COBGI2024

Challenges and Opportunities in BIM - GIS integration

Overview of existing extrinsic camera calibration methods for mobile mapping systems

Luka Zalović, mag. ing. geod. et geoinf.

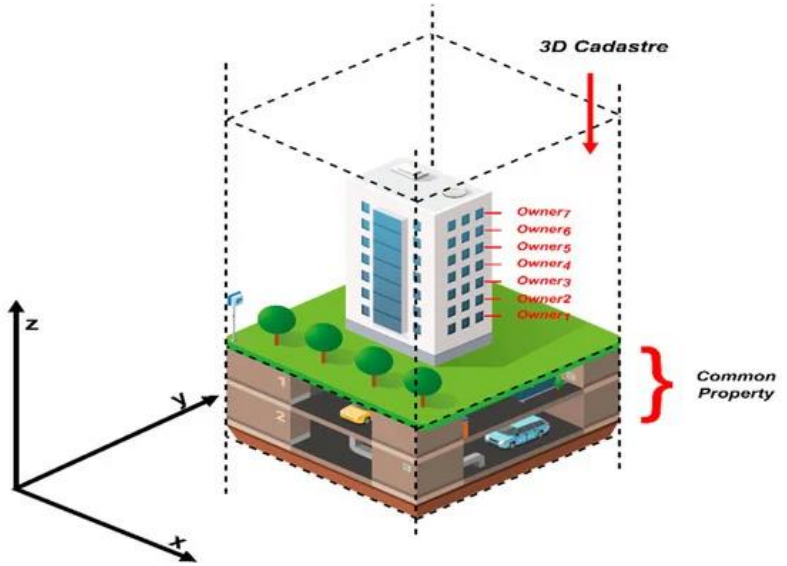
prof. dr. sc. Siniša Mastelić – Ivić

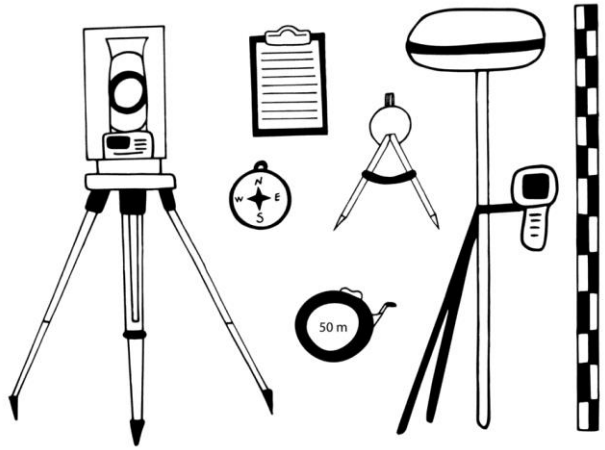
izv. prof. dr. sc. Ante Rončević

Sveučilište Sjever

Introduction

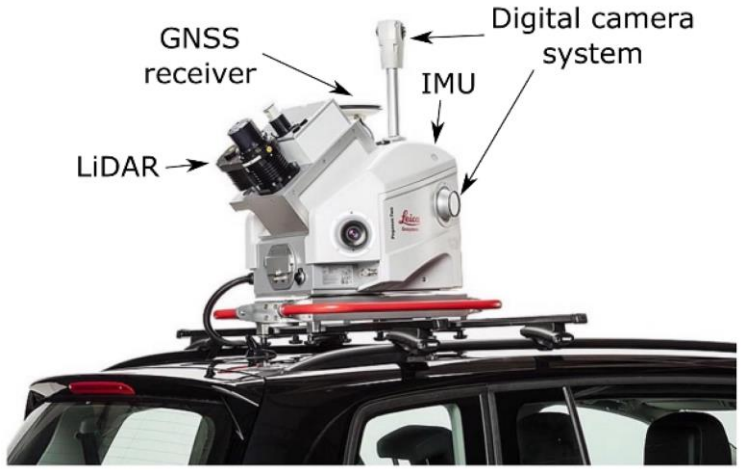
- 2D to 3D transformation
  - 3D GIS
  - BIM
  - 3D cadastre
- traditional data collection methods
- transition to modern data collection methods





Mobile mapping systems (MMS)

- systems on a moving platforms
  - car
  - boat
  - plane / drone
  - user
- integration of multiple sensors
- SLAM technology



Pros and cons of MMS

	PROS	CONS
Vehicle-based MMS	Data quality	Access to objects
Handheld MMS	Flexibility	Camera integration

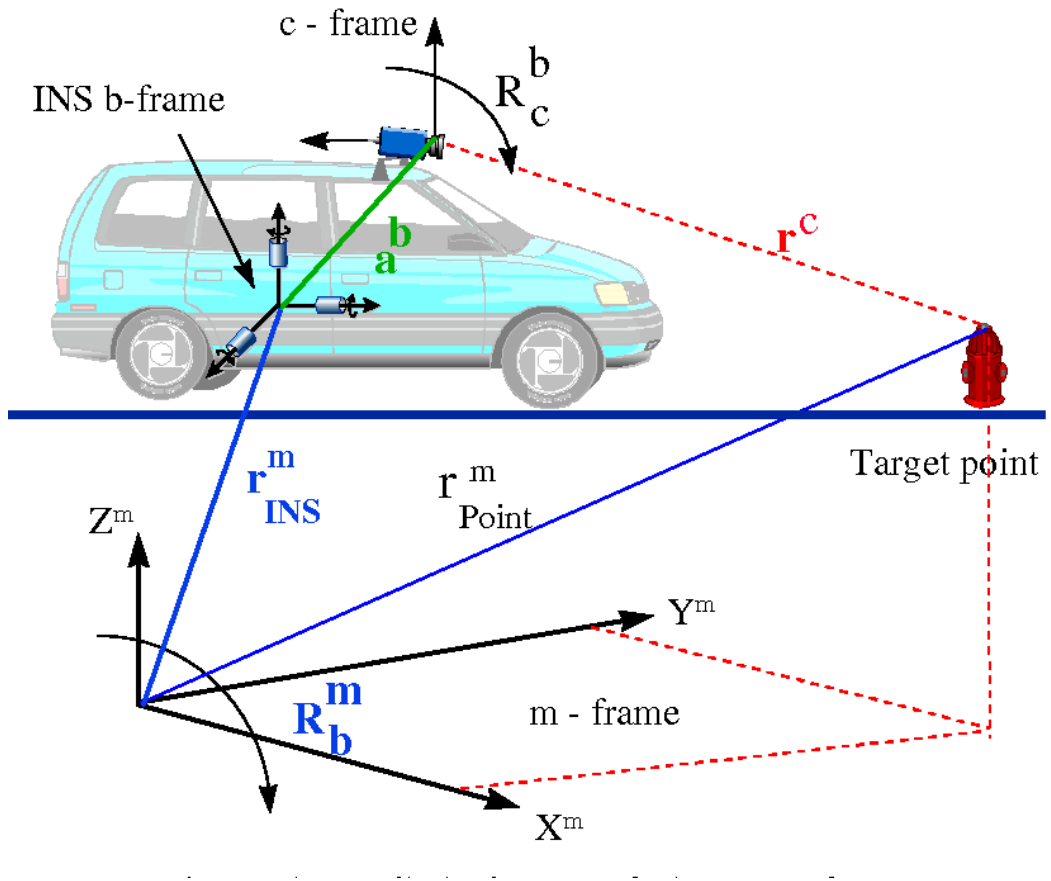
External camera

Integrated camera

No camera

Why do we need a camera?

- camera – oriented (panoramic) imagery
  - visualisation
  - point cloud colorisation
  - monoplotting
- extrinsic calibration
  - c-frame and b-frame relation
  - lever arm and boresight angles
- recalibration?



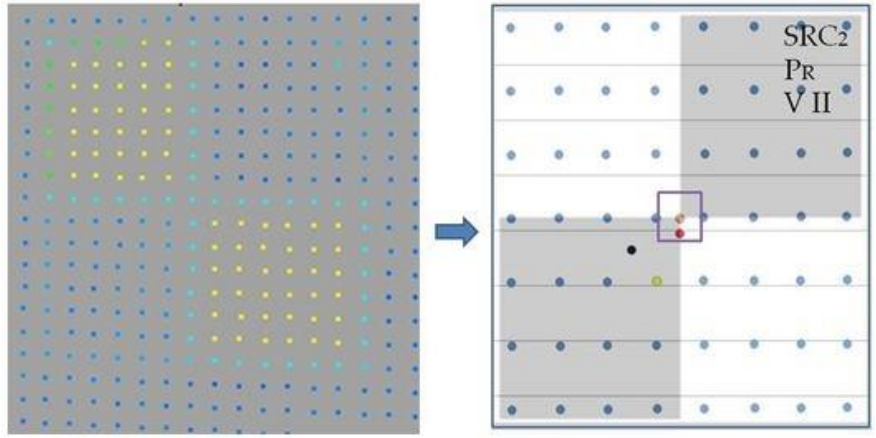
Existing calibration methods

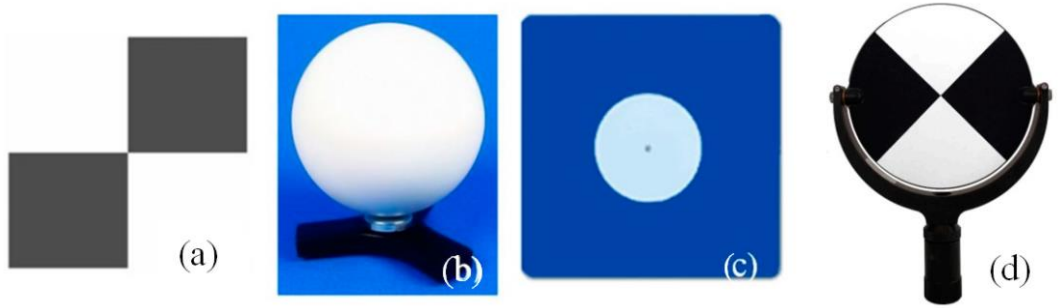
- target based
- feature based
- 3D alignment based
- motion based
- dependence based

- can we use them for both MMS types?

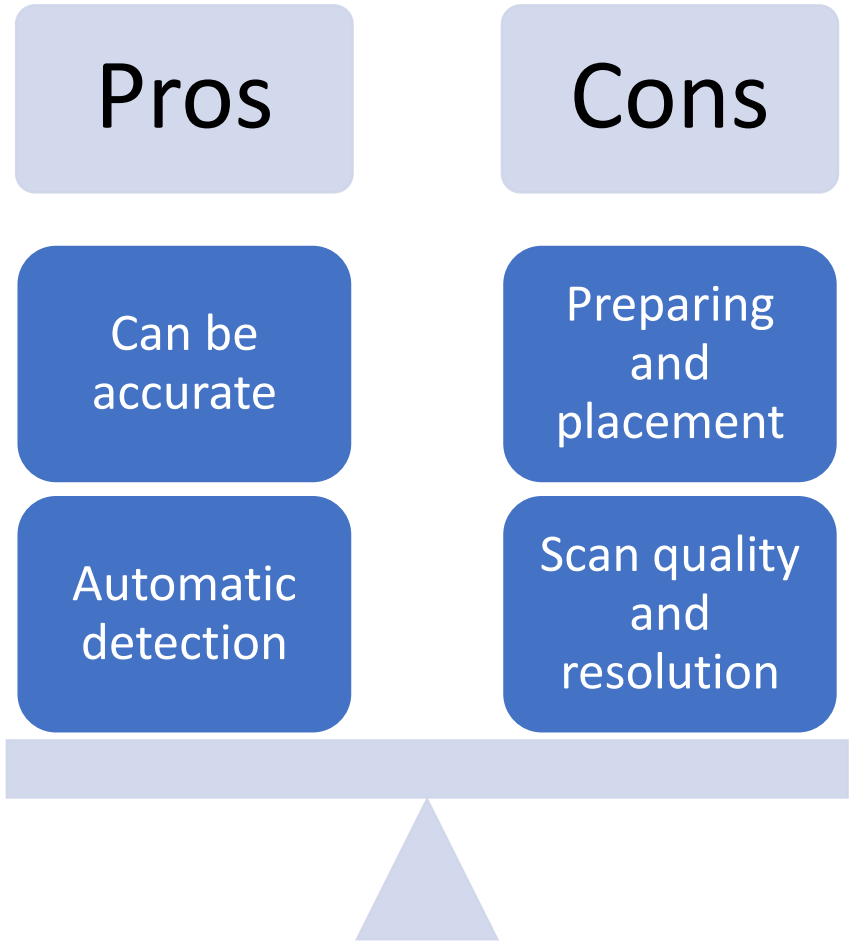
Target based calibration methods

- artificial targets for calibration
  - black-and-white patterns
  - same targets on images and laser scan
- image and scan differences
  - 2D vs 3D
  - resolution
  - scale



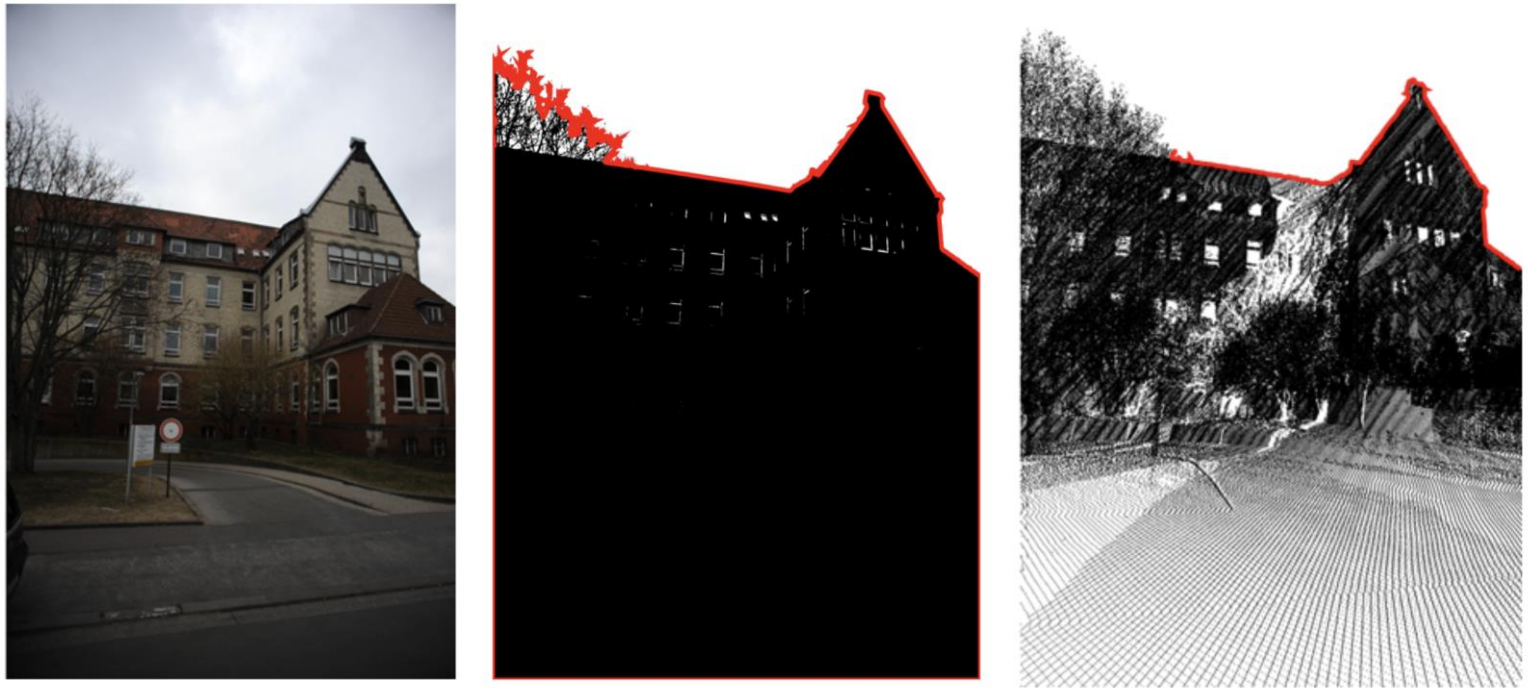


Target based calibration methods

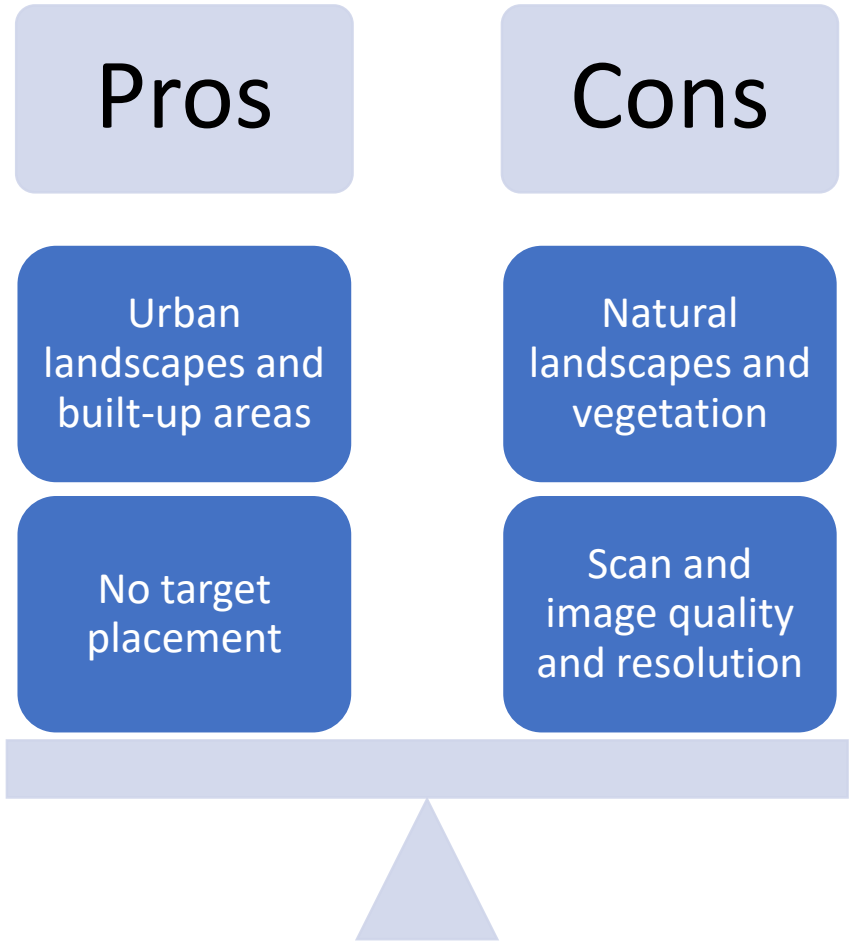


Feature based calibration methods

- non-artificial targets for calibration
  - characteristic points, lines, or shapes
- different approaches:
  - 3D – 3D
  - 3D – 2D
  - 2D – 2D

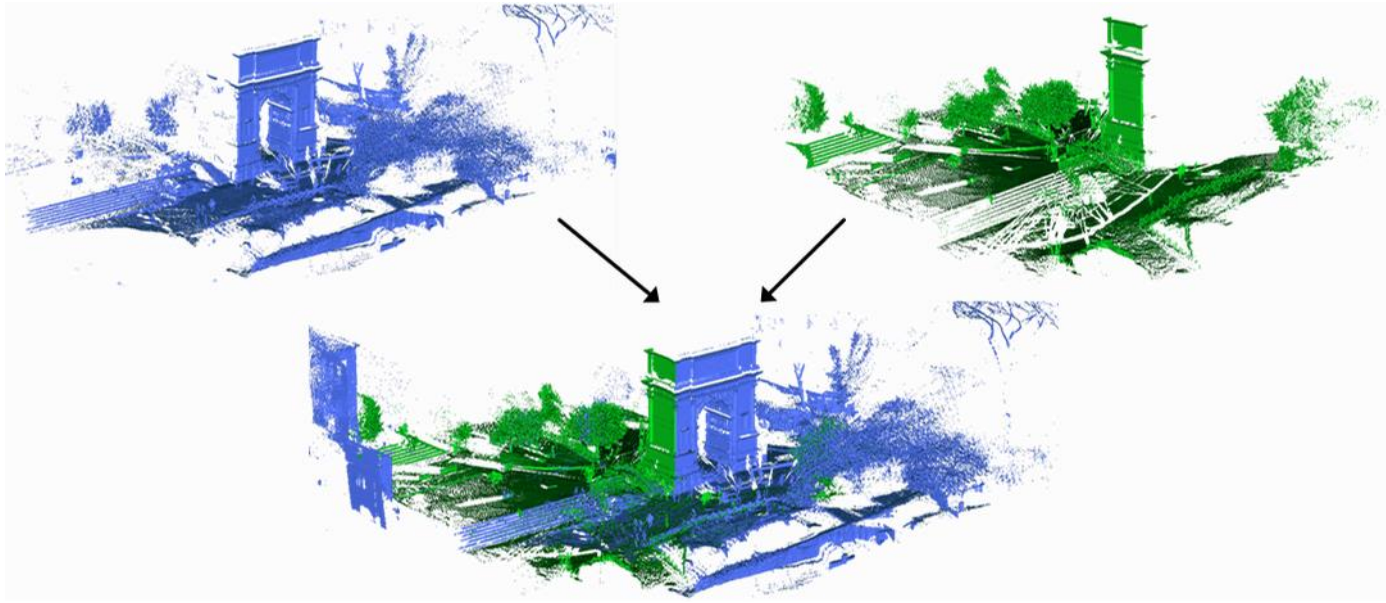


Feature based calibration methods

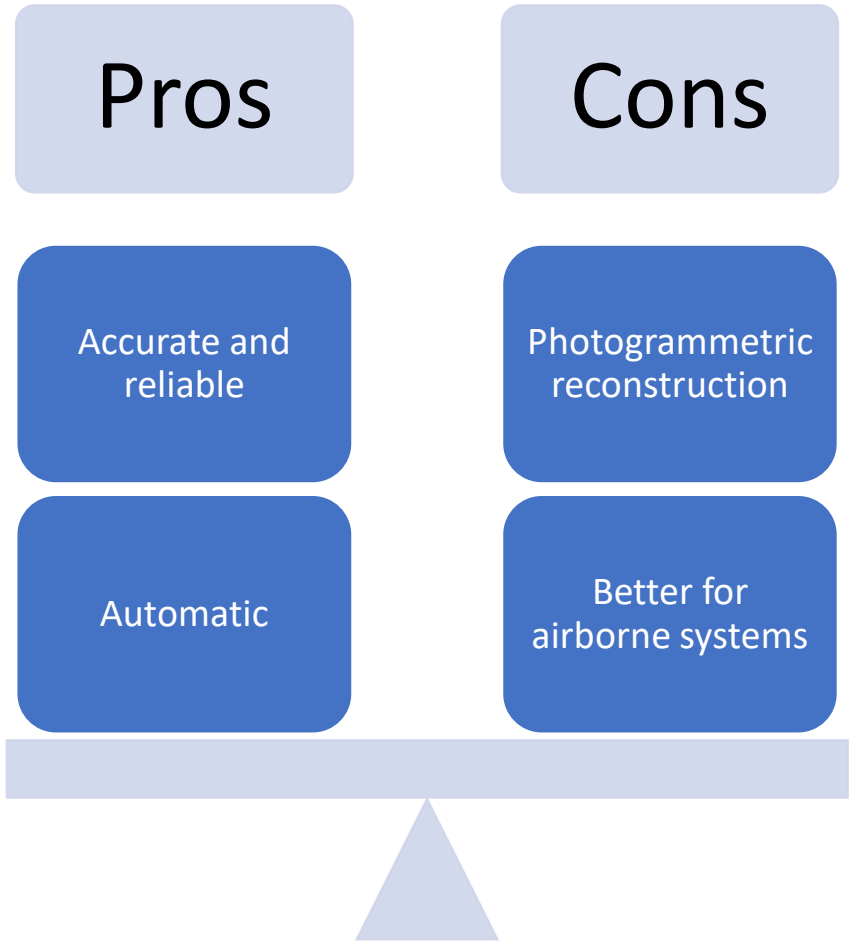


3D alignment based calibration methods

- utilises 2 point clouds
  - laser scan
  - photogrammetric reconstruction from images
- point cloud alignment
  - ICP (Iterative Closest Point)
  - calibration parameters calculation

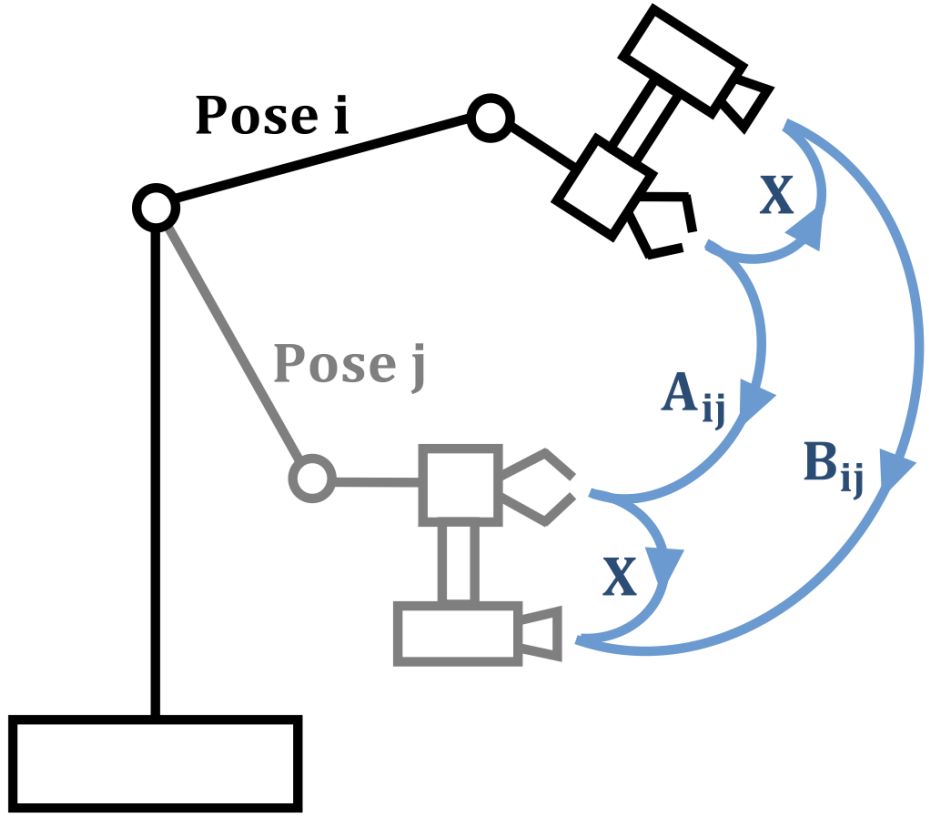


3D alignment based calibration methods



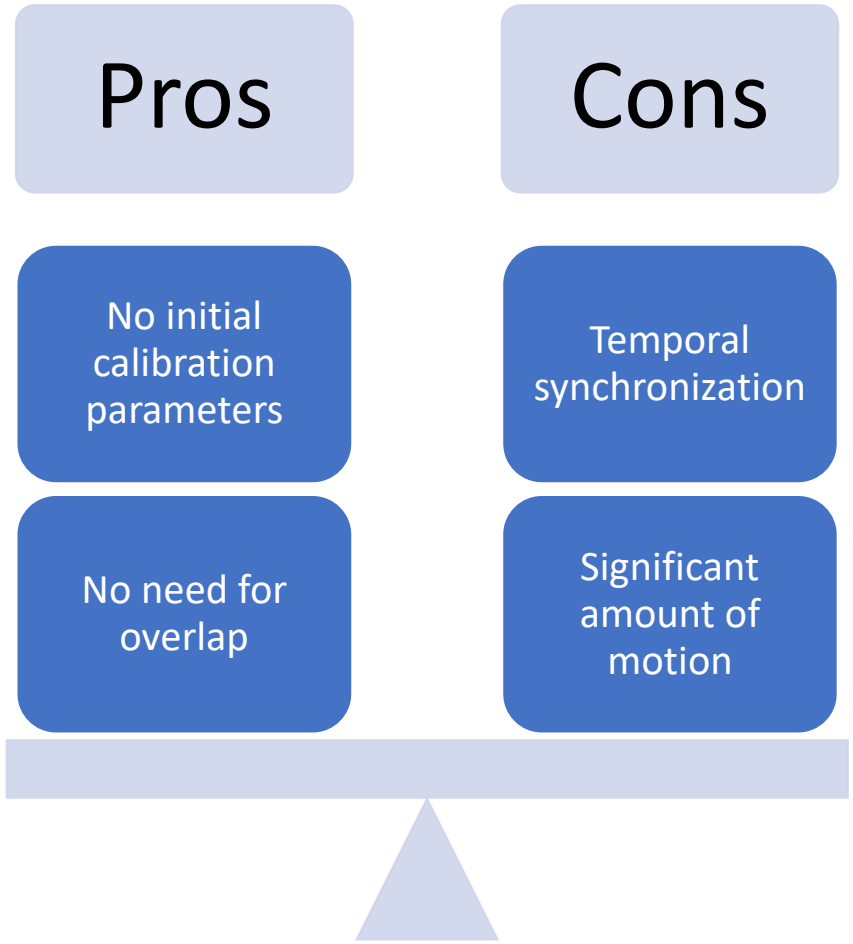
Motion based calibration methods

- calibration using the knowledge of the sensor motion
  - rigidly mounted sensors
  - estimate camera motion (SfM – Structure from Motion)
  - estimate LiDAR sensor motion (ICP – Iterative Closest Point)
- “hand-eye” calibration problem



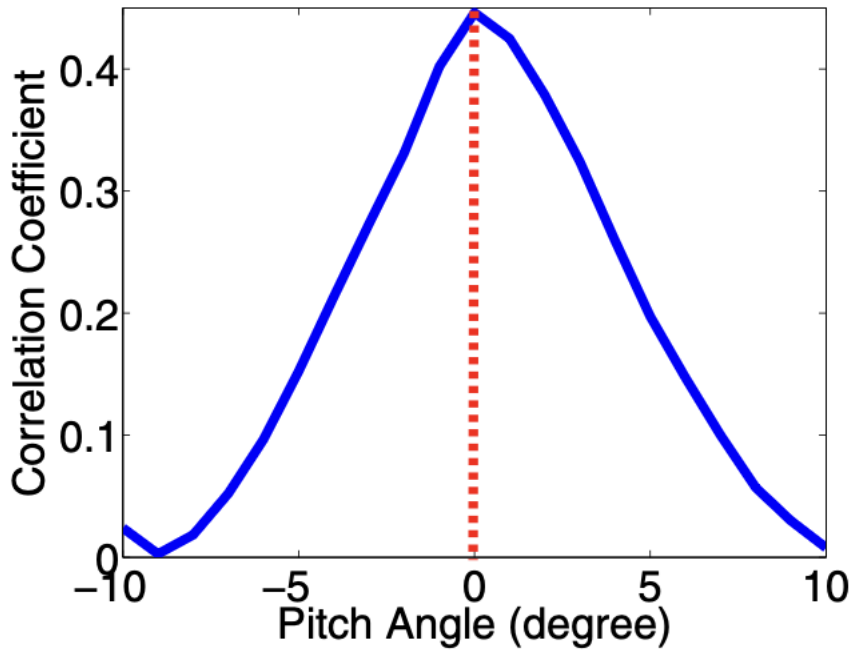
AX = XB

Motion based calibration methods

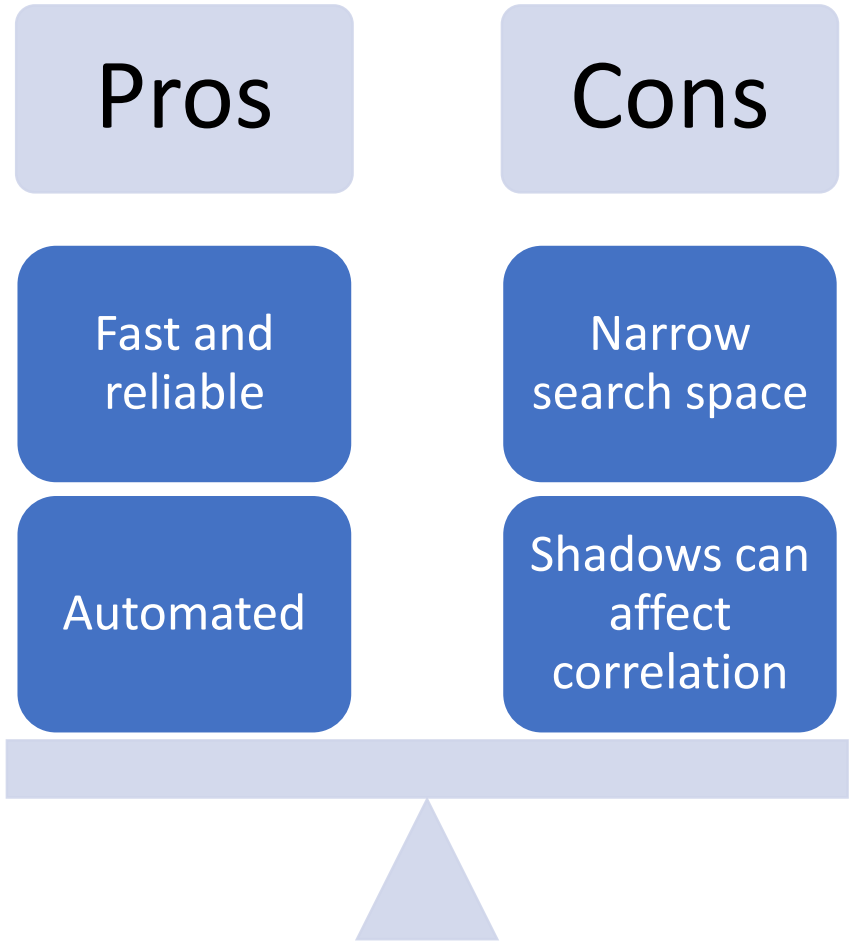


Dependence based calibration methods

- based on the similarity of signals in 2D space
- correlation between signals
  - from laser data (reflectivity)
  - from images (greyscale)



Dependence based calibration methods



Conclusion

- sensor calibration is usually done by manufacturers
- existing camera calibration methods
  - not simple do conduct
  - well suited for vehicle-based MMS
- calibration for handheld MMS
  - should be easy for user to conduct
  - should be objective
  - should utilize specific characteristics of handheld systems

COBGI2024

Challenges and Opportunities in BIM - GIS integration

Thank you!

Sveučilište Sjever

Luka Zalović, mag. ing. geod. et geoinf.

prof. dr. sc. Siniša Mastelić – Ivić

izv. prof. dr. sc. Ante Rončević