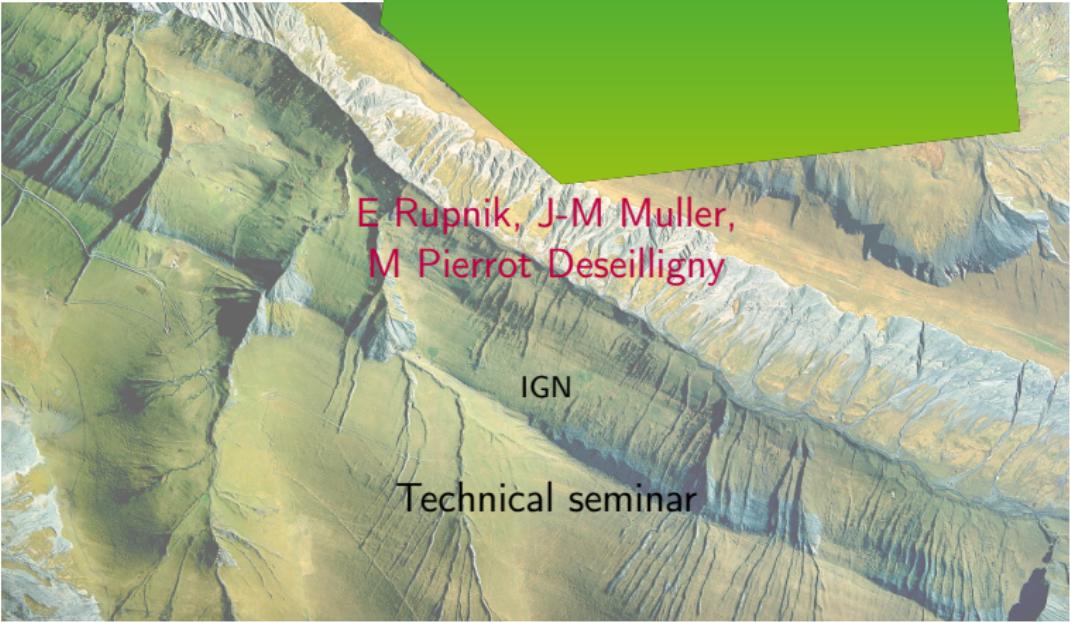




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MicMac – a global overview



A large, semi-transparent green rectangular overlay is positioned in the upper right quadrant of the slide, containing the title text. Below this, the background image shows a detailed aerial or satellite view of a mountainous terrain. The slopes are covered in green vegetation, with numerous blue lines indicating stream or river paths. In the lower center, the word "IGN" is written in a light blue, semi-transparent font.

E Rupnik, J-M Muller,
M Pierrot Deseilligny

IGN

Technical seminar

Introduction

Tie points extraction

Without a priori geometry

With a priori geometry

Reduction algorithms

Image orientation

SfM and structureless method

Bundle block adjustment

Misc



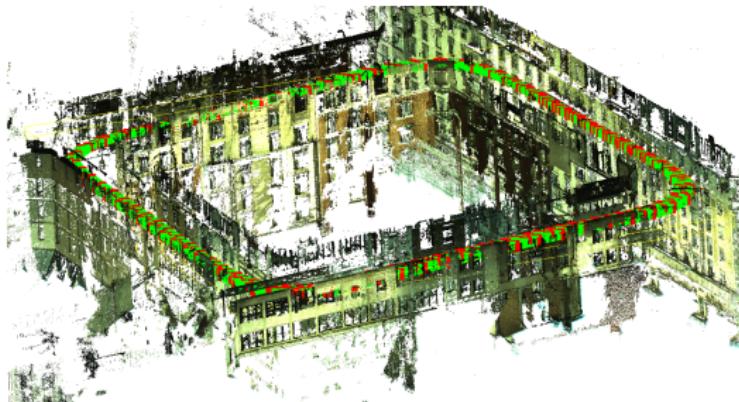
1

Introduction

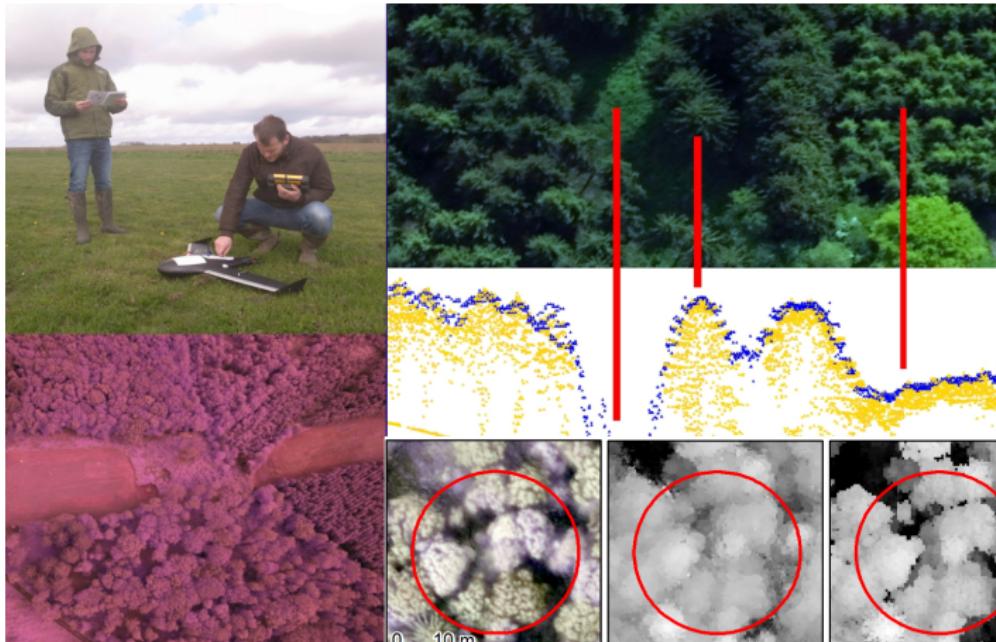
Applications



Applications



Applications



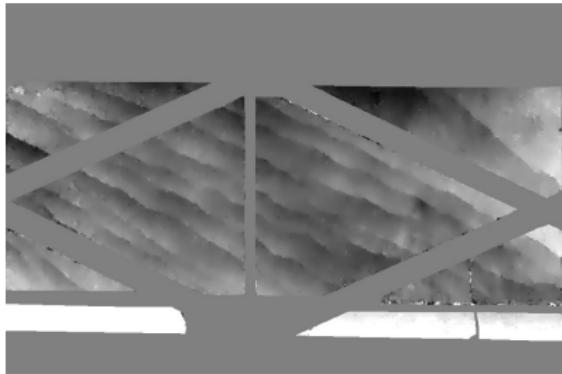
Applications



Applications



Applications



Applications



Applications

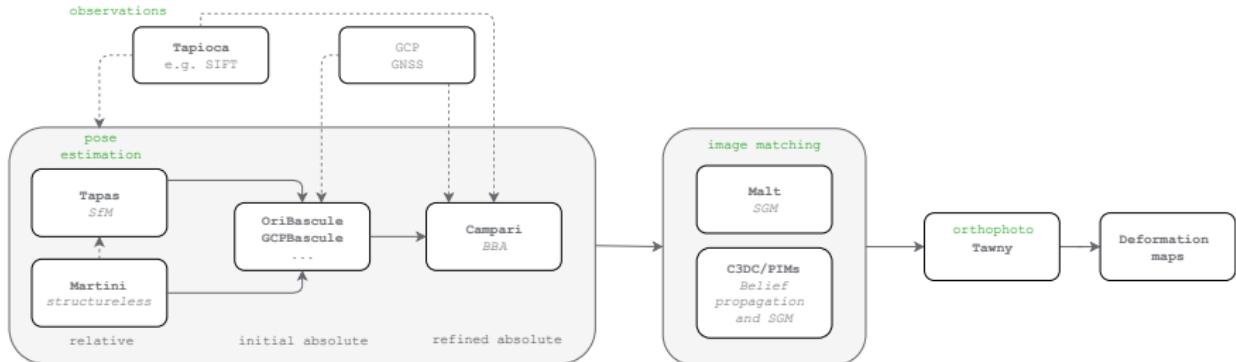


At IGN

At IGN, MicMac is used for production and innovation:

- ▶ Aerial images correlation for France digital terrain model
- ▶ 3D modelization for metrology
- ▶ mobile mapping trajectories
- ▶ research
- ▶ education

Overview of the processing pipeline





2

Tie points
extraction



Tie points extraction

Without a priori geometry

Tie points extraction Without *a priori* geometry

Tie points detection

- ▶ SIFT : default
- ▶ Digeo : slightly faster, possibility to use only max or min
- ▶ AIME (presented by MPD during spotlight), under developpment; generally faster than SIFT

Tie points extraction Without *a priori* geometry

Tie points detection

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Tie points Matching

- ▶ ANN (Approximate Nearest Neighbor)
- ▶ for a point in pic A, find best and second best points in pic B. The best point is accepted if his score is high and second best score is low.

Tie points extraction

Without *a priori* the geometry

Tie points extraction

Without *a priori* the geometry

Extraction organization : lists of pictures pairs

- ▶ All, MulScale, Line...
- ▶ from an orientation (GPS, approximate orientation)

Tapioca command. See §3.3 and §16 of documentation.

Tie points extraction Without *a priori* the geometry

Extraction organization : lists of pictures pairs

- ▶ All, MulScale, Line...
- ▶ from an orientation (GPS, approximate orientation)

Tapioca command. See §3.3 and §16 of documentation.

Tie points files format (binary and ASCII)

- ▶ Default : 1 file per pair, simple and universal
- ▶ New format : 1 file with points multiplicity, faster but only usable with few commands

mm3d TestLib ConvNewFH command. See §16.8 of documentation.



Tie points extraction

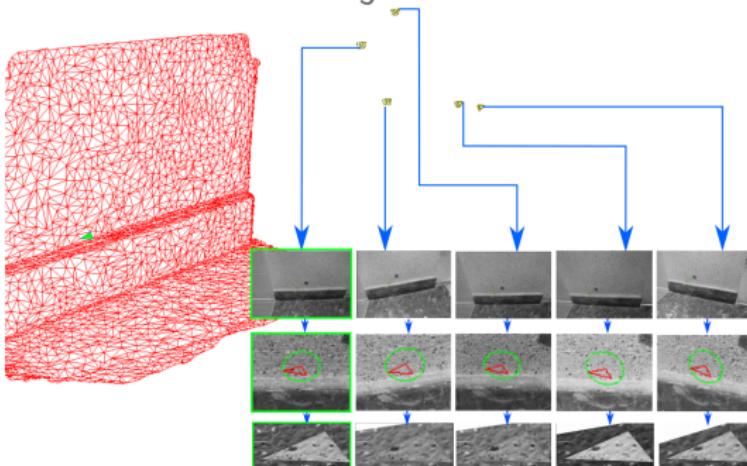
With a priori geometry

Tie points extraction With *a priori* geometry

Tie points extraction With *a priori* geometry

- ▶ “Second iteration”: using camera orientations and a 3d mesh
- ▶ finds tie points with good repartition on pictures and 3d mesh
- ▶ use orientations for perspective corrections before correlation

mm3d TiePTri command. See §16.9 of documentation.





2

Tie points extraction

Reduction algorithms

Tie points reduction algorithms

Tie points reduction algorithms

Four tools are dedicated to Tie points reduction:

- ▶ **RedTieP / Schnaps** (generic case): only one point per picture part, favor manifold
- ▶ **OriRedTieP** (quasi-vertical case) : favor scene repartition and minimize reprojection errors
- ▶ **Ratafia** : use local orientations, works with any geometry





Image orientation

1. no *a priori*, **iterative** (i.e. SfM)
2. no *a priori*, **structureless** method (aka *global motion first*)
3. initial orientations are known,
collinearity-based bundle block adjustment (BBA)

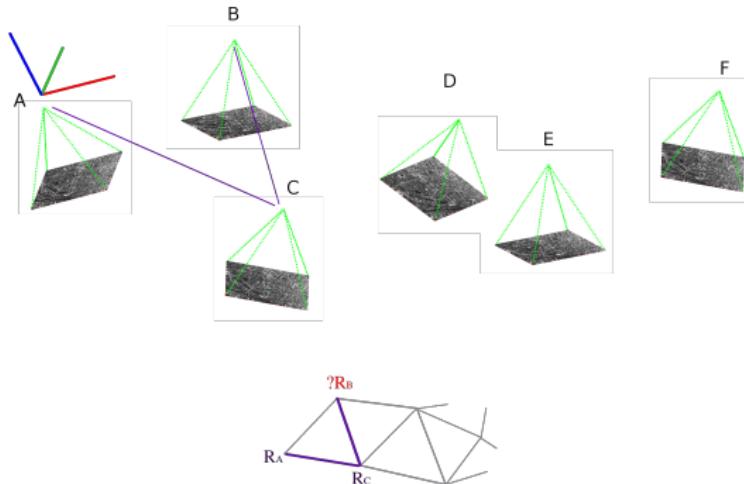


Image orientation

SfM and structureless method

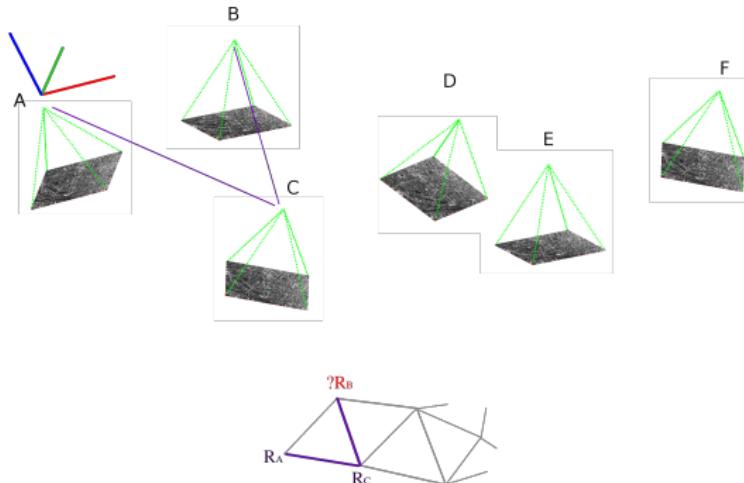
Pipeline:

- ▶ **iterative** creation of global poses
- ▶ all poses in the coordinate system attached to a selected camera
- ▶ direct algorithms
(e.g. essential matrix, resection)
- ▶ bundle block adjustment
every n images



Pipeline:

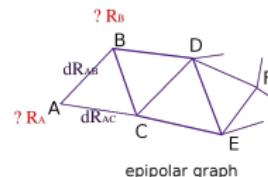
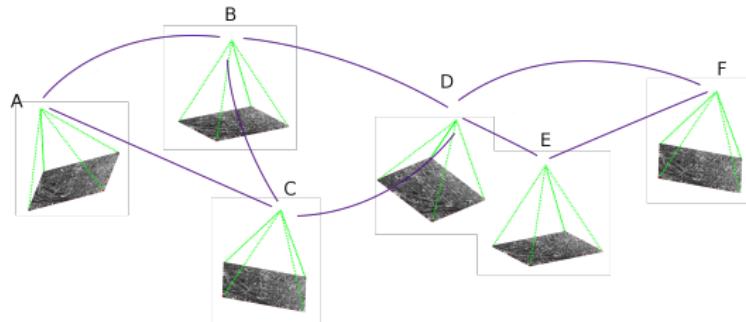
- ▶ **iterative** creation of global poses
- ▶ all poses in the coordinate system attached to a selected camera
- ▶ direct algorithms
(e.g. essential matrix, resection)
- ▶ bundle block adjustment
every n images
- ▶ **camera poses and calibrations**
are estimated



Structureless method

Pipeline:

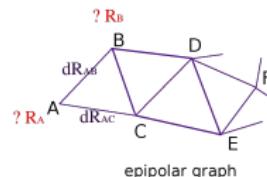
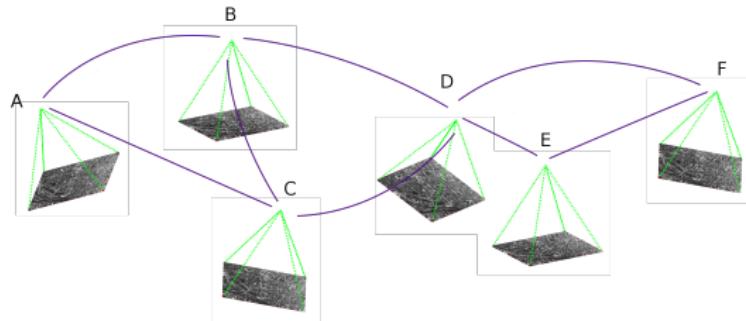
- ▶ relative poses between all possible pairs **simultaneously** (i.e. epipolar graph)
- ▶ composition of triplets
- ▶ initialisation of global poses and error averaging



Structureless method

Pipeline:

- ▶ relative poses between all possible pairs **simultaneously** (i.e. epipolar graph)
 - ▶ composition of triplets
 - ▶ initialisation of global poses and error averaging
-
- ▶ **only camera poses are estimated !**
 - ▶ followed by the BBA to refine camera calibrations



SfM and structureless method

- ▶ in MicMac

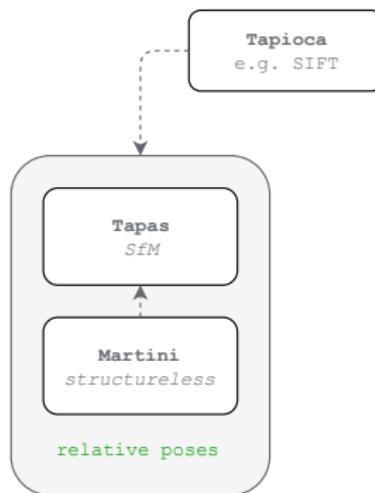




Image orientation

Bundle block adjustement

Bundle block adjustement (BBA)

Generalities:

- ▶ collinearity equations
- ▶ heterogenous observations/parameters possible, e.g.:
 - ▶ Ground Control Points (GCP),
 - ▶ GNSS,
 - ▶ lever-arm,
 - ▶ rigid bloc
- ▶ non-linear → **initial poses necessary**

BBA initial poses

BBA adopted in

1. SfM, alternates with direct methods
always the same relative system initialisation not an issue

BBA initial poses

BBA adopted in

1. SfM, alternates with direct methods
always the same relative system initialisation not an issue
2. absolute positioning
 - ▶ input1: poses known in relative coordinates (SfM output)
 - ▶ input2: GCP, GNSS are given in absolute coordinates

BBA initial poses

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1. SfM, alternates with direct methods
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2. absolute positioning
 - ▶ input1: poses known in relative coordinates (SfM output)
 - ▶ input2: GCP, GNSS are given in absolute coordinates
 - ▶ **Spatial similarity transformation
from input1 to input2 coordinates**

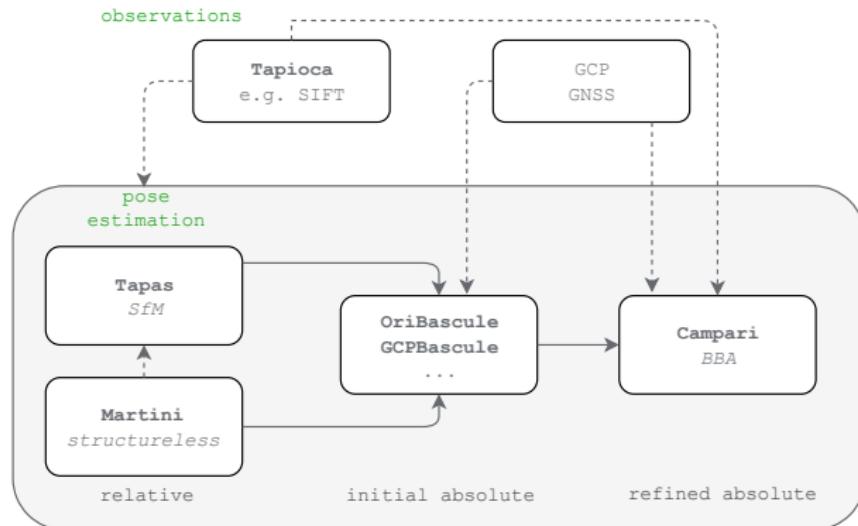
BBA initial poses

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 - ▶ **Spatial similarity transformation
from input1 to input2 coordinates**
 - ▶ followed by BBA

Image orientation

► in MicMac





Misc

MicMac vs other software tools

Some unique MicMac features

- ▶ access to intermediary results, no black box
- ▶ MicMac as a library
- ▶ qualitative evaluation of the results
- ▶ a wide range of camera calibration models
- ▶ processing of frame and pushbroom cameras
- ▶ ...

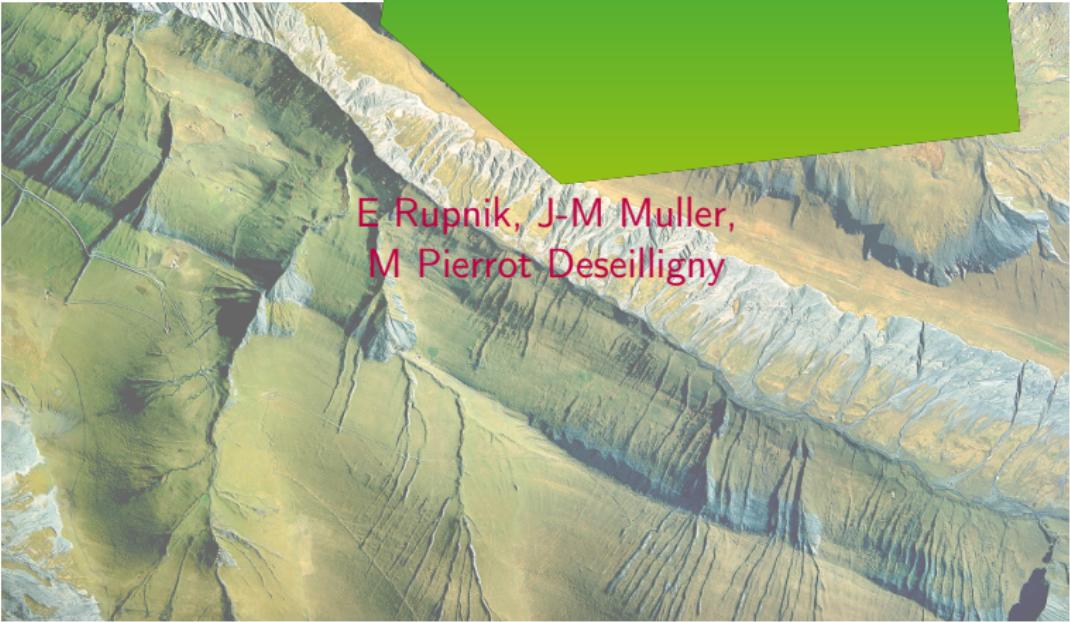
Community

?



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Thank you for your
attention!



A large aerial photograph of a mountainous region, likely the Alps, occupies the bottom half of the slide. The terrain is a mix of green pastures, blue lakes, and rocky mountain peaks. In the center-left of this image, there is a semi-transparent white rectangular box containing the names of the speakers.

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M Pierrot Deseilligny