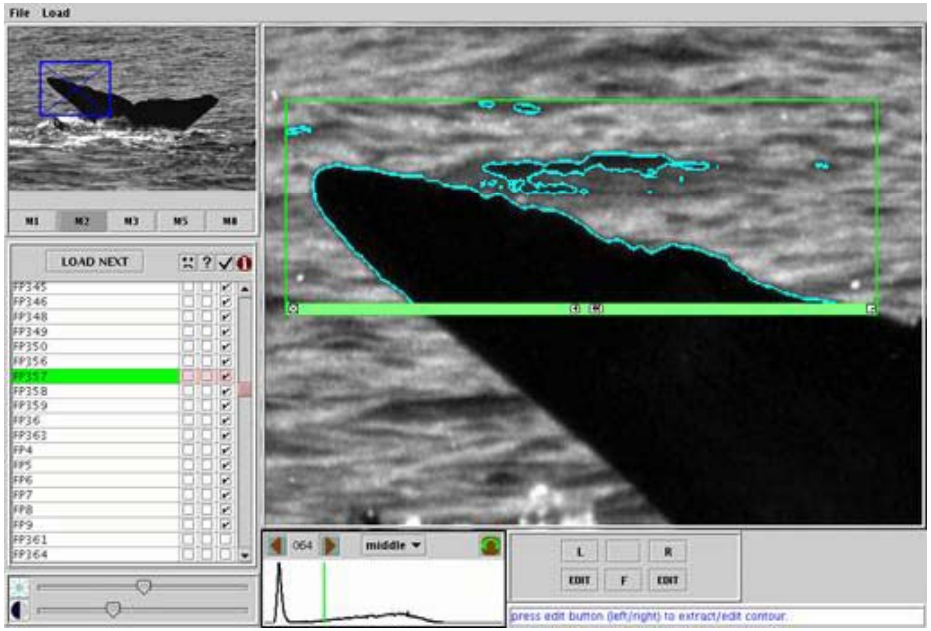
Matching of extracted contours

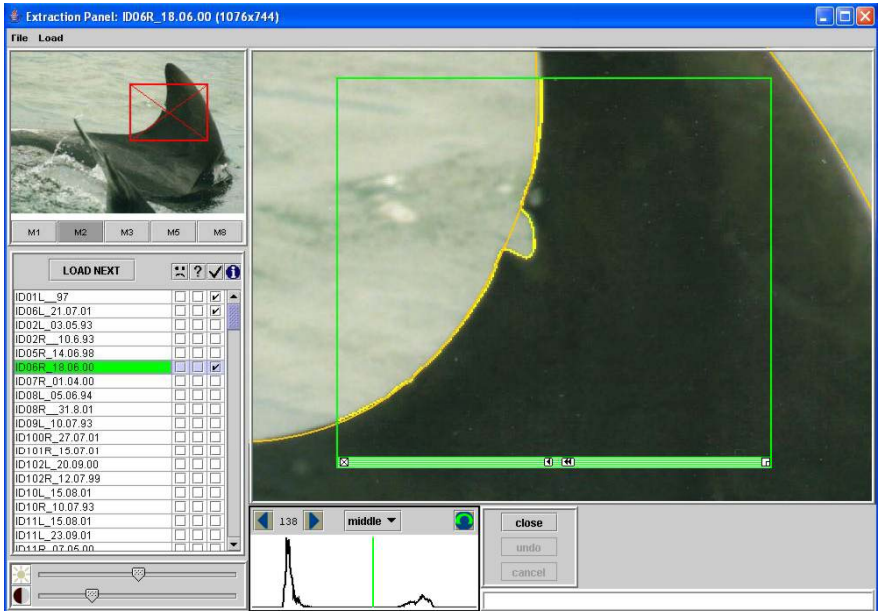


- Best fits are retrieved from database and presented to expert for final visual confirmation

ER1

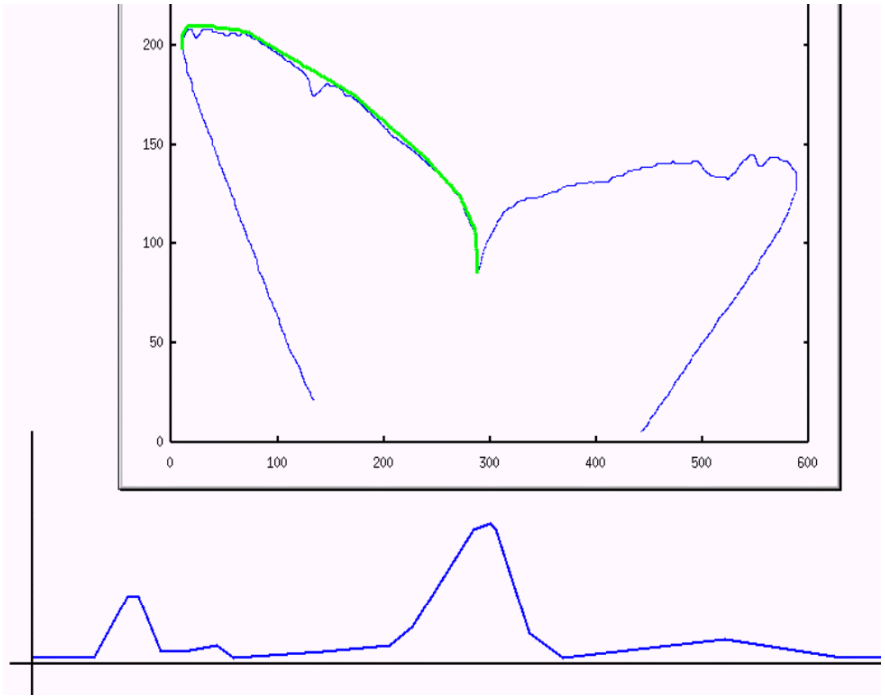
Semi-automatic contour extraction

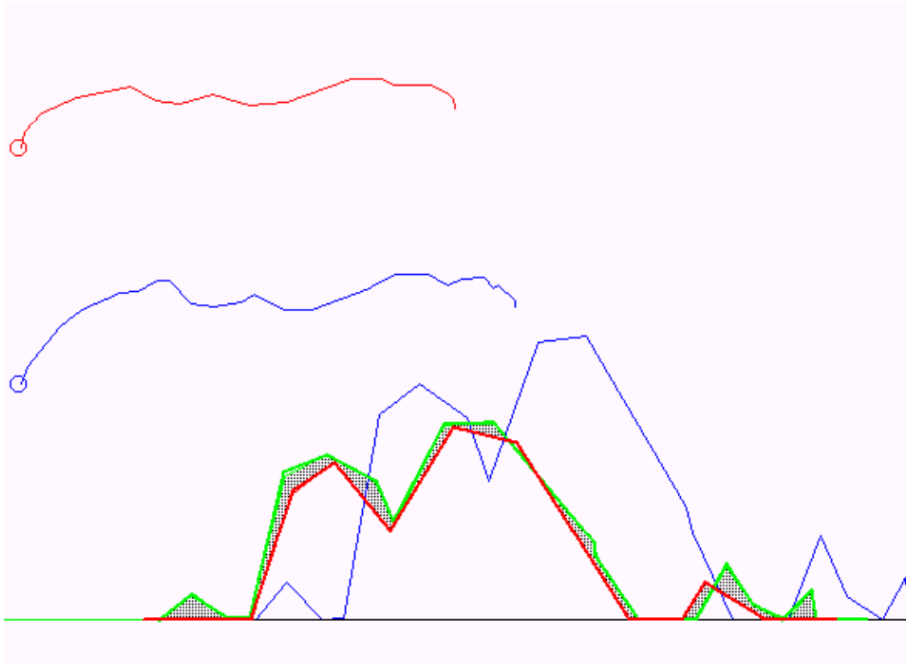




ER1 Elena Ranguelova, 3/15/2005

Contour description and matching

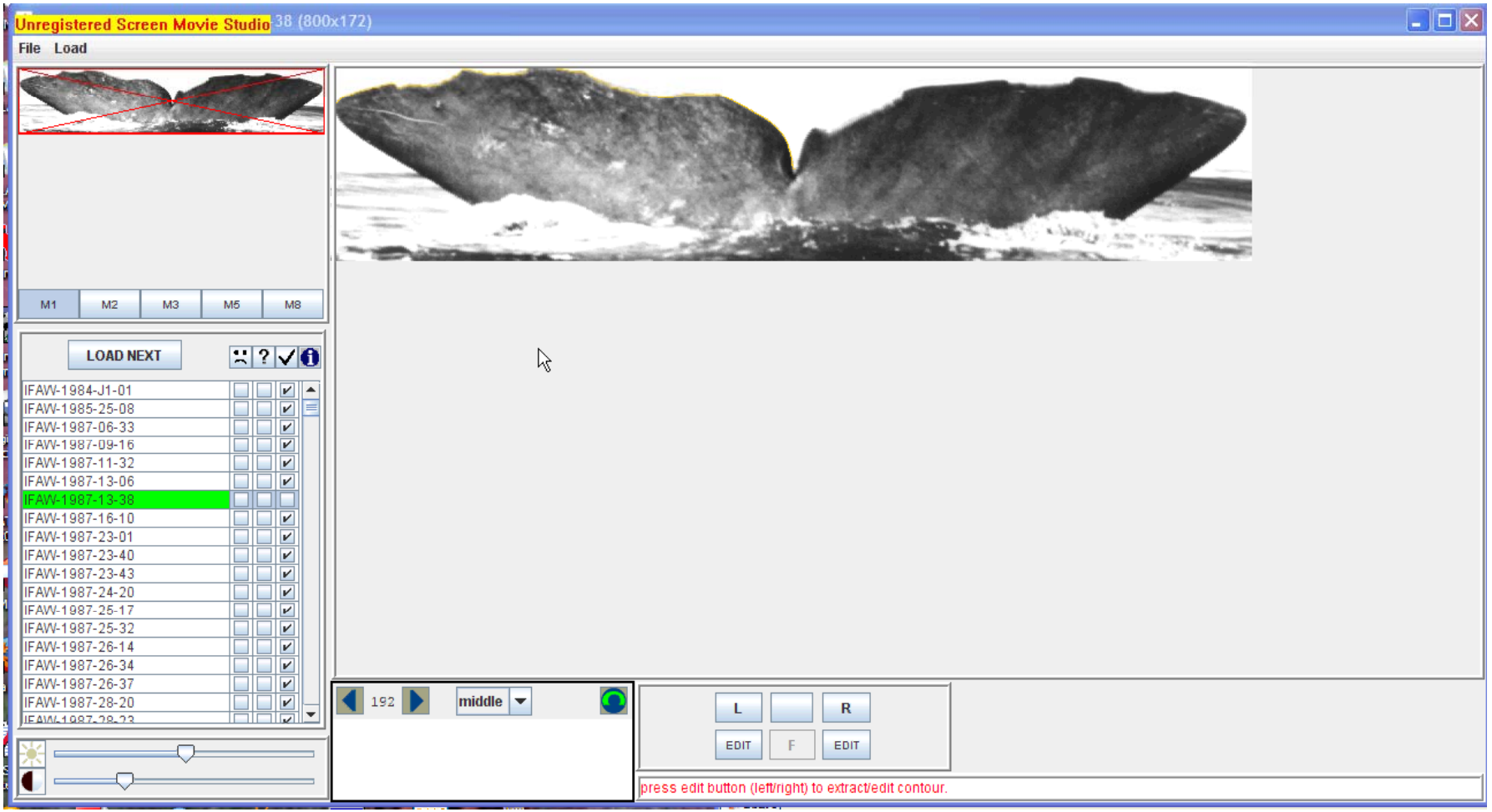




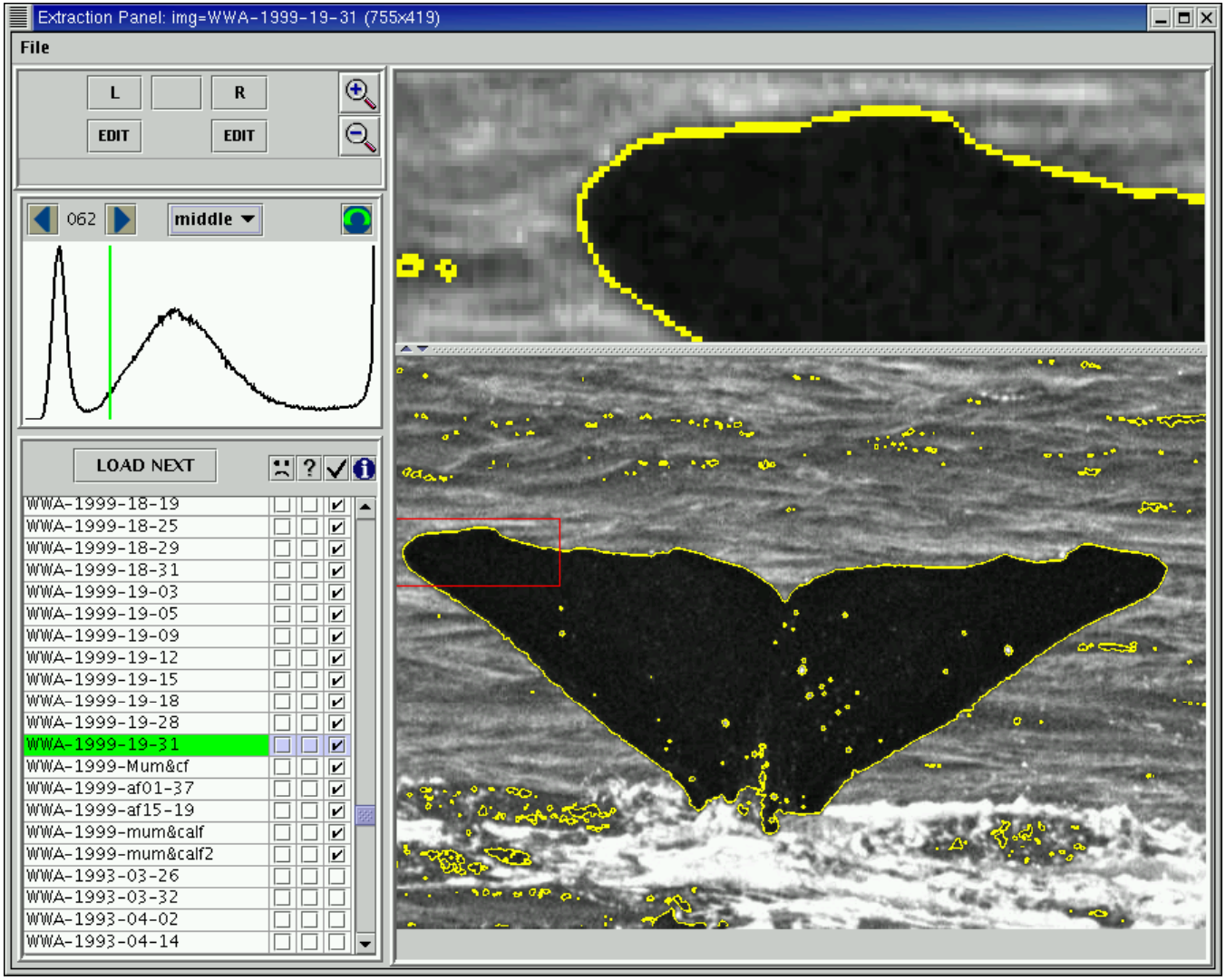
Account for variability due to:

- Imaging viewpoint (distance, angle)
- Inclination of tail

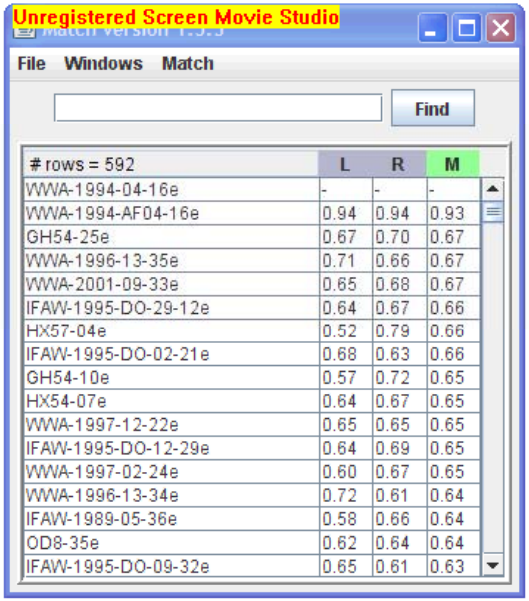
Semi-automatic contour extraction



Semi-automatic contour extraction



Matching results: demo



# rows = 592	L	R	M
WWA-1994-04-16e	-	-	-
WWA-1994-AF04-16e	0.94	0.94	0.93
GH54-25e	0.67	0.70	0.67
WWA-1996-13-35e	0.71	0.66	0.67
WWA-2001-09-33e	0.65	0.68	0.67
IFAW-1995-DO-29-12e	0.64	0.67	0.66
HX57-04e	0.52	0.79	0.66
IFAW-1995-DO-02-21e	0.68	0.63	0.66
GH54-10e	0.57	0.72	0.65
HX54-07e	0.64	0.67	0.65
WWA-1997-12-22e	0.65	0.65	0.65
IFAW-1995-DO-12-29e	0.64	0.69	0.65
WWA-1997-02-24e	0.60	0.67	0.65
WWA-1996-13-34e	0.72	0.61	0.64
IFAW-1989-05-36e	0.58	0.66	0.64
OD8-35e	0.62	0.64	0.64
IFAW-1995-DO-09-32e	0.65	0.61	0.63

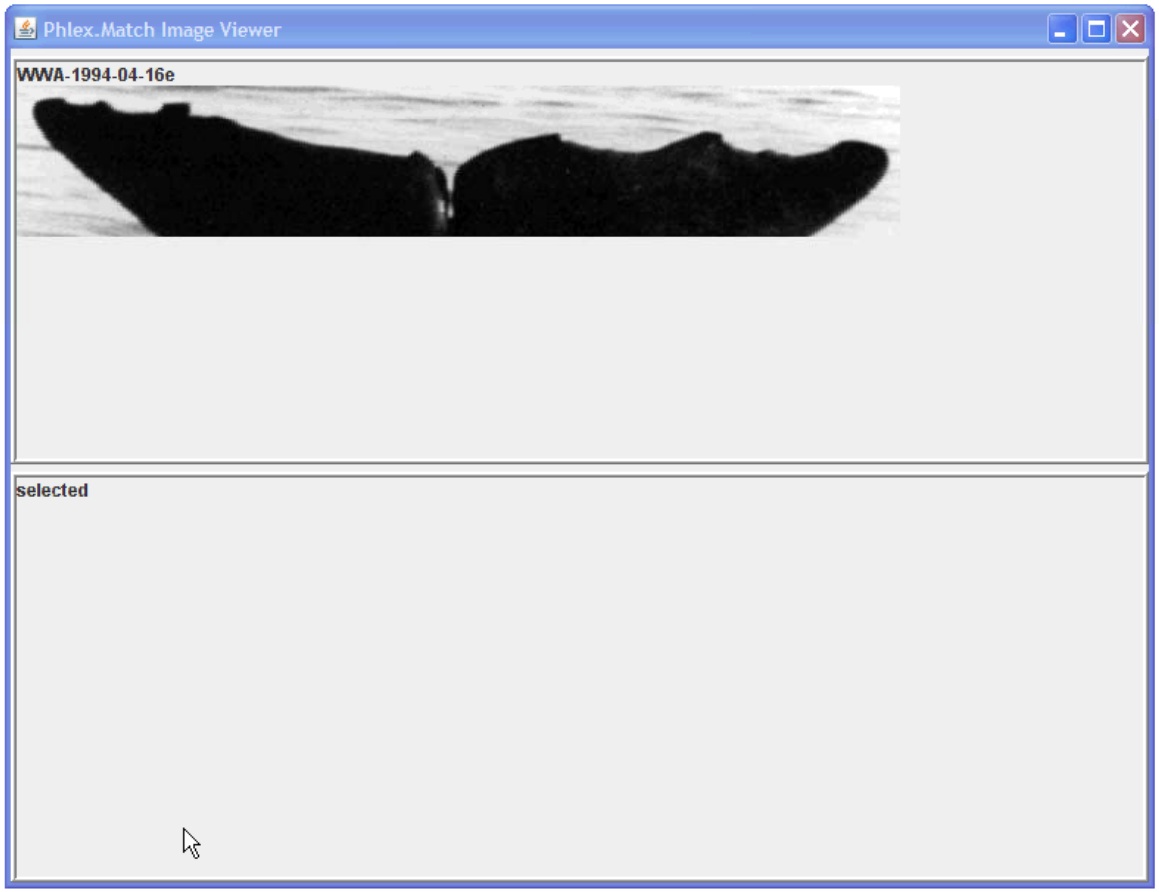
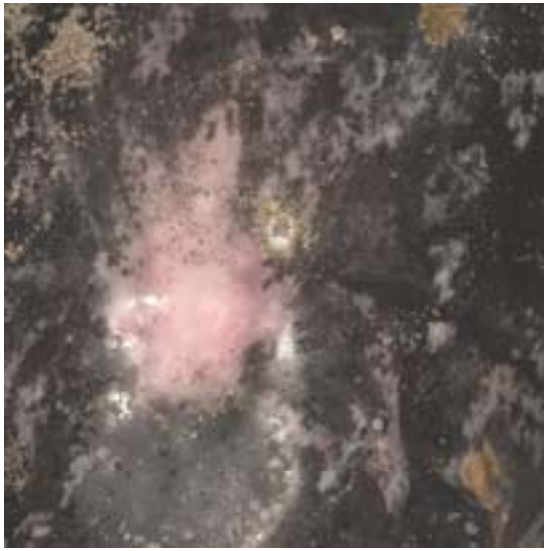


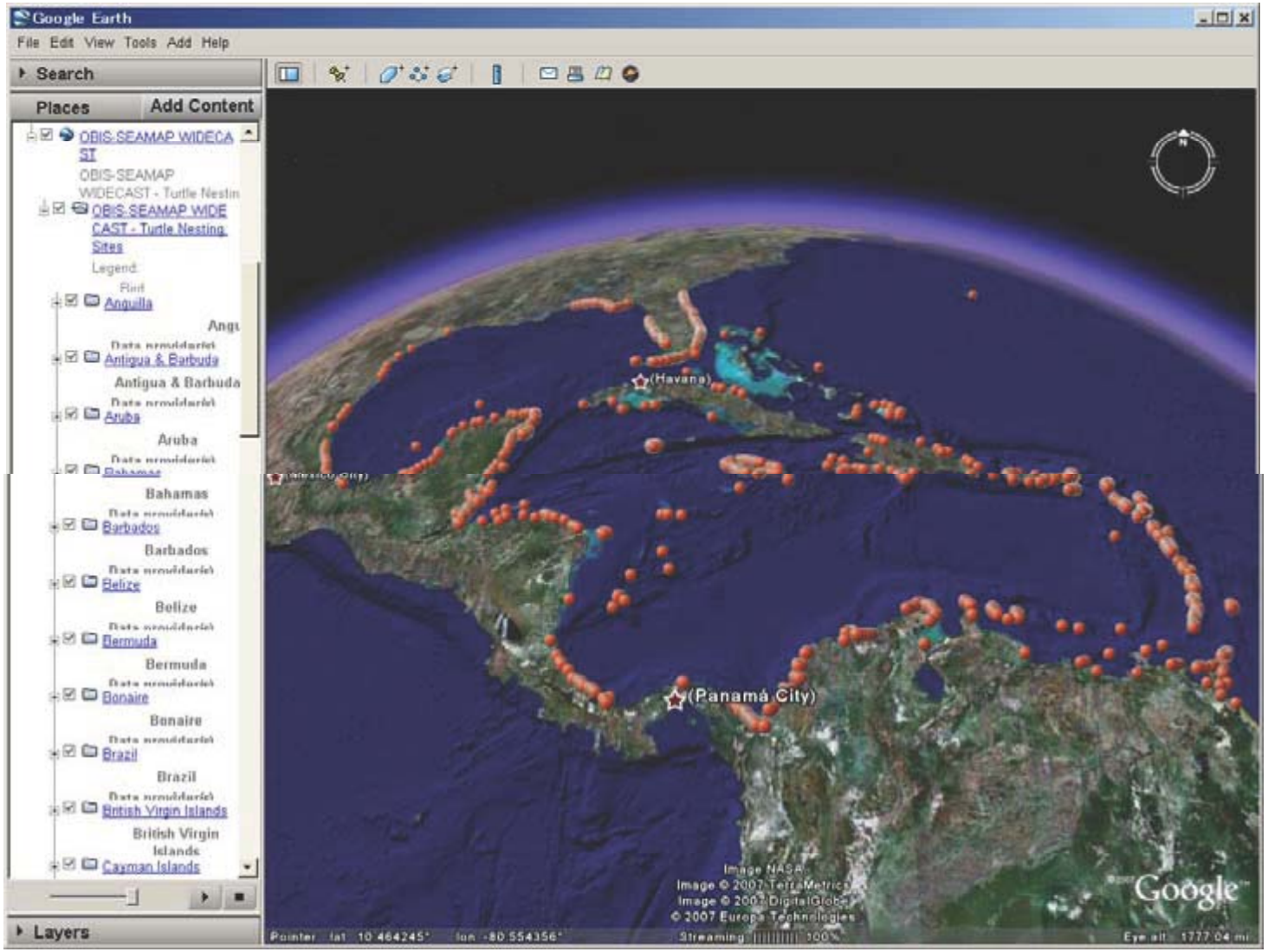
Photo-ID Example 2: Leatherback Turtles

Pink spot as unique identifier



Images of leatherbacks: courtesy of D. Buonantony, S. Eckert (Duke)

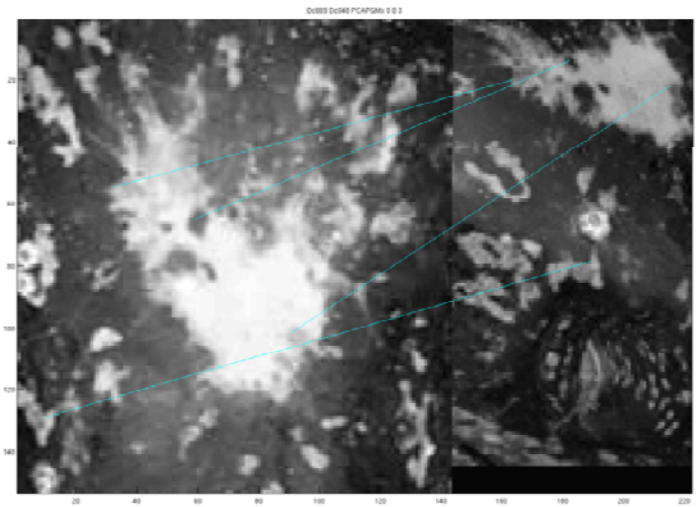
Nesting sites in Caribbean



Females are photographed on nest

Images of leatherbacks: courtesy of D. Buonantony, S. Eckert (Duke)

Identification of individuals over extended periods



Images of leatherbacks:
courtesy of
D. Buonantony, S. Eckert (Duke)

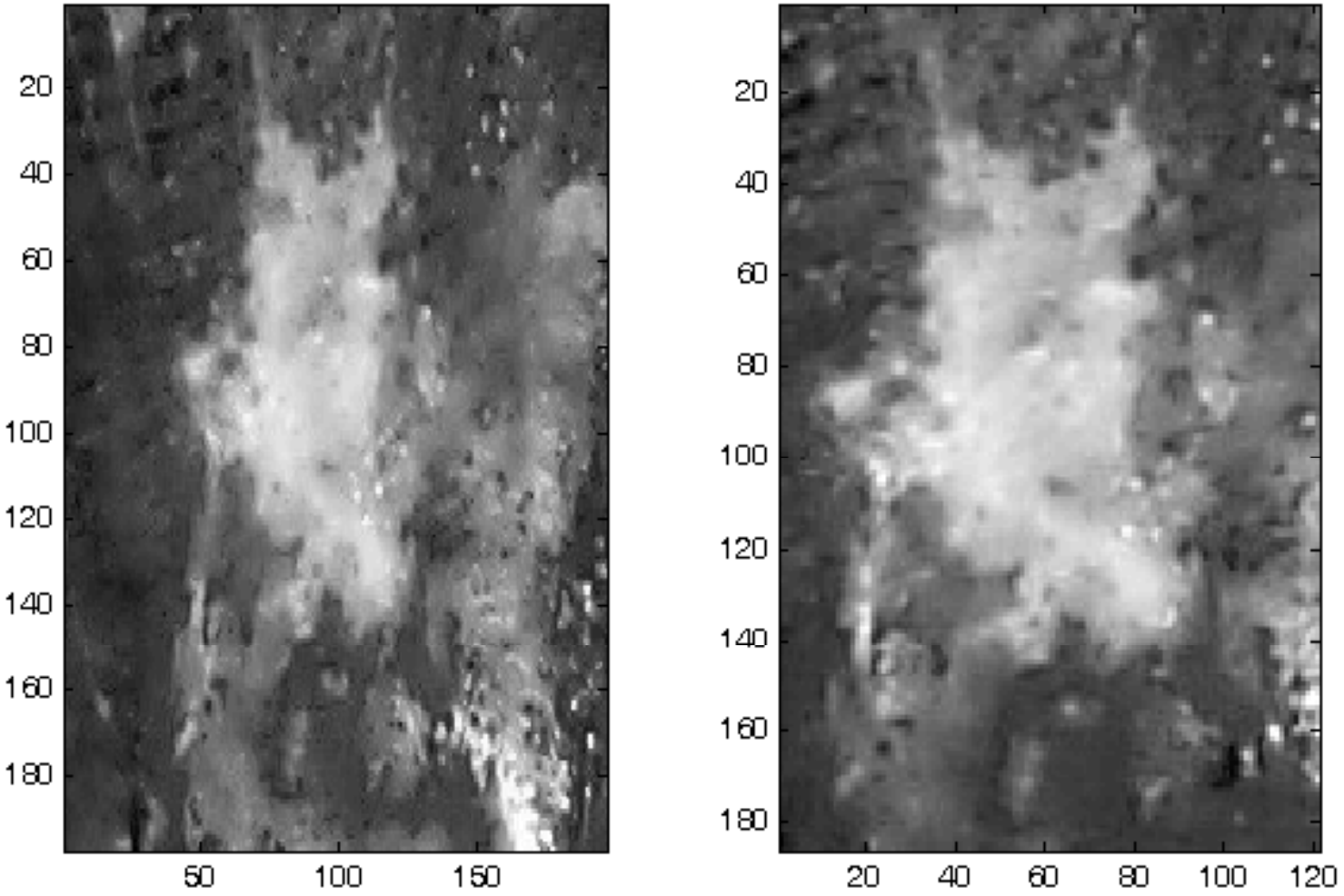
Examples of matches

Examples of matches (2)

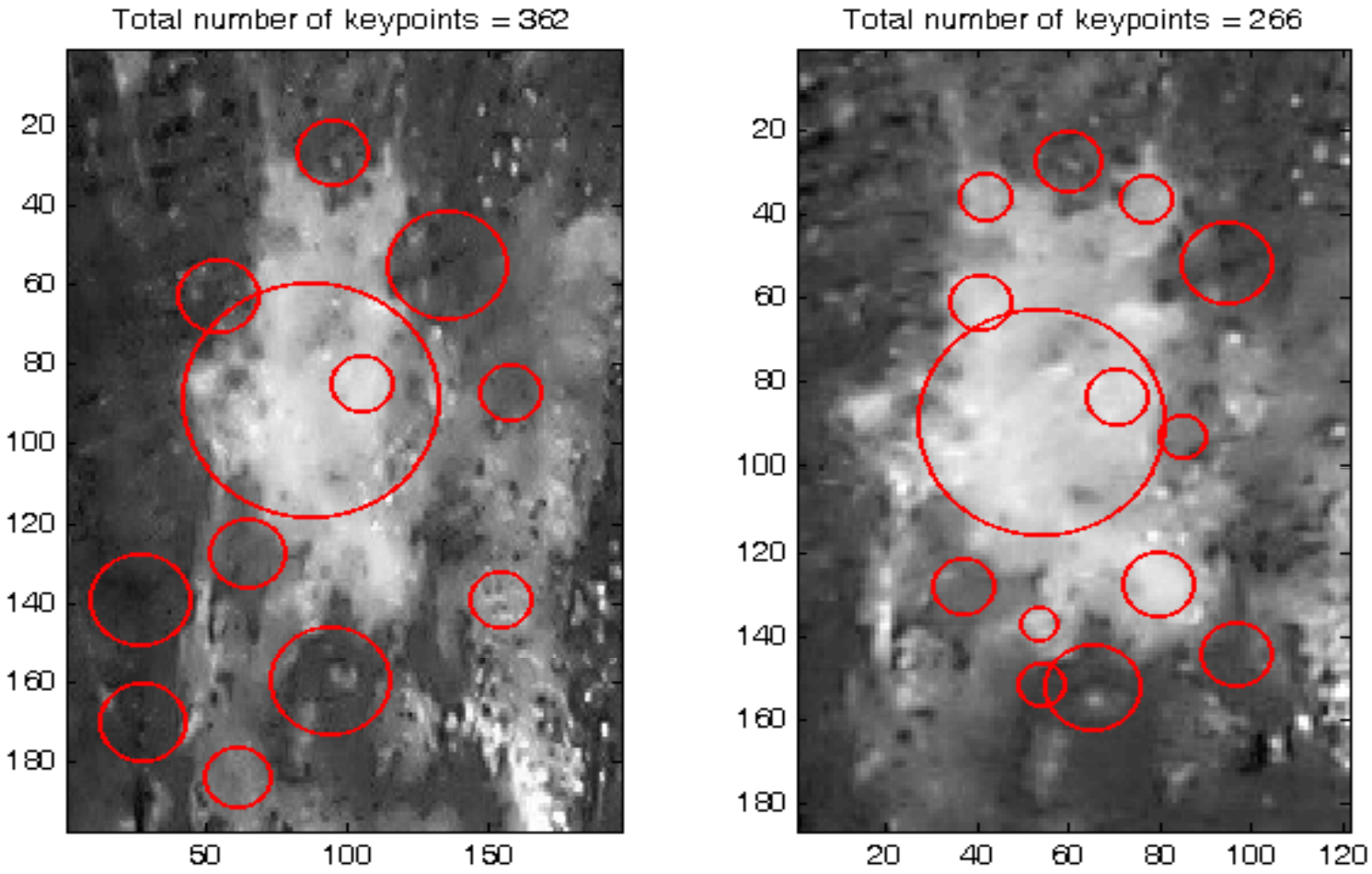
Examples matches (3)

Images of leatherbacks: courtesy of D. Buonantony, S. Eckert (Duke)

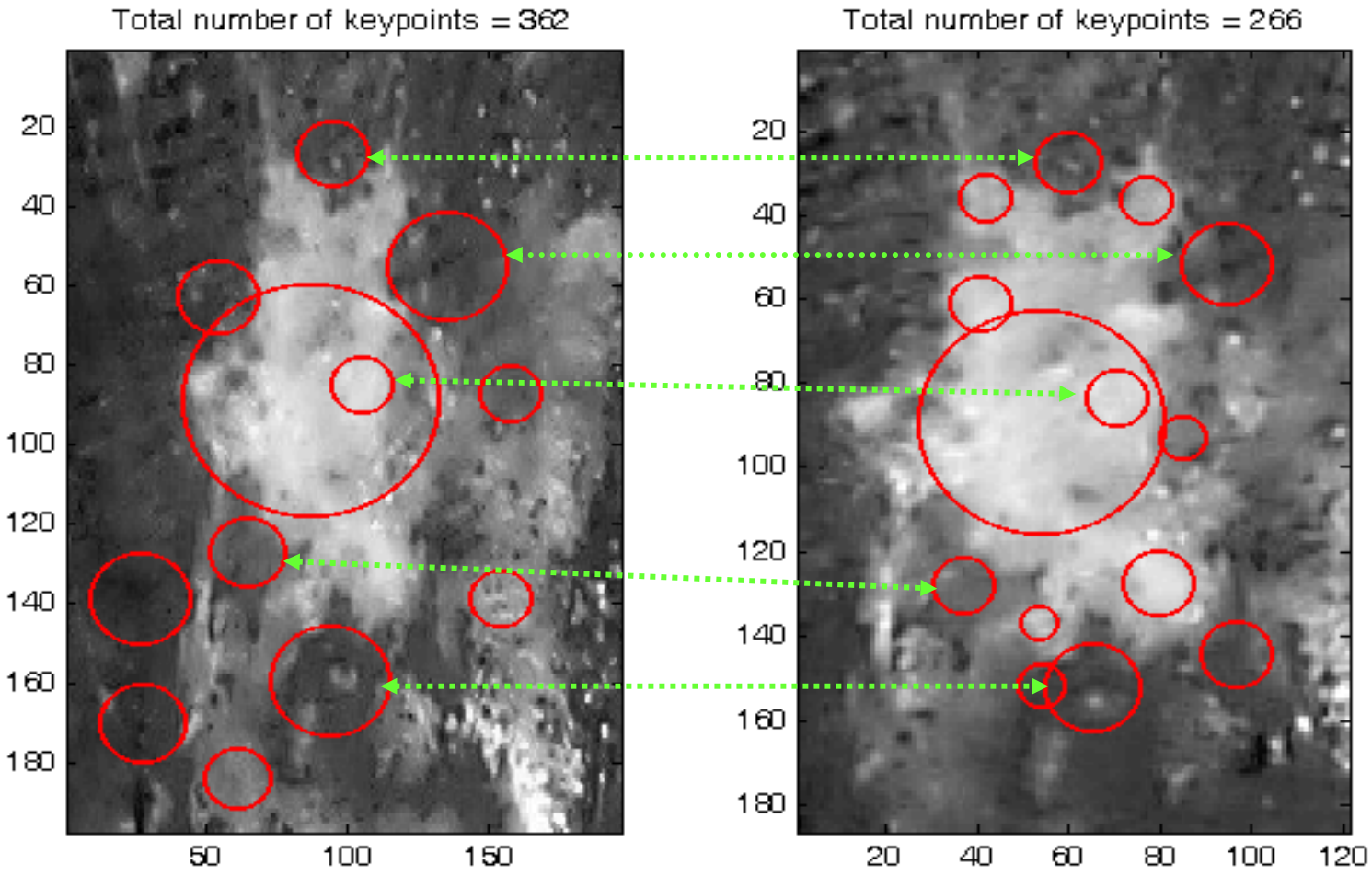
Computer vision problem: detecting similarity



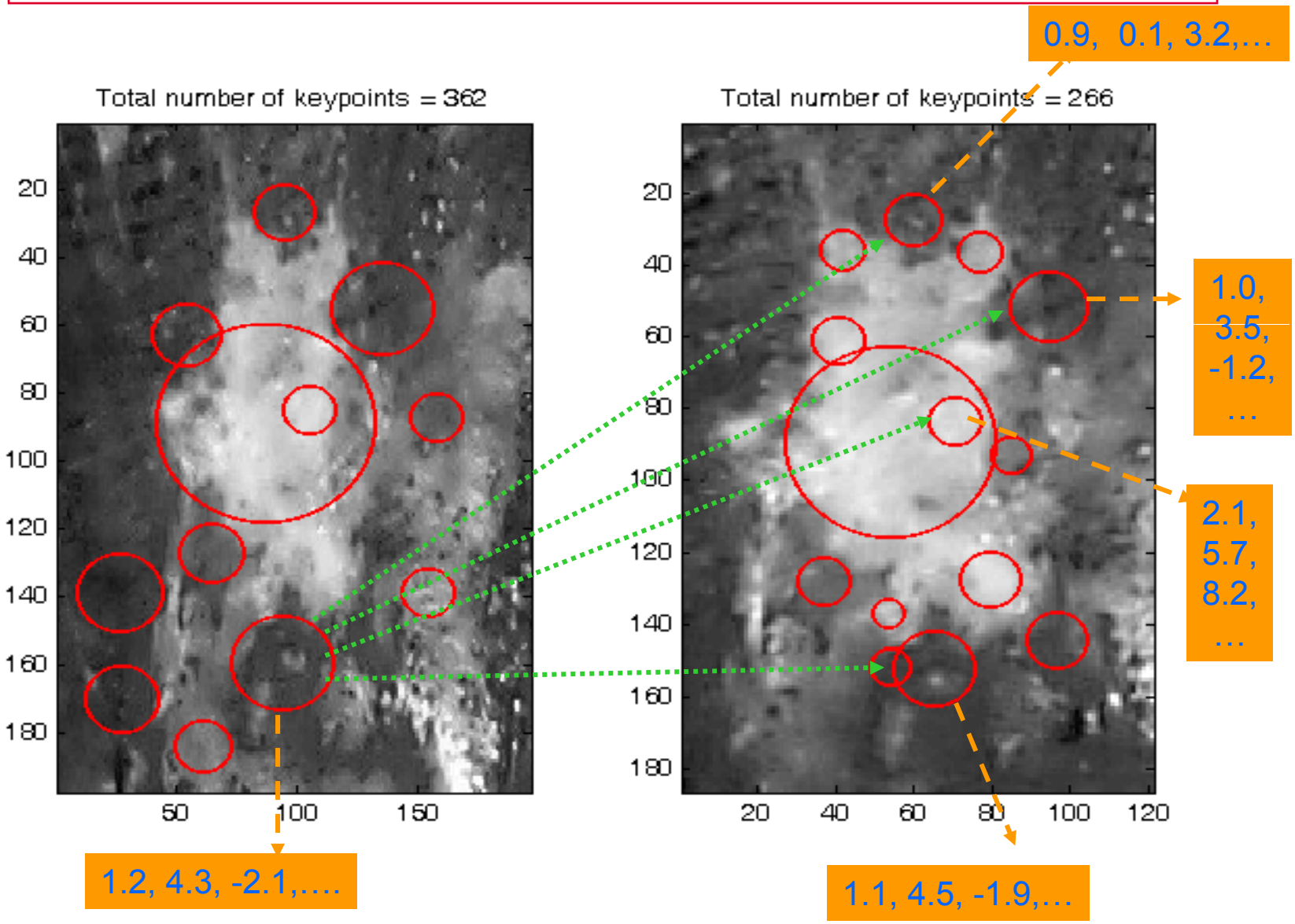
Detection of SIFT keypoints



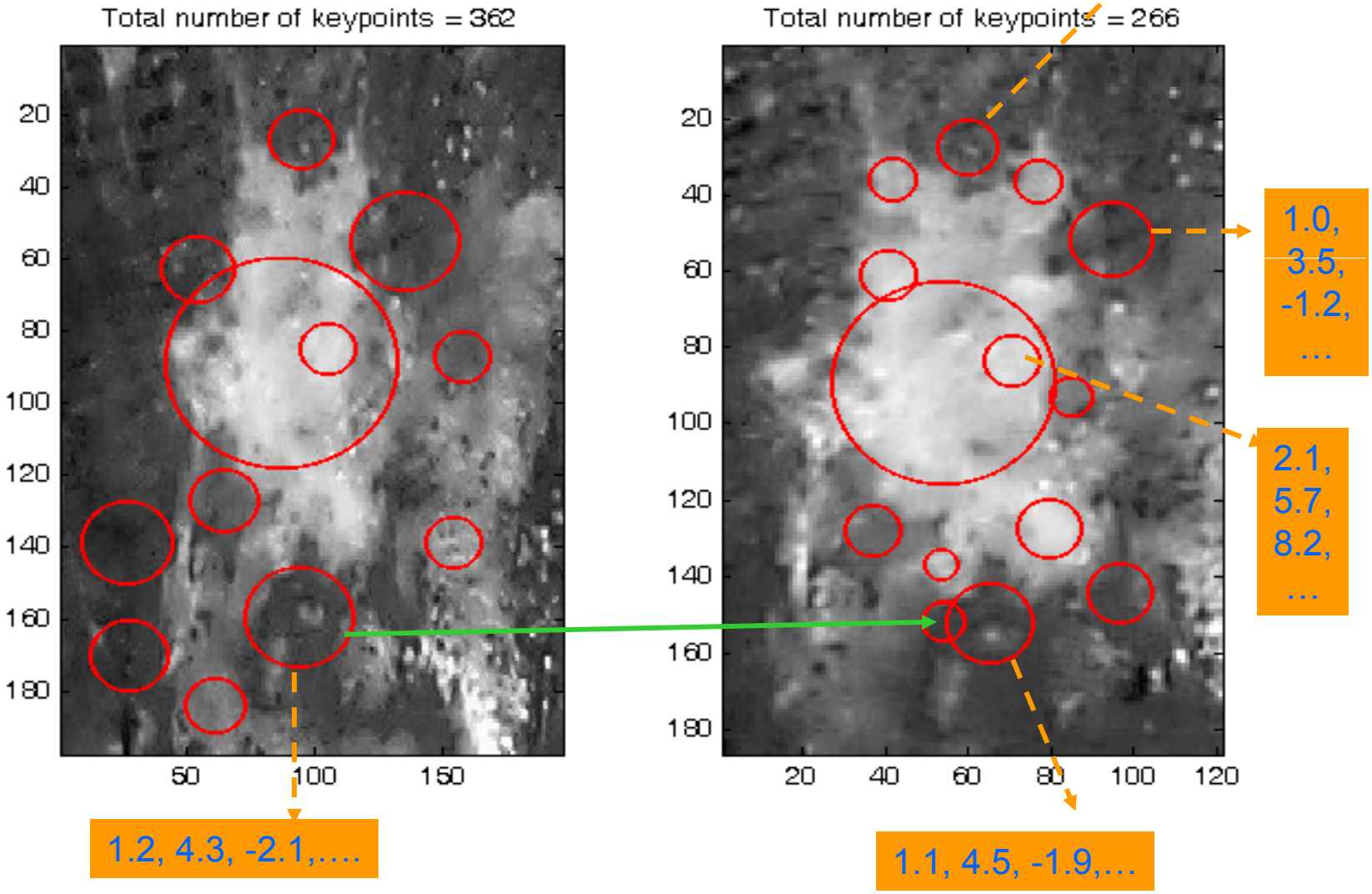
Clearly, some keypoints appear in both images



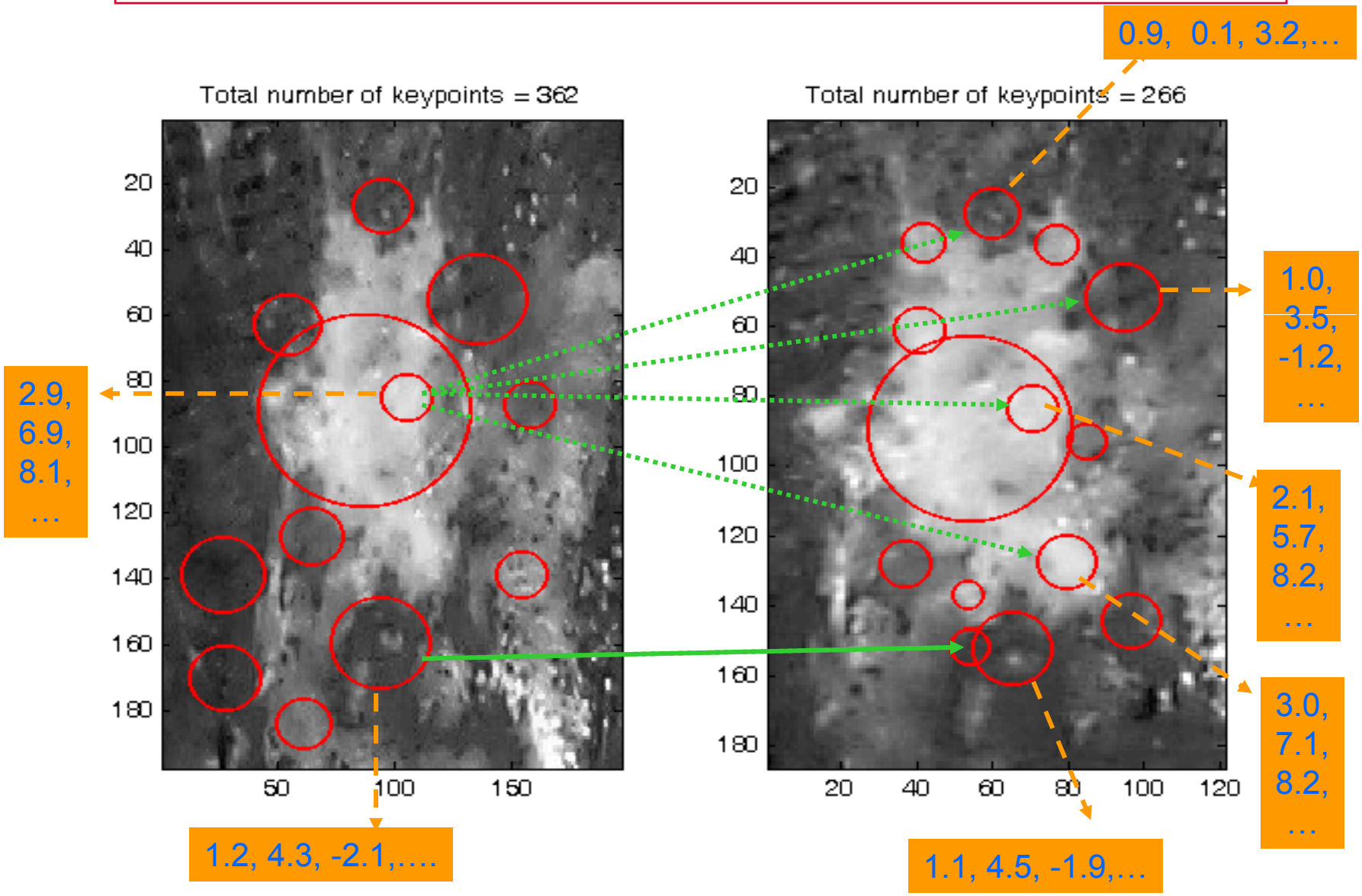
MATCHING the keypoints



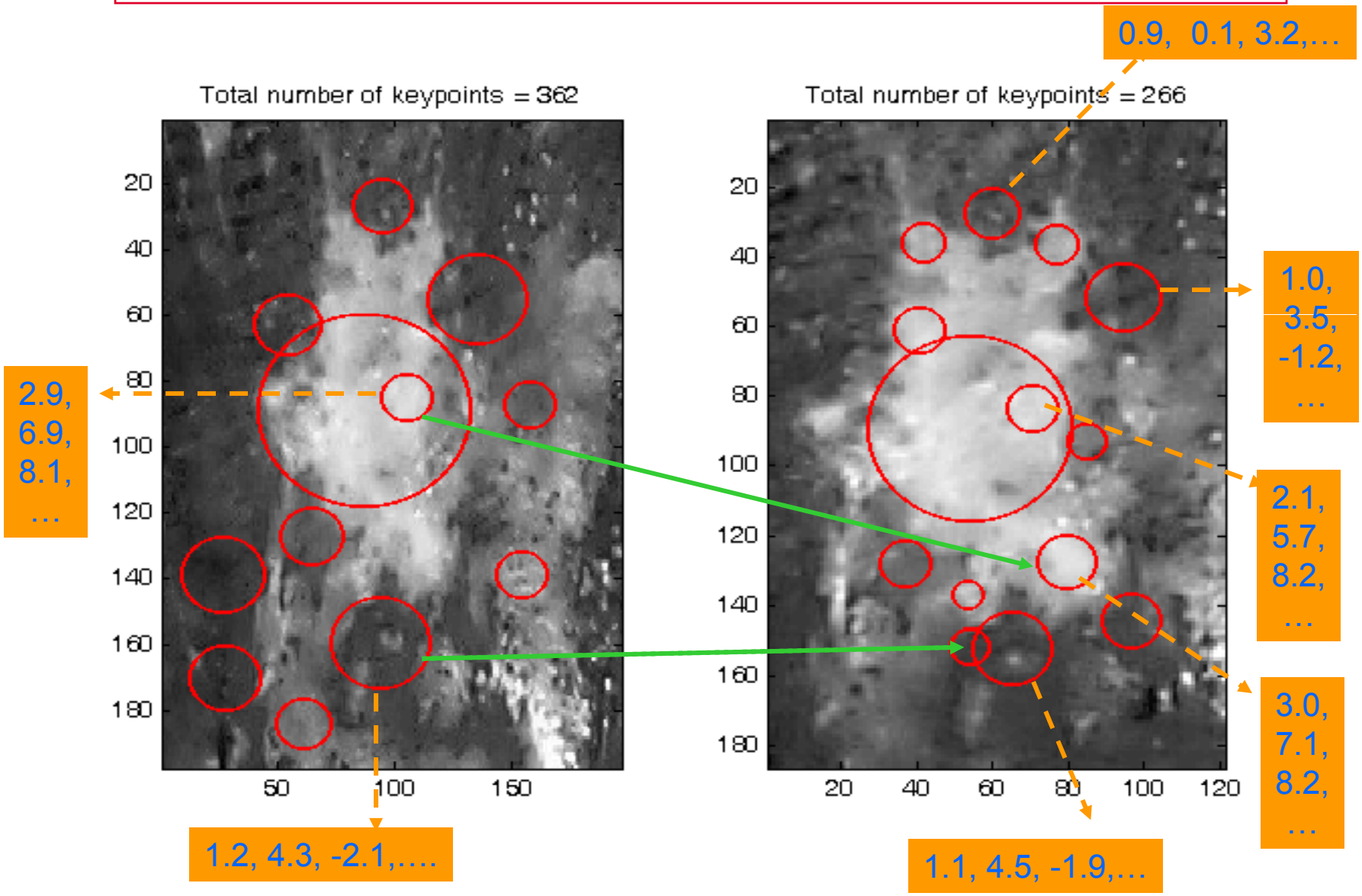
MATCHING the keypoints (2)



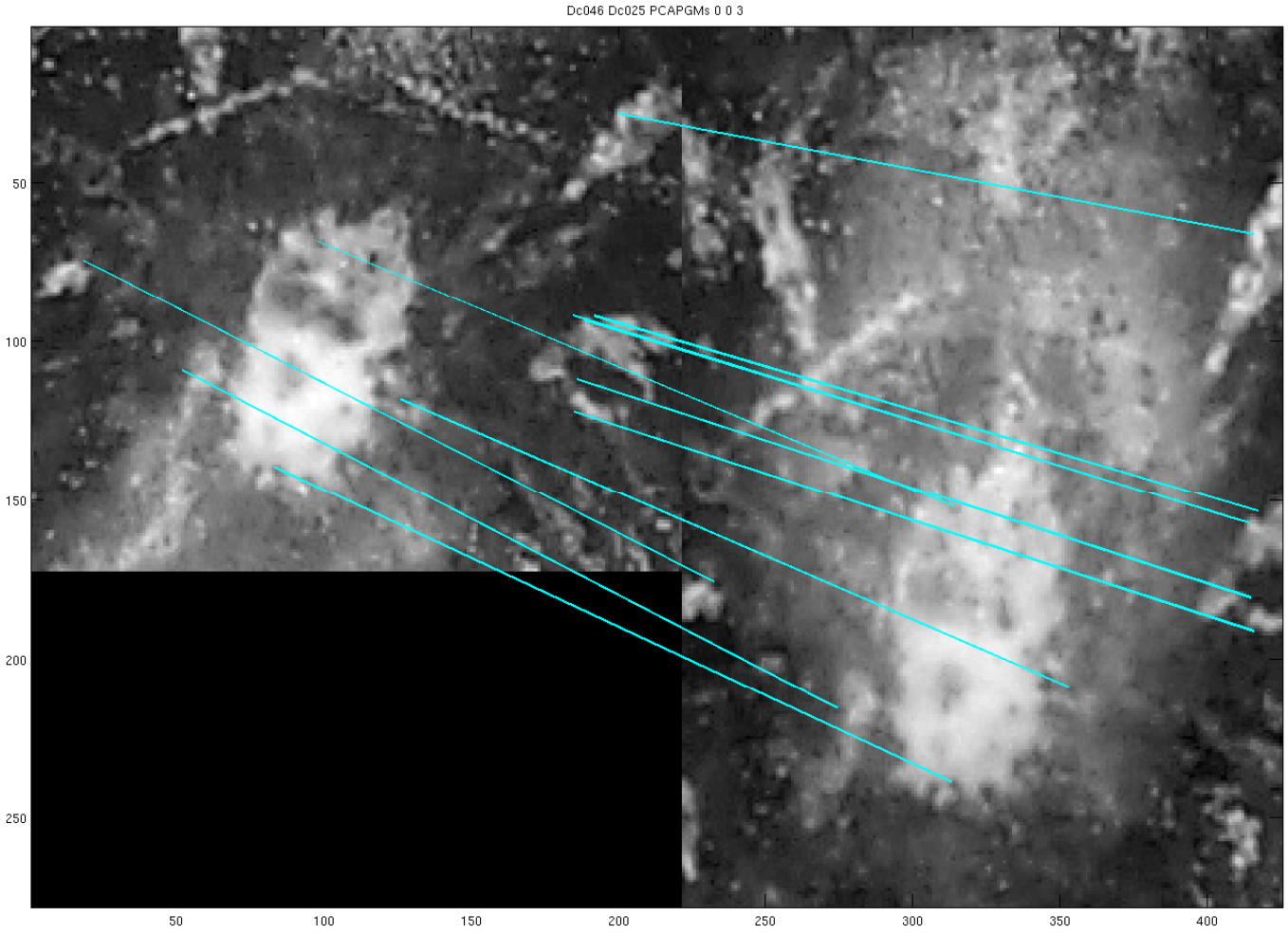
MATCHING the keypoints (3)



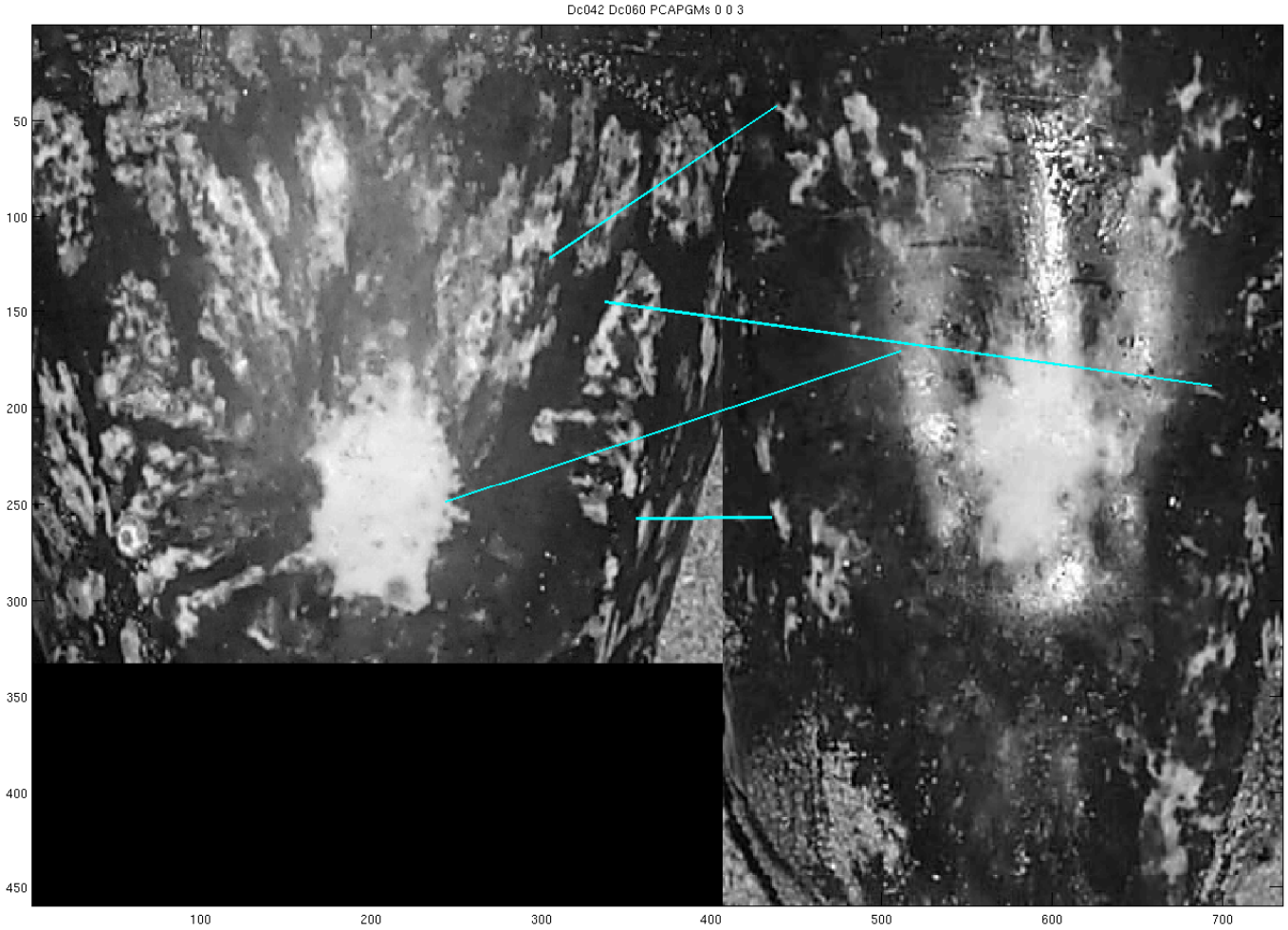
MATCHING the keypoints (4)



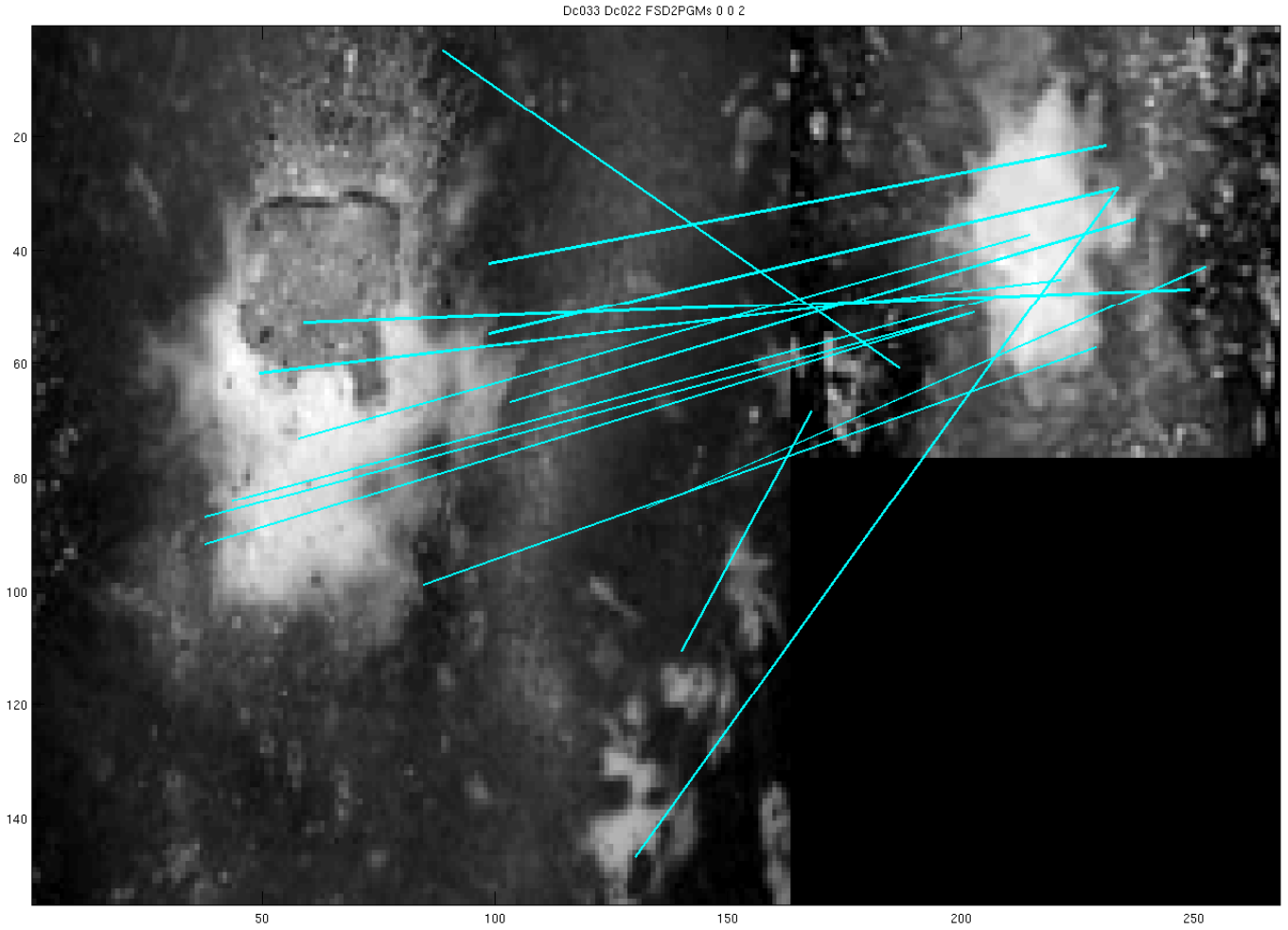
Matching results: numerous matches



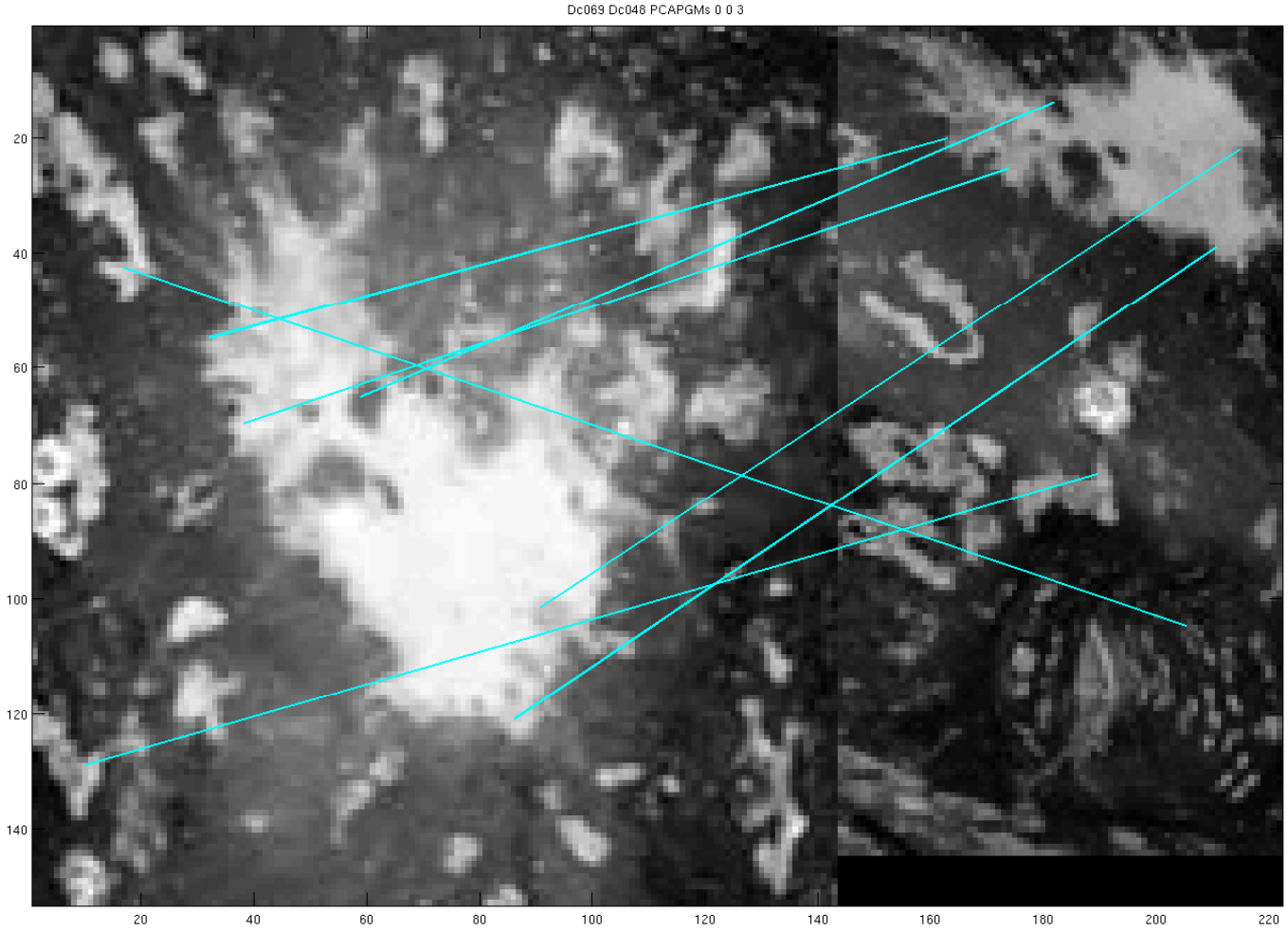
Matching results: few matches



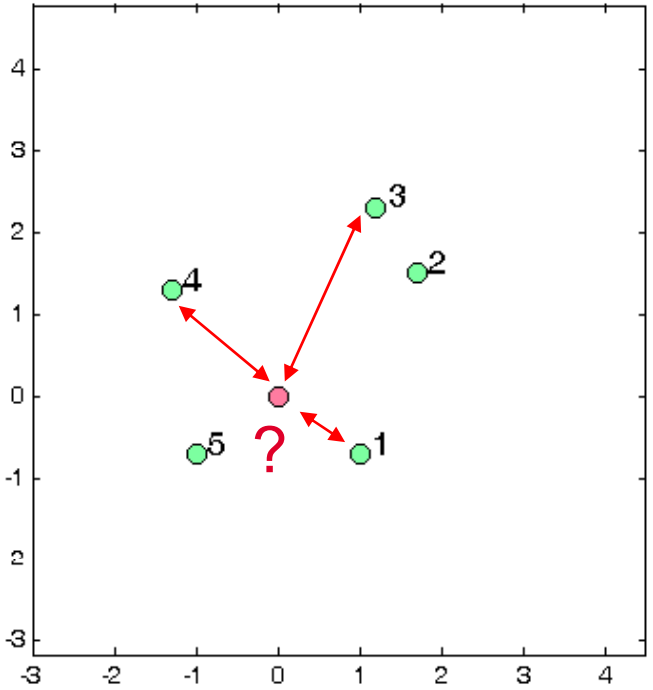
Spatial inconsistency of proposed matches

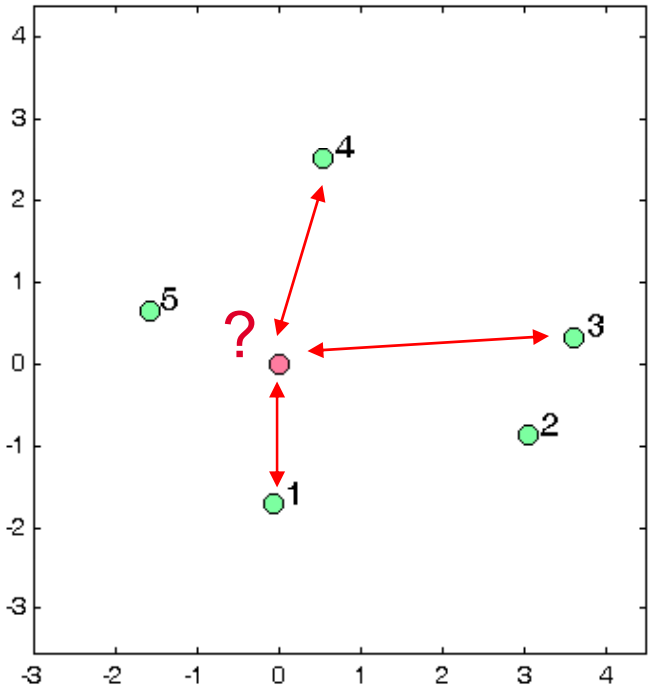


Spatial inconsistency of proposed matches (2)



Check spatial inconsistency: pass!



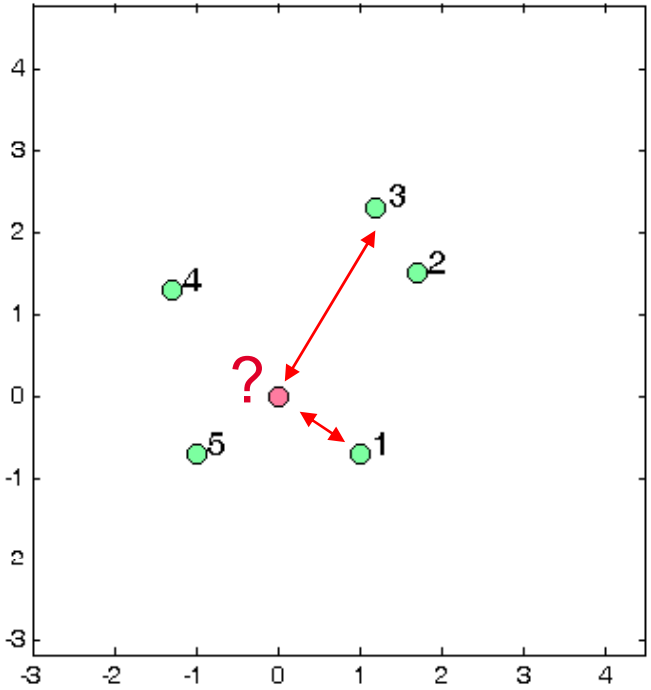


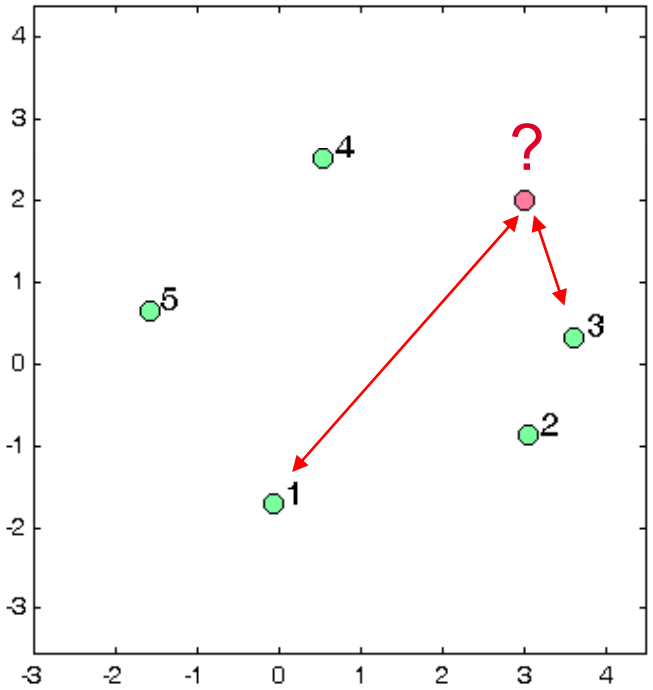
d3 = 2.59 Ratio = 1.40 d3' = 3.63

d4 = 1.84 Ratio = 1.39 d4' = 2.57

d1 = 1.22 Ratio = 1.40 d1' = 1.71

Check spatial inconsistency : fail!





d1 = 1.22

Ratio = 3.94

d1' = 4.81

d3 = 2.59

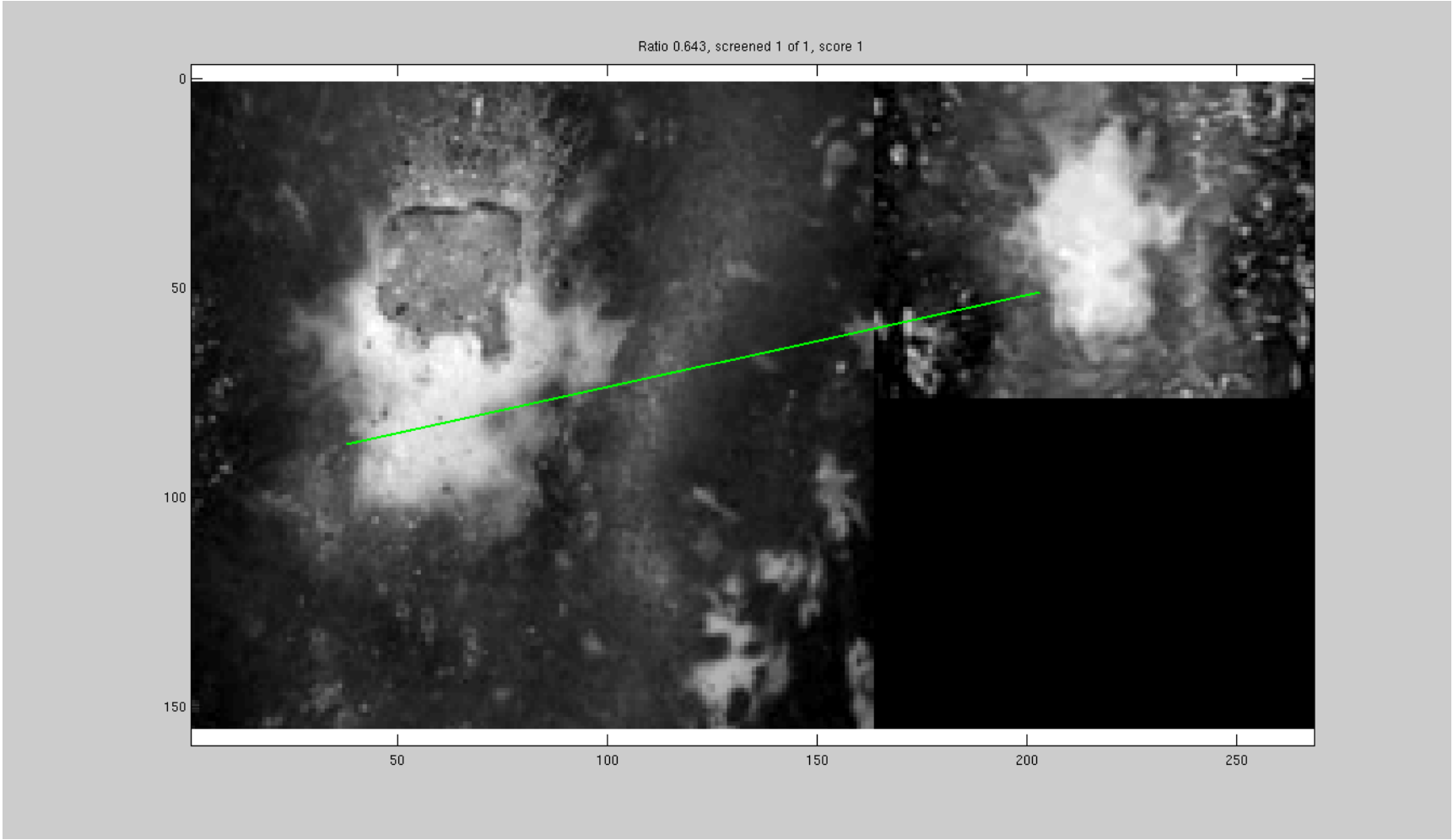
Ratio = 0.69

d3' = 1.78

Use triangular surface area for affine invariance

Hypothesize and check

- Check matches for internal consistency



Decision logic

To check whether two images depict the same animal:

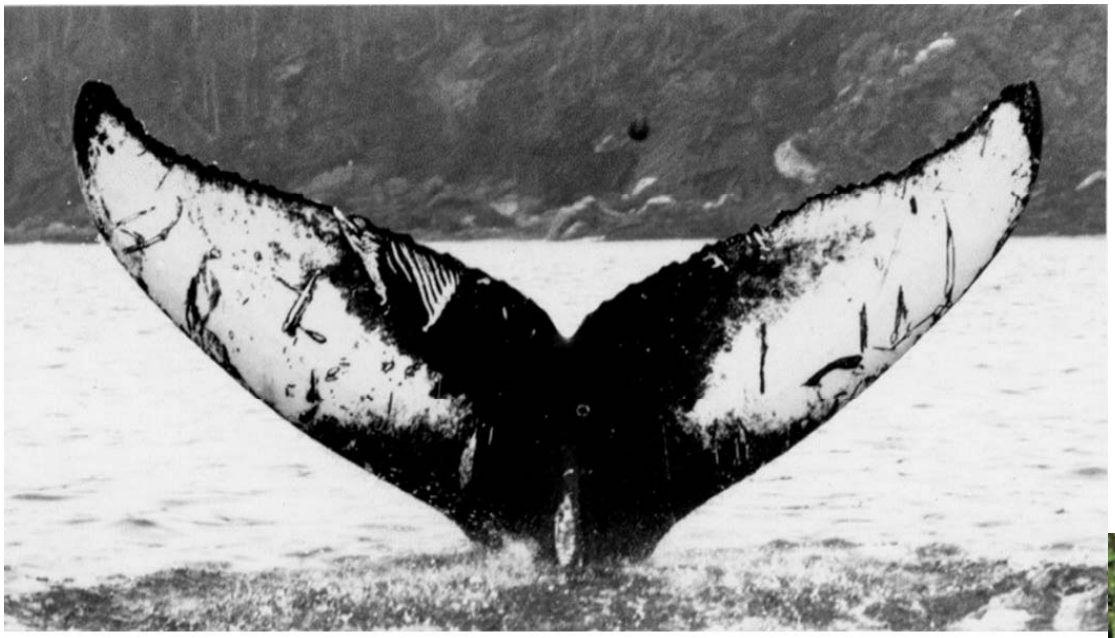
- Find the SIFT keypoints in each picture;
- Match keypoints between pictures (taking into account local spatial consistency)

- Decide based on number of matching keypoints (n)
  - if n small (n < 3): reject as match
  - if n large (n>5): accept as match
  - if 3<= n<= 5: set aside for inspection by human

Resultaten

Results	
Nr. Images in database	613
Nr. Of matches performed by computer	187,578
Nr. of false negatives	0
Nr. of Pairs Manually Viewed/Rejected	73, (i.e. 0.04%)
Time to process image	5 secs

To Do List



NAHWC #3683

YoNAH #1406

Conclusions

- ICT will play an increasingly more prominent role in the collecting and processing of biodiversity data:
  - Collecting: sensors, networks of amateurs/experts;
  - Processing: computer based filtering and representation (e.g. maps)
- Interesting example of collective intelligence :(e.g. in photo-ID)
  - Animals photographed by marine biologists, but also by (eco)-tourists (from all over the world);
  - Images uploaded to webportal
  - Analyzed by computers who can handle 95% of incoming data
  - For remaining 5% of difficult/ambiguous case: invoke assistance of human expert (possibly remote).

Thank you.

For more info, contact

eric.pauwels@cwi.nl