

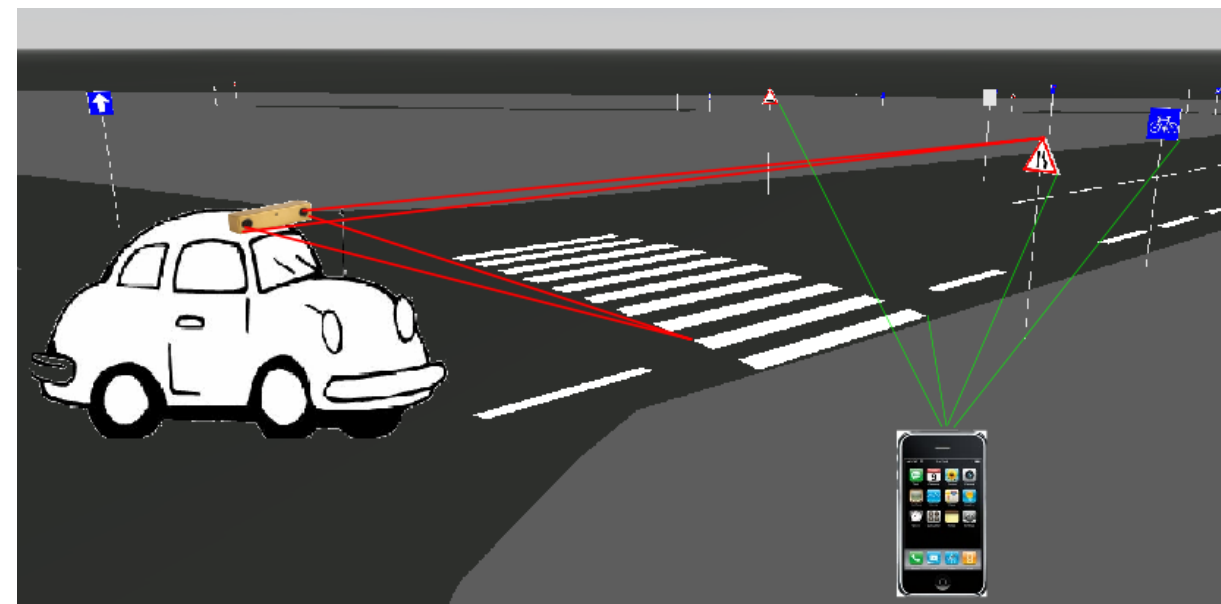
Context

Context:

- GPS suffer from multipath and mask phenomenon in **urban areas** caused by high buildings and trees.
 - High precision INSS are often used to interpolate between the masks of GPS.
 - Very costly.
- Drift of INS leads to decimetric localization errors for **long GPS masks**.
- The state of the art of optical images as localization system is very rich (structure from motion, visual odometry etc.), but they suffer also from drift problem.

Goal : Low cost localization system for update and change detection.

Method : Use georeferenced landmark database as GCP in bundle adjustment with uncertainty analysis.



Visual odometry

– 2D feature detection

- SIFT (*current method*)
- SURF
- Harris

– Feature matching

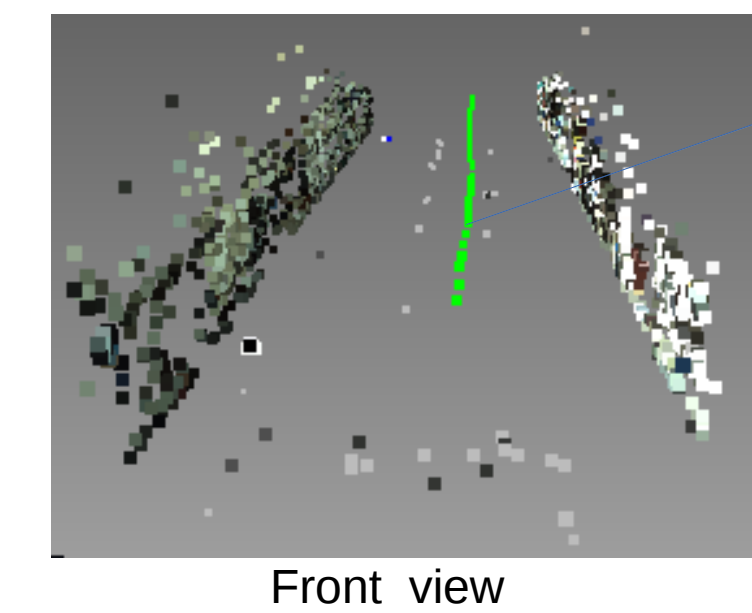
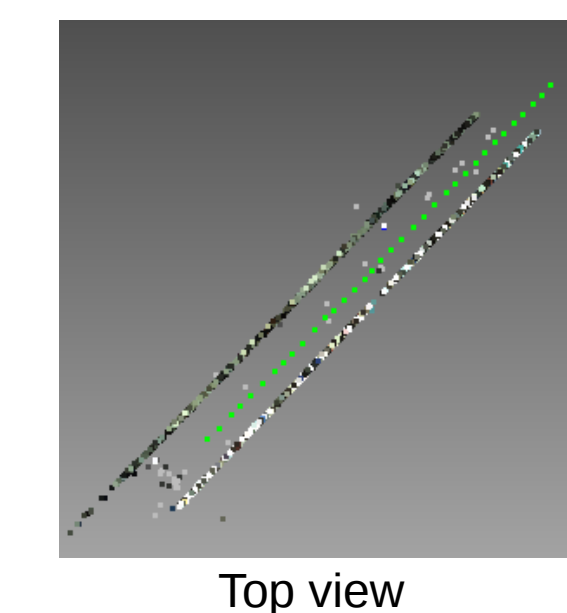
– Robust pose estimation

Right figures show the result of image based pose estimation.



Data :

- Simulated views of a photorealistic 3D model.
- Extrinsic and intrinsic parameters are known.



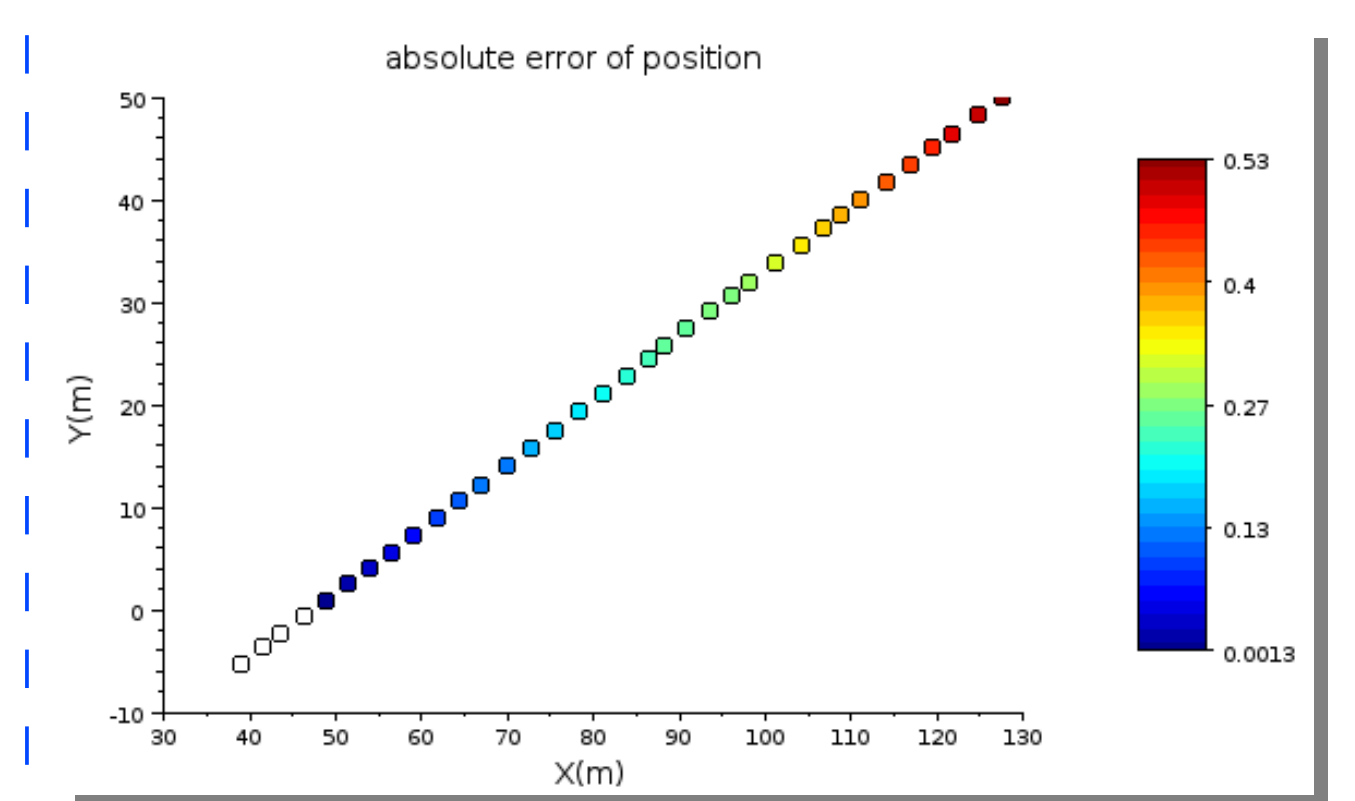
3D camera position

Sparse structure and camera position (Pierre Moulon, et. al)

Experiment of error analysis

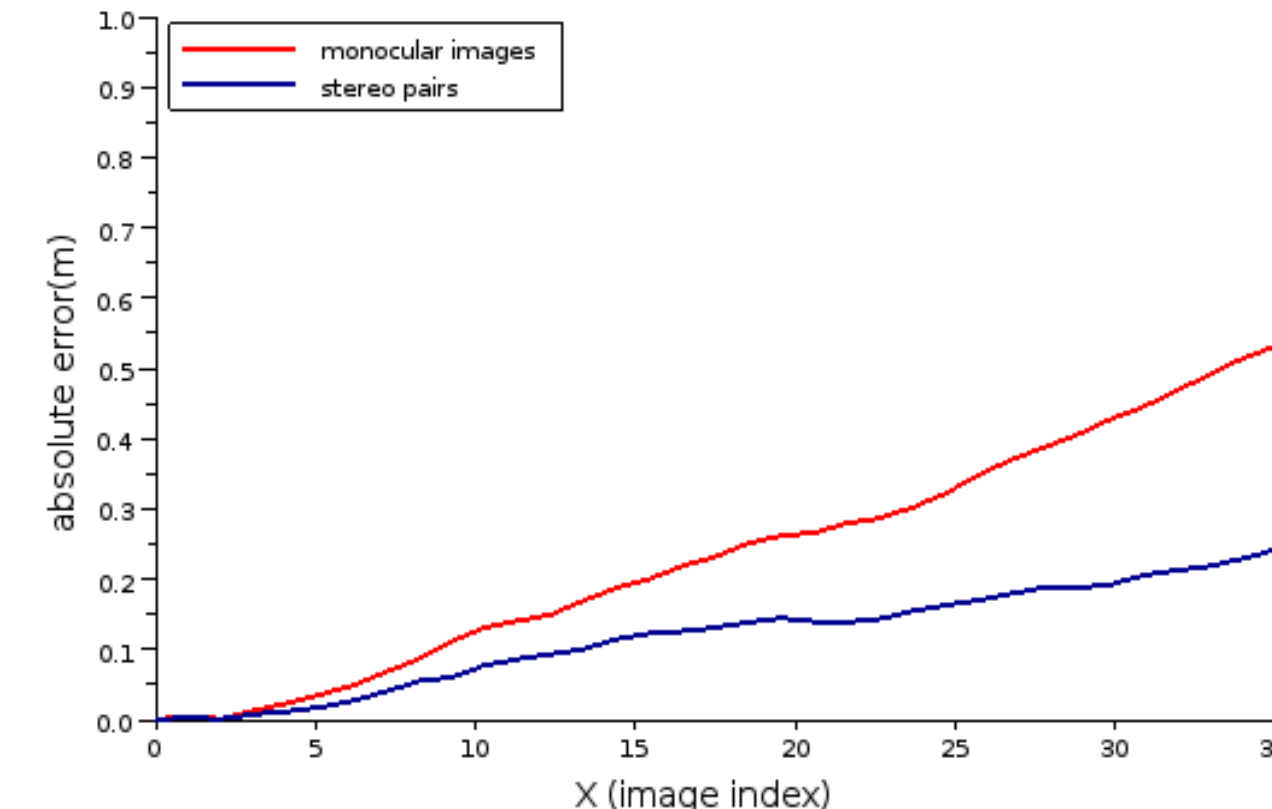
Feature :

- **Simulation images**
 - As showed in last section.
- **Absolute error of position**
 - Difference between known extrinsic parameters of simulated data and our result.
- **Stereo pairs and monocular images.**
- **Bundle adjustment**
 - analyze the result of global and local bundle adjustment (Sameer Agarwal, et. al).
 - limit the search area for local bundle adjustment and add stereo constraint for stereo sequences.

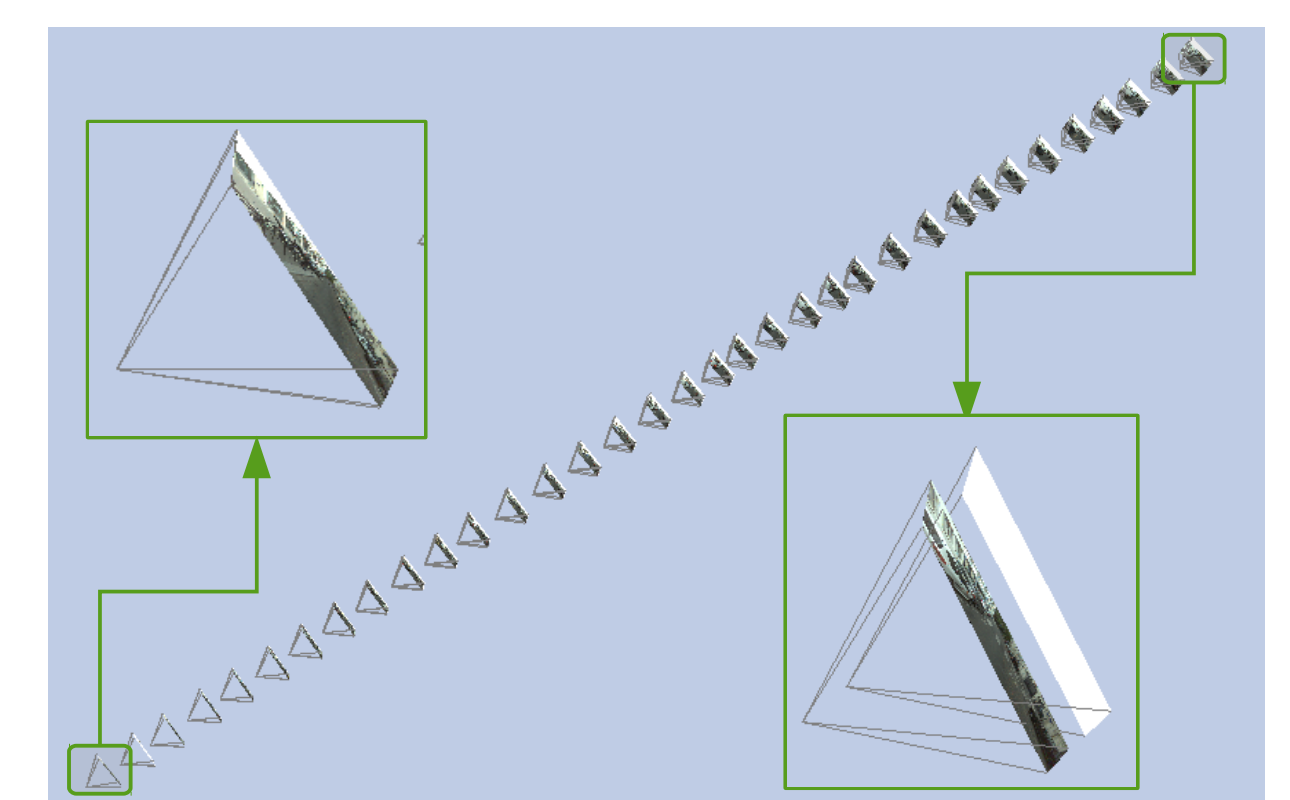


Trajectory and absolute error of camera position, optimized by local bundle adjustment for monocular images.

absolute error of monocular and stereo images for LBA

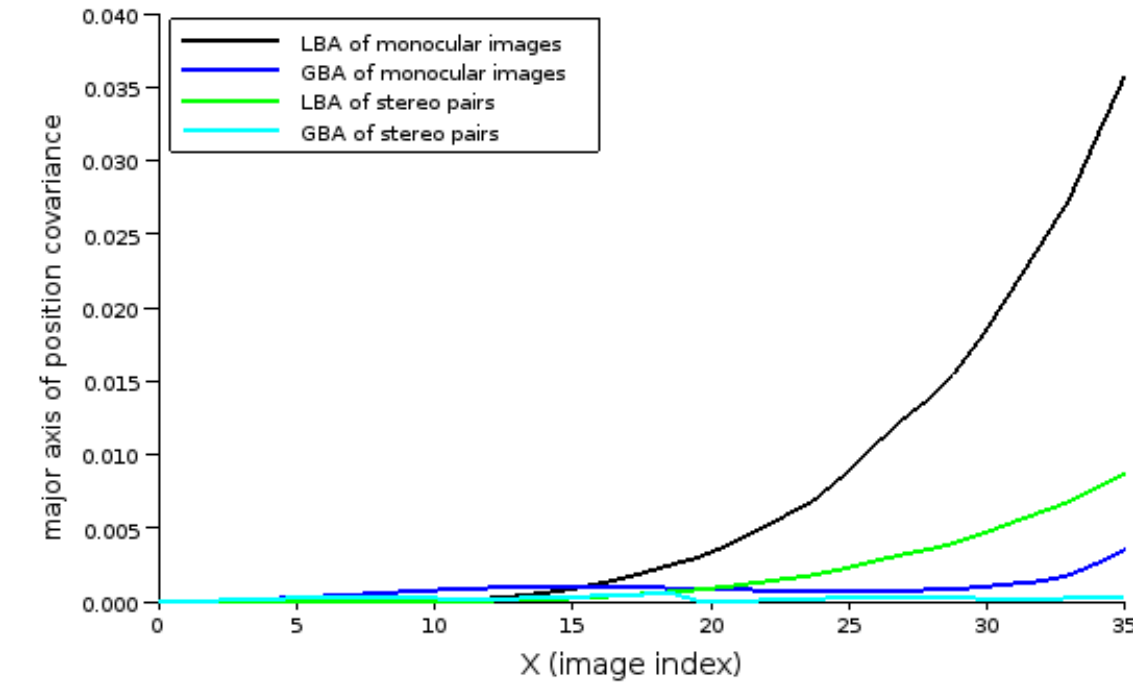


Absolute error of Local Bundle Adjustment for stereo and monocular images, constant constraint used for stereo pairs.



textured rectangle -- reference position
white rectangle -- our result

major axis distribution for monocular and stereo images



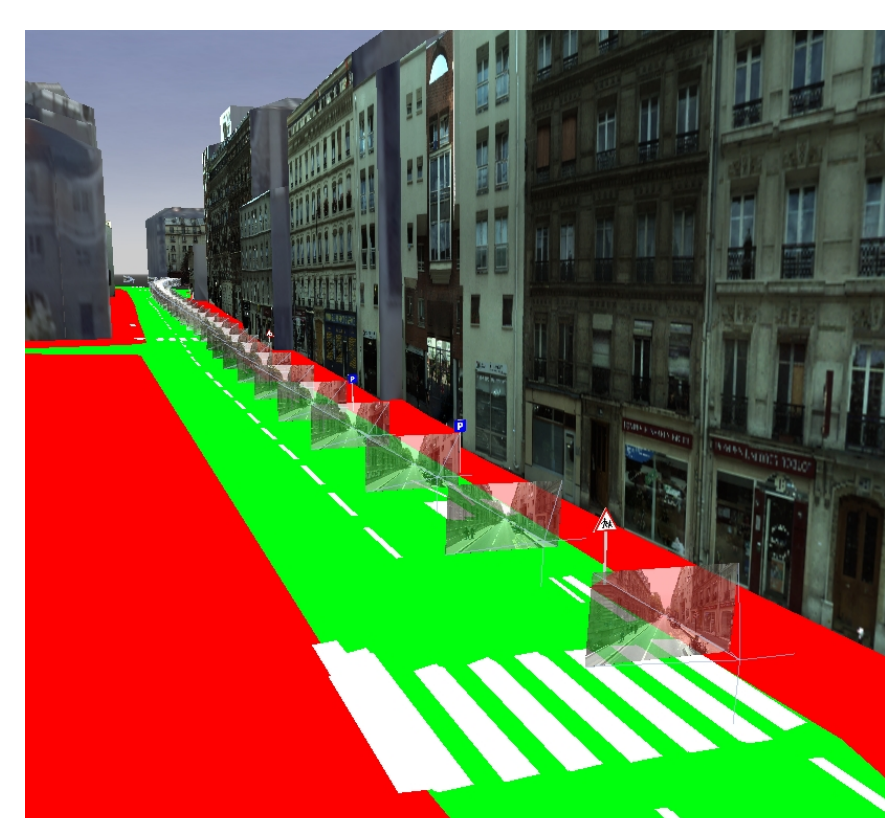
Uncertainty analysis of LBA and GBA

- **LBA** -- local bundle adjustment
- **GBA** -- Global bundle adjustment
- **Major axis**
 - Error ellipsoid's major axis express the uncertainty of corresponding parameters

Georeferenced landmark DB

Three types of landmark are defined in our current database (B. Soheilian, et.al) :

- Road marks
- Road signs
- 3D textured facades



Absolute pose estimation

This research part is not started yet, the future work contains :

- Real-time landmark matching.
- Add different weight for observations during bundle adjustment according the uncertainties.
- Limit or reduce the error propagation of local bundle adjustment.

Conclusion & future work

Conclusion :

- The covariances of camera poses are good references to determine the search area for landmark matching in real-time localization.
- The result of stereo pairs based pose estimation is more reliable than monocular images.
- Local bundle adjustment suffers from error accumulation, compared with global bundle adjustment.

Future work :

- Test the algorithms on real dataset.
- Evaluate the data on video sequences.
- Consider the impact of image distortion on pose estimation and self-calibration.

Cadre de la thèse

- Inscrit à l'Université PARIS-EST en Octobre 2013
- Réalisée au laboratoire MATIS de l'IGN
- Direction : Nicolas Paparoditis.
- Encadrement : Bahman Soheilian, Bertrand Cannelle
- École doctorale : MSTIC

Références

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- Pierre Moulon, Pascal Monasse, Renaud Marlet, "Adaptive Structure from Motion with a Contrario Model Estimation", *ACCV, Volume 7727, pp 257-270, 2013.*
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- A. Eudes and M. Lhuillier, "Error propagations for local bundle adjustment" *2009 IEEE Conf. CVPR, pp. 2411-2418, Jun. 2009.*

