

# Feature matching for multi-epoch historical aerial images

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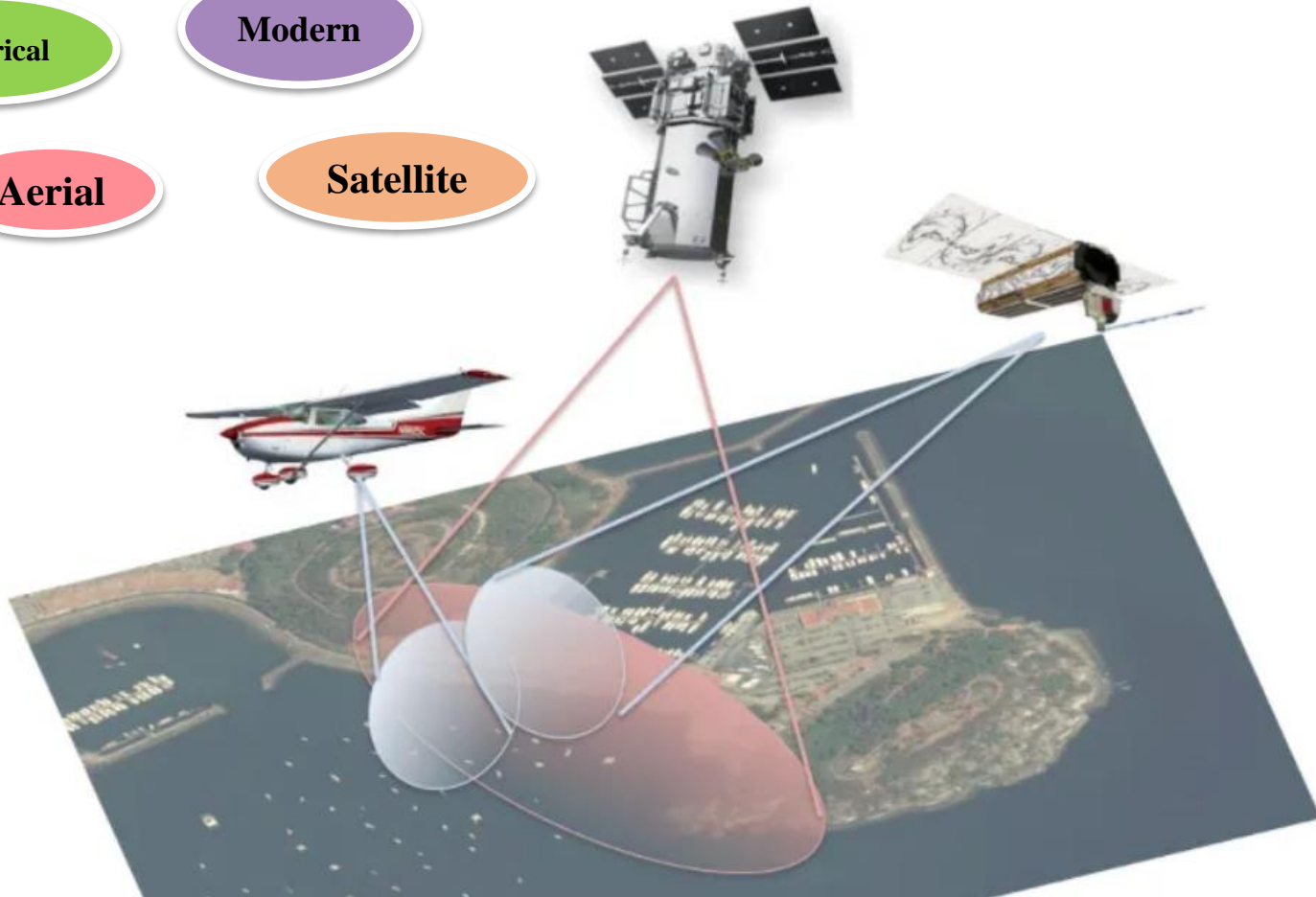
# Suitable scope

**Historical**

**Modern**

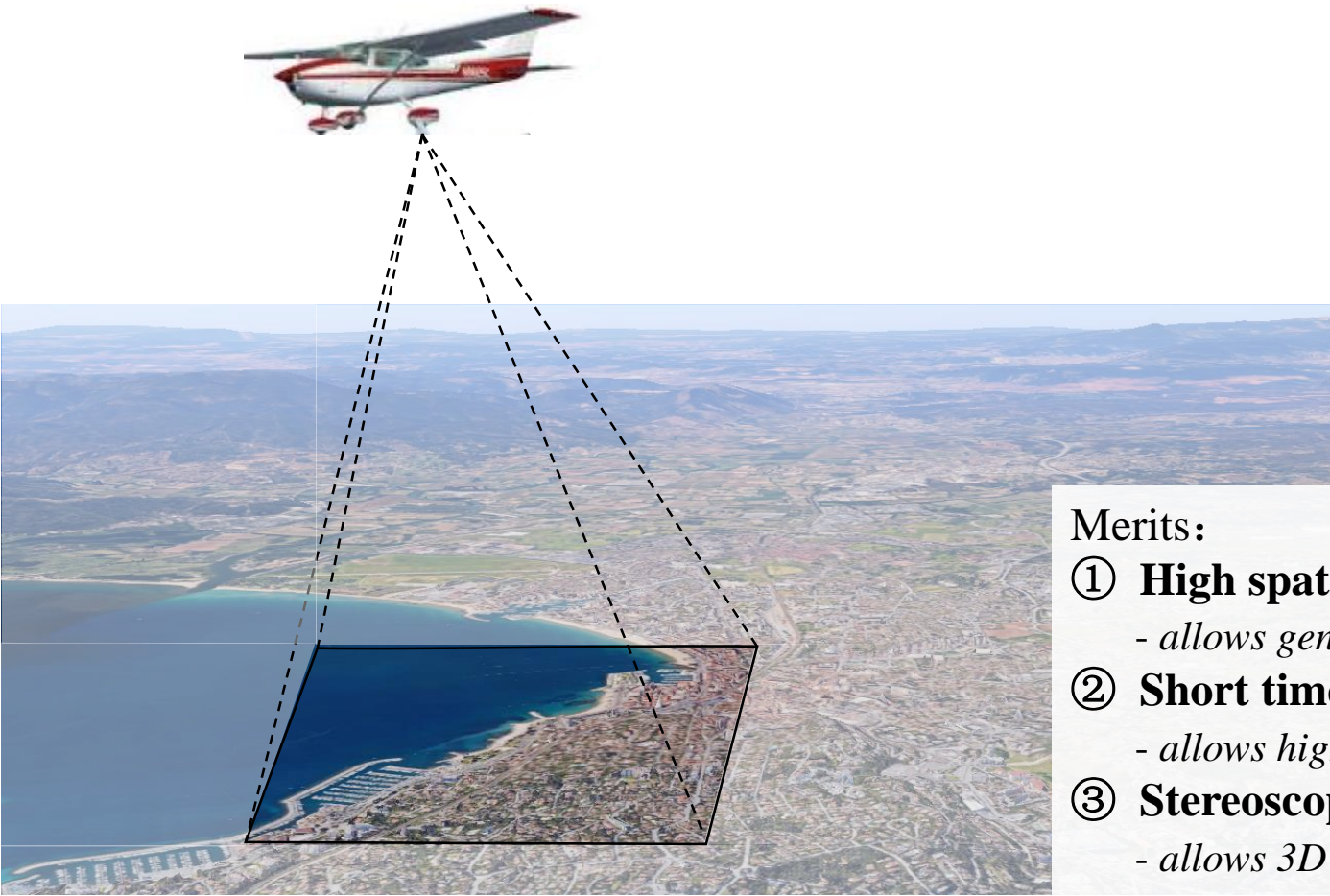
**Aerial**

**Satellite**



# Introduction

## Historical aerial image



Merits:

- ① **High spatial resolution**
  - *allows generating precise DSMs*
- ② **Short time interval**
  - *allows high frequency change detection*
- ③ **Stereoscopic acquisitions**
  - *allows 3D mapping*



# Introduction

## Problem

Before change



After change



Multi-epoch  
comparison



Bundle  
adjustment



Matches  
(similar points)

## State-of-the-art

SI  
Matches: 12

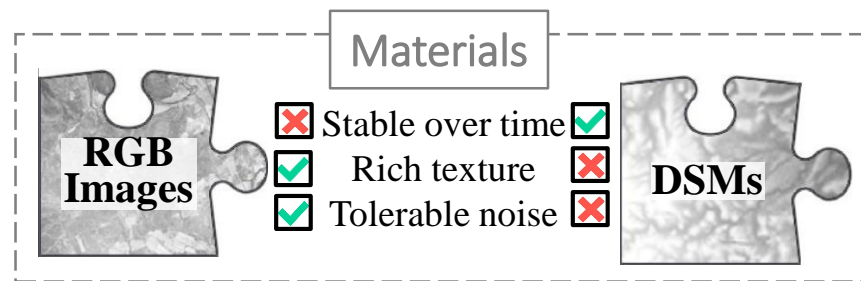
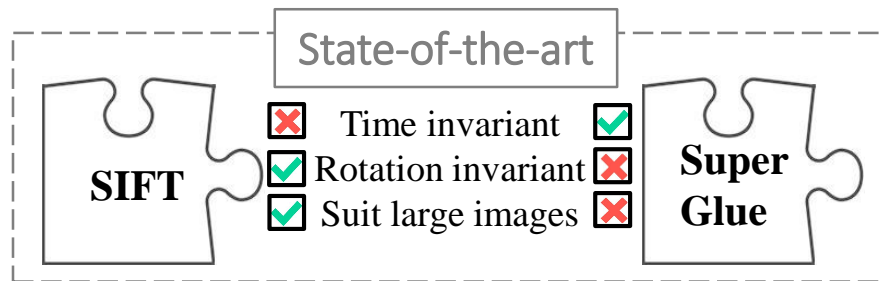


## Goal

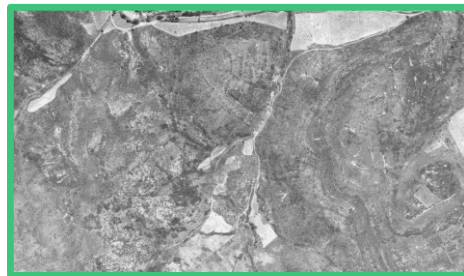
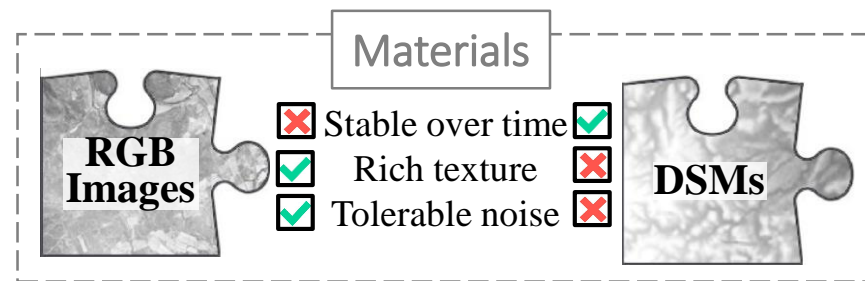
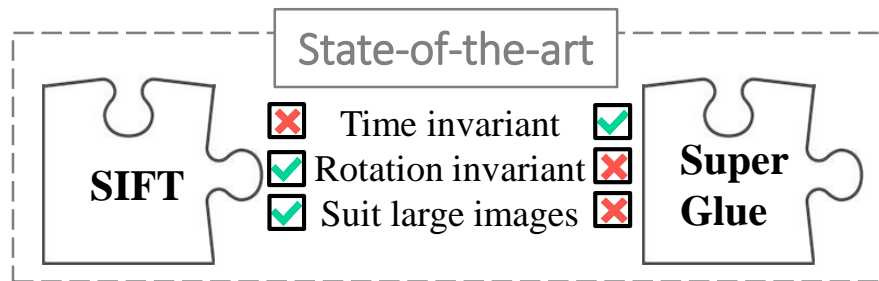
Our  
Matches: 734



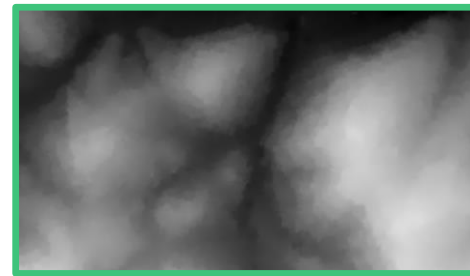
# Methodology



# Methodology



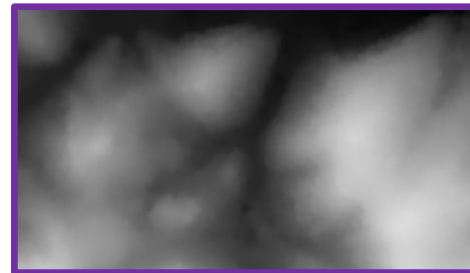
RGB image 1971



DSM 1971

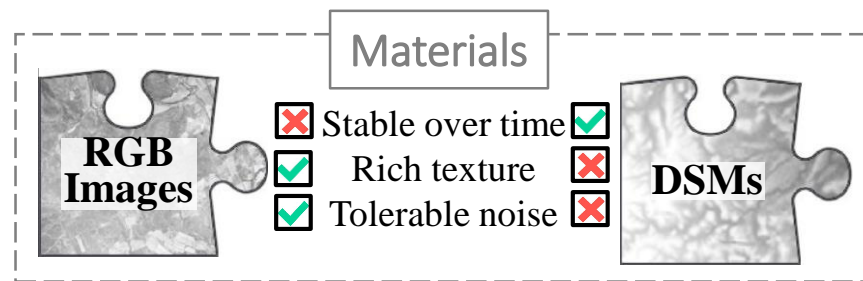
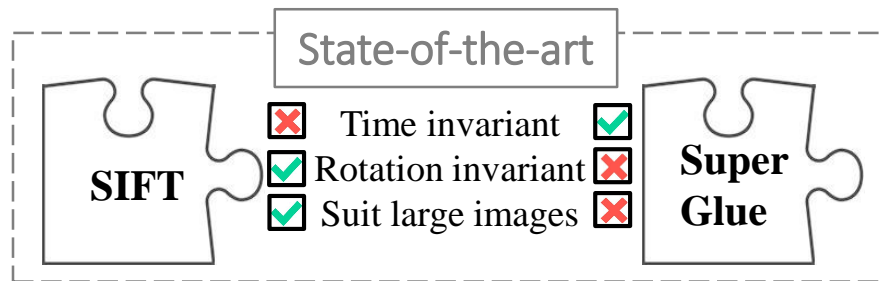


RGB image 2015



DSM 2015

# Methodology



## Our ideas

**Rough to precise**

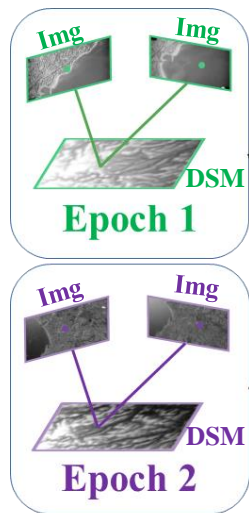
Bring time invariance

Tiling scheme

Scale up deep learning methods

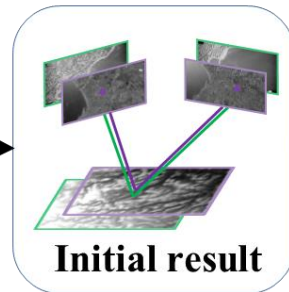
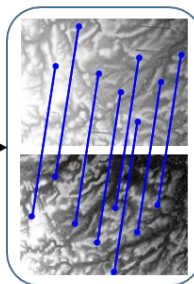
Rotation hypo

Bring rotation invariance

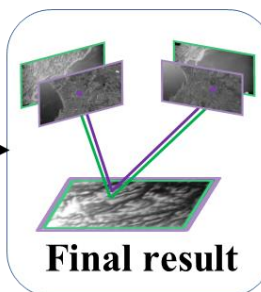


*Intra-epoch processing*

**Rough co-registration**



**Precise matching**

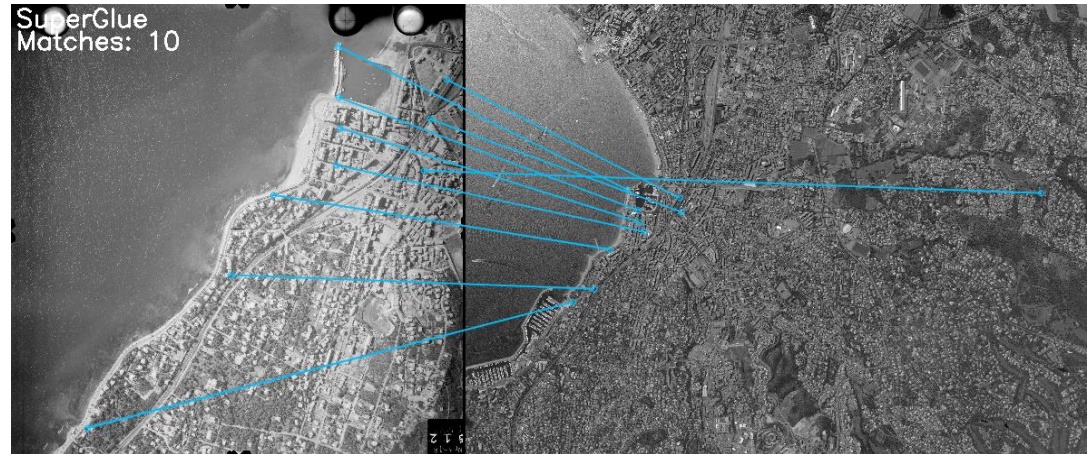
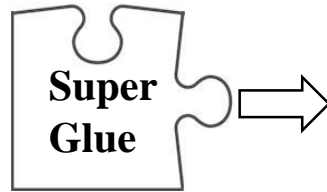


*Inter-epoch processing*



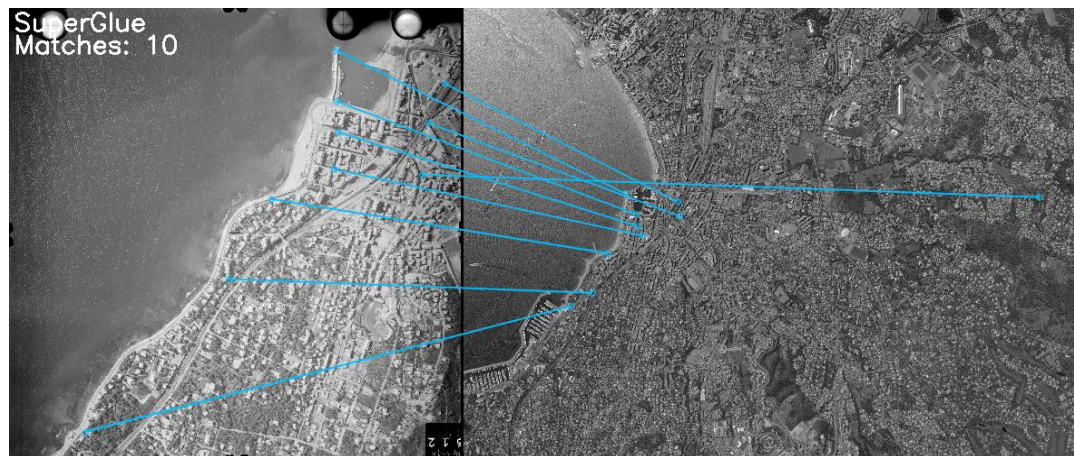
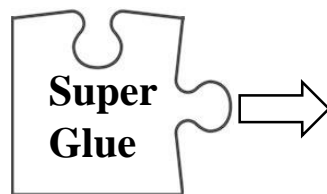
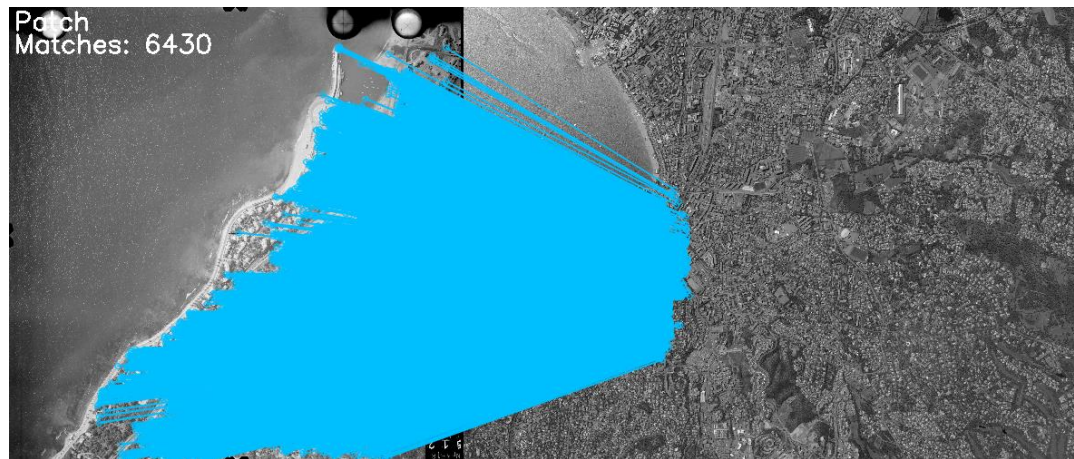
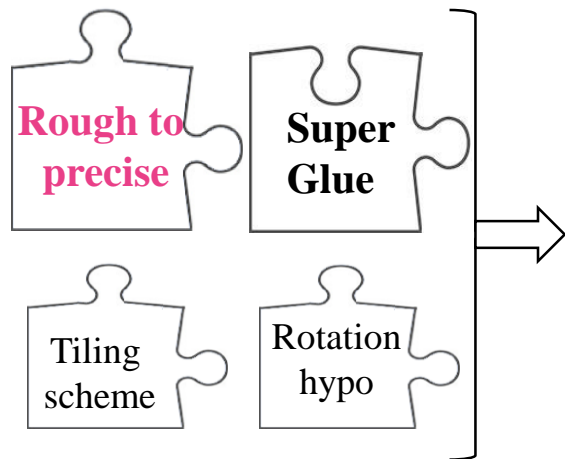
# Comparison

Overlapping zone

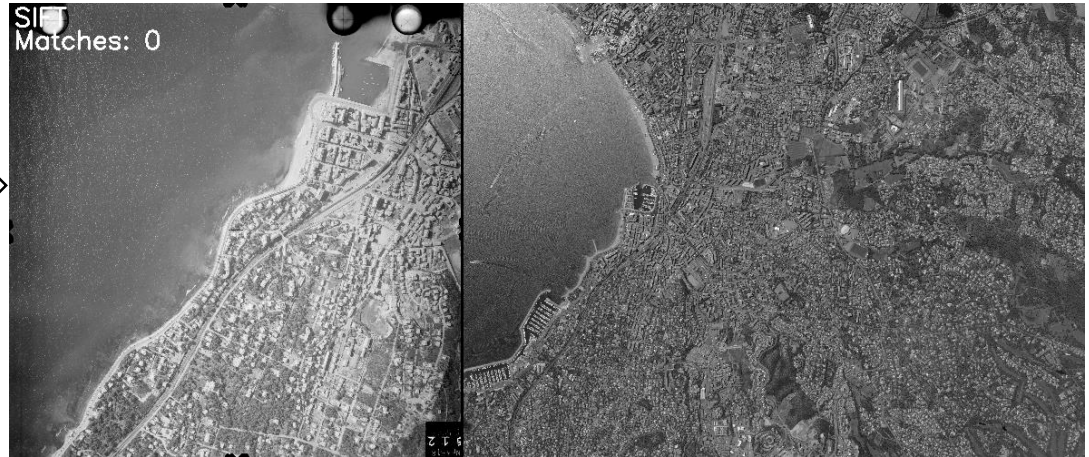
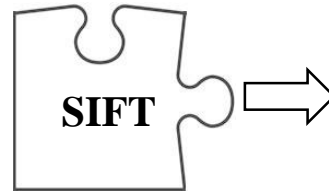
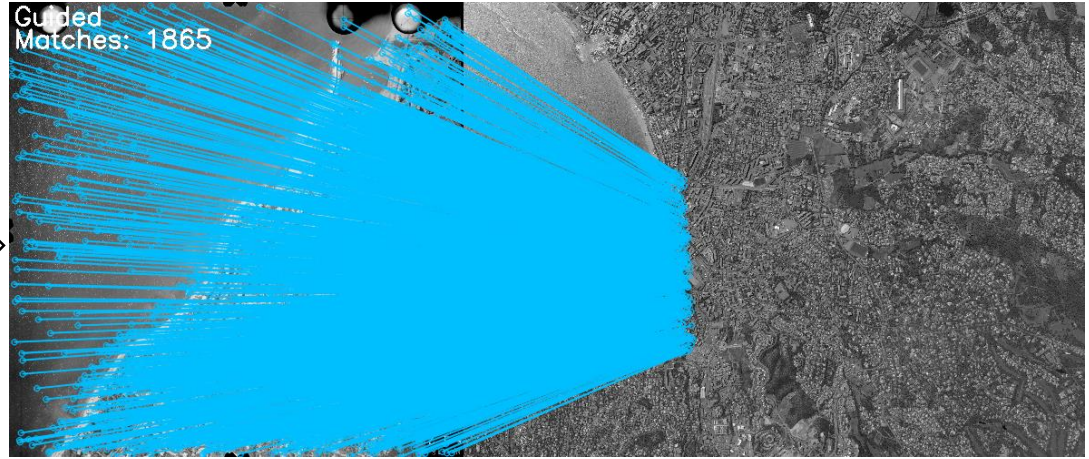
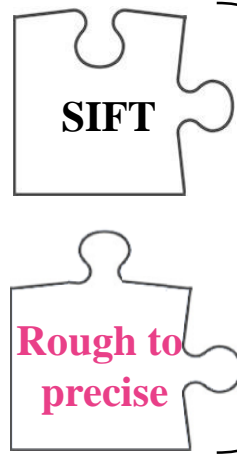




# Comparison



# Comparison

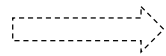




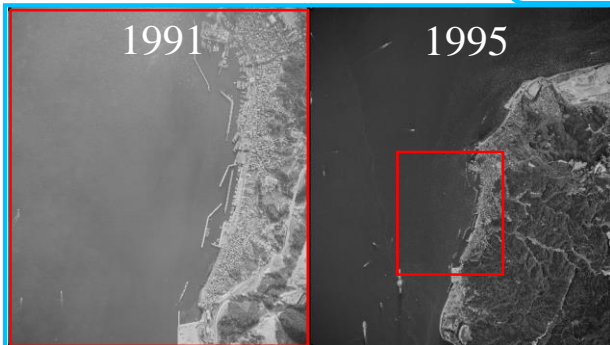
# Result

Test site: *Kobe, Japan*  
(*Kobe earthquake, 1995*)

Matches  
(similar points)



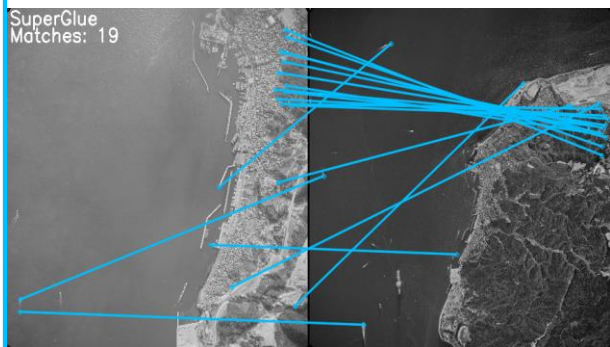
Multi-epoch  
comparison



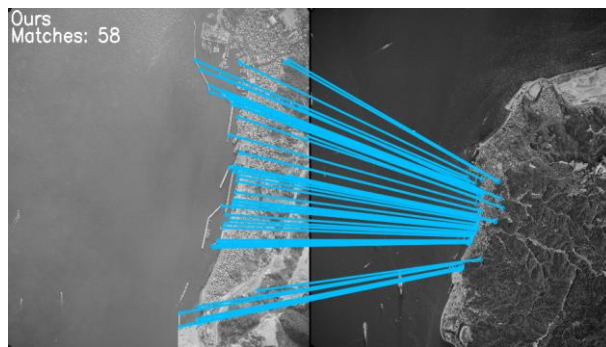
Overlapping zone



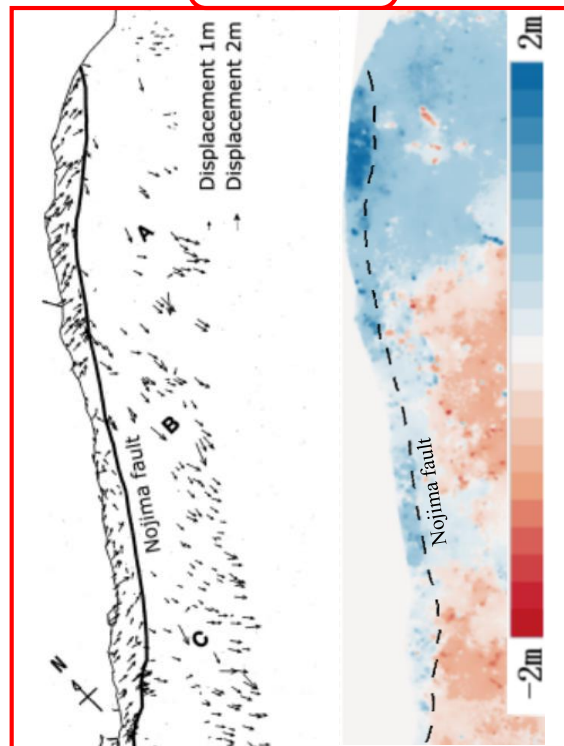
SIFT



SuperGlue



Ours



Ground truth  
(Hoshino et al. 1996)

Ours



# More information

## ISPRS 2022 posters

- ★ 16:00 > 17:30 • **Poster Session 2 - 7th June - TCII-Photogrammetry** • BALCONY - AGORA 2 - ZONE B
- ★ • **Feature matching for multi-epoch historical aerial images** > L. ZHANG (LaSTIG, IGN-Univ. Gustave Eiffel)
- ★ 16:00 > 17:30 • **Poster Session 22 - 10th June - TCII-Photogrammetry** • BALCONY - AGORA 2 - ZONE B
- ★ • **Landslide Evolution Pattern Revealed By Multi-Temporal DSMs Obtained From Historical Aerial Images**  
> M. SANTANGELO (Consiglio Nazionale delle Ricerche - Istituto di Ricerca per la protezione Idrogeologica)

## Publications

- ① **L Zhang**, E Rupnik, M Pierrot-Deseilligny. **Guided feature matching for multi-epoch historical image blocks pose estimation**. ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., 2020.
- ② **L Zhang**, E Rupnik, M Pierrot-Deseilligny. **Feature matching for multi-epoch historical aerial images**. ISPRS Journal of Photogrammetry and Remote Sensing 121 (2021): 143-156.
- ③ M Santangelo, **L Zhang**, E Rupnik, M Pierrot-Deseilligny, M. Cardinali. **Landslide evolution pattern revealed by multi-temporal dsms obtained from historical aerial images**. ISPRS Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2022.



Youtube videos



MicMac code



Tutorial



Santangelo et  
al. 2022



Zhang et al.  
2021

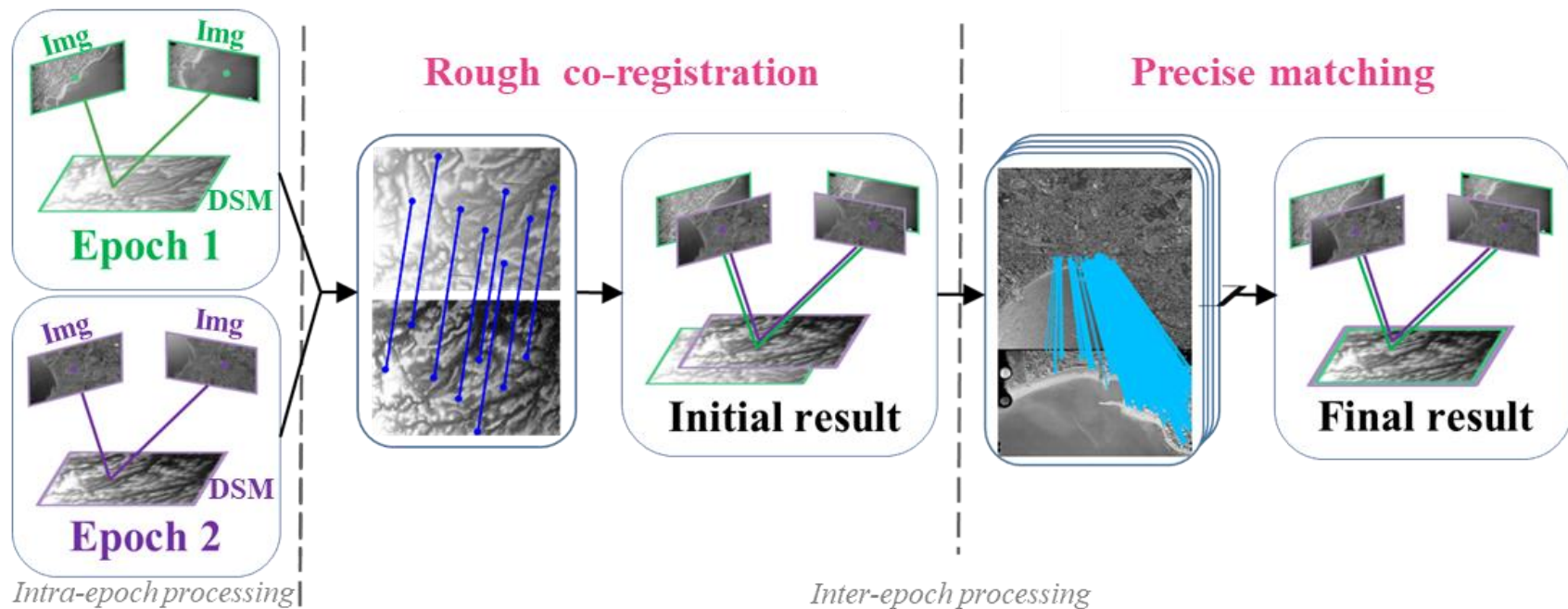


Zhang et al.  
2020



Email Me

# Workflow



# MicMac commands

## (1) Rough co-registration

##### (1.1) Preprocess DSM #####

DSM\_Equalization

Wallis

##### (1.2) Match DSM #####

GetPatchPair BruteForce

SuperGlue

MergeTiePt

RANSAC R2D

}  $\times 4$

#### (1.3) Create virtual GCPs from DSMs ####

CreateGCPs

##### (1.4) 3D Helmert transformation #####

GCPBascule

## (2) Precise matching

##### (2.1) Get overlapped image pairs #####

GetOverlappedImages

#### (2.2) Get patch pairs (One-to-one tiling) ####

GetPatchPair Guided

##### (2.3) Get tentative tie-points #####

SuperGlue

MergeTiePt

GuidedSIFTMatch

#### (2.4) Get enhanced tie-points (3D RANSAC) ####

RANSAC R3D

## (2.5) Get final tie-points (cross correlation) ##

CrossCorrelation





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FRANÇAISE**

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Égalité  
Fraternité*



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ET FORESTIÈRE



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DES SCIENCES  
GÉOGRAPHIQUES



**Thank you  
for your attention!**