

## Abstract

Image registration is a process in which images that exhibit geometric deviations are mapped to each other in a common coordinate system. In the present work, the usefulness of the registration to satellite imaging is examined. For this purpose, a feature-based method was implemented to calculate the geometric transformation that aligns the images. The method was implemented with the OpenCV and FLANN libraries. In particular, the performance of SIFT and SURF detectors and brute-force and multiple randomized K-D trees matching methods were evaluated. Finally, two satellite imaging applications were implemented in which image registration is applied, change detection on the Earth's surface and image mosaicking for mapping a bigger area.

## Implementation

### Feature – based Method [1]

#### Feature Detection & Description

- SIFT
- SURF

#### Feature Matching

- Brute – Force
- Multiple Randomized k-d trees
- Distance Ratio [2]

#### Estimation of Transformation Model

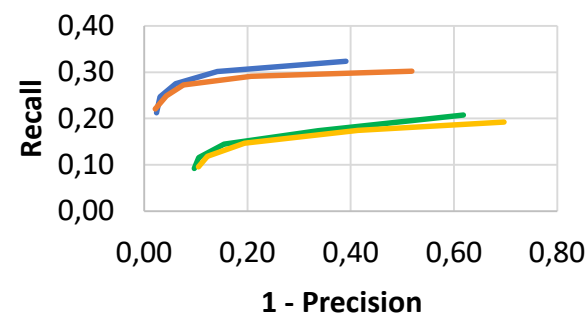
- RANSAC

#### Image Resampling

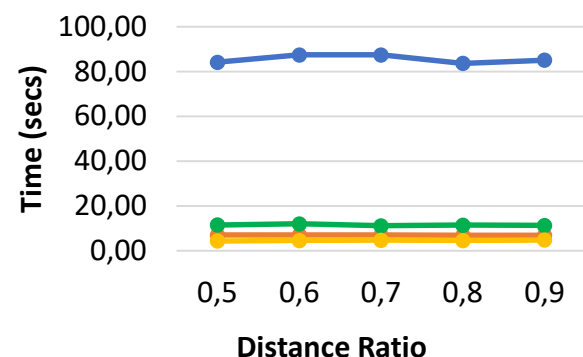
- Bilinear Interpolation

— SIFT (BF) — SIFT (KD Tree)  
— SURF (BF) — SURF (KD Tree)

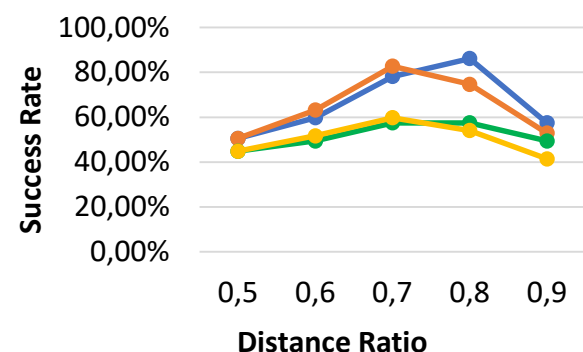
### ROC Curve



### Running Time



### Success Rate



## Change Detection

**Preprocessing Step:** Registration of multitemporal satellite images  $I_1, I_2$  of the same region

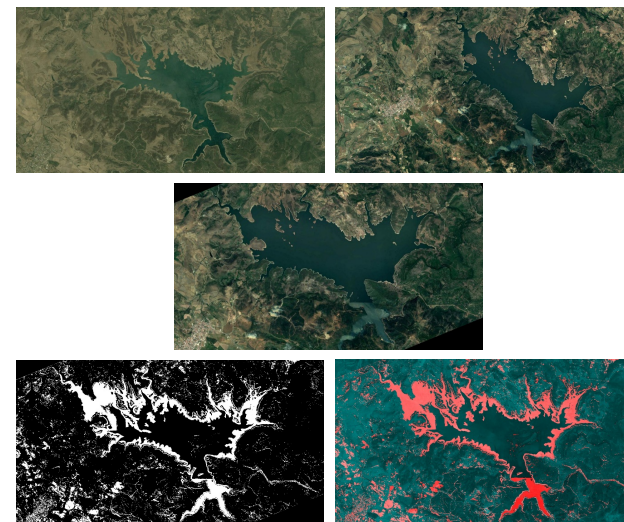
**Image Differencing [3]**

$$\bar{I}_2(x, y) = \frac{\sigma_1}{\sigma_2} (I_2(x, y) - \mu_2) + \mu_1$$

$$I_d(x, y) = |I_1(x, y) - \bar{I}_2(x, y)|$$

$$T(x, y) = \begin{cases} 255, & I_d(x, y) \geq \tau \\ 0, & \text{else} \end{cases}$$

$\tau$  : Otsu's Thresholding Method



Lake Mulargia, Sardinia, 2003 - 2011

## Image Mosaicking

- Sequential registration of multiple images for region mapping
- For every image to be registered -> Find a nearby location on the reference image -> Feature Detection
  - Utilization of Geographical Coordinates (latitude, longitude)
  - Measure distance between two points given their longitudes and latitudes (Haversine formula)



The satellite images were retrieved from Google Earth Pro.

## References

- [1] B. Zitová and J. Flusser, "Image Registration Methods: A survey", Image and Vision Computing, vol. 21, no. 11, pp. 977-1000, 2003.
- [2] D. G. Lowe, "Distinctive Image Features from Scale Invariant Keypoints", International Journal of Computer Vision, vol. 60, pp. 91-110, 2004.
- [3] M. İlsever and C. Ünsalan, "Chapter 2: Pixel-Based Change Detection Methods" in Book: Two-Dimensional Change Detection Methods, pp. 7-21, Springer, 2012.