VISUAL LANDMARK-BASED OUTDOOR LOCALIZATION FOR MAVS

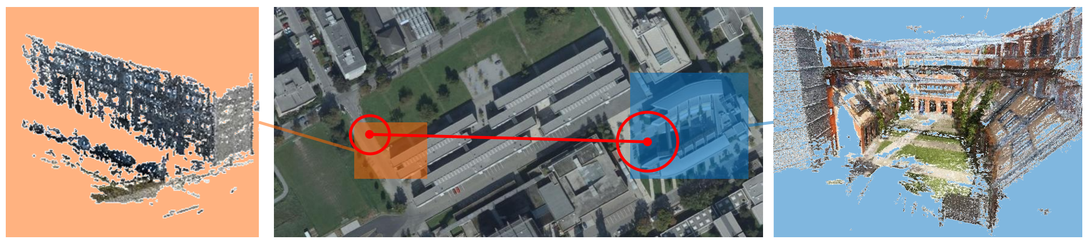
Wendel A., Irschara A., Bischof H.

Institute for Computer Graphics and Vision, Graz University of Technology
{wendel, irschara, bischof}@icg.tugraz.at

Abstract Highly accurate localization of a micro aerial vehicle (MAV) with respect to a scene is important for a wide range of applications, in particular surveillance and inspection. We introduce approaches for robust reconstruction of suitable visual landmarks, for the alignment in a world coordinate system, and for fast monocular visual localization based on the concept of virtual views in 3D space. Our system outperforms not only state-of-the-art visual SLAM but also consumer-grade GPS systems.

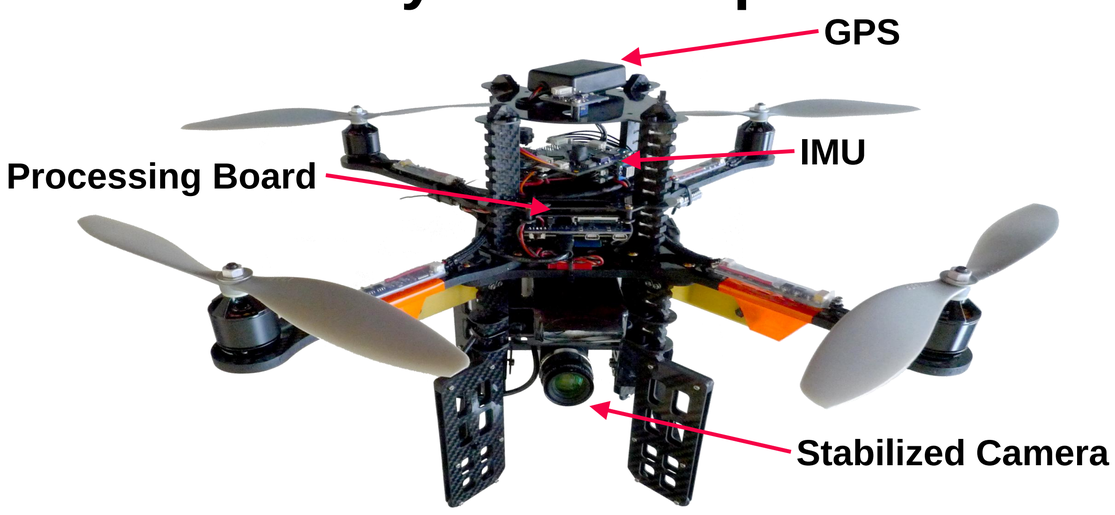
Motivation

Applications such as inspection and surveillance in urban environments require accurate MAV navigation.



- Large scale: GPS waypoint navigation is suitable
- Small scale, close-up: GPS is „blind“ and inaccurate, ***navigation within visual landmarks is required!***

System Setup



We use an AscTec Pelican MAV running ROS [1] on-board.

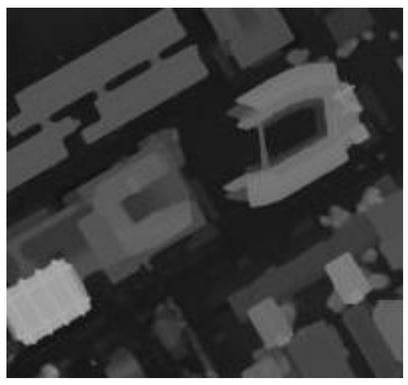
Robust Structure from Motion [4]

Feature Extraction → Image Matching → Geometric Verification → Track Generation

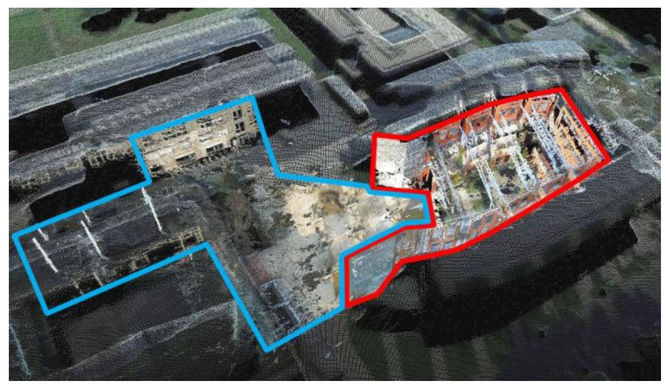
Initial Structure from Motion → Bundle Adjustment → Semi-Dense Matching → 3D Visual Landmark

GPU/CPU Speedup: 10-20

Accurate Geo-Alignment [2]



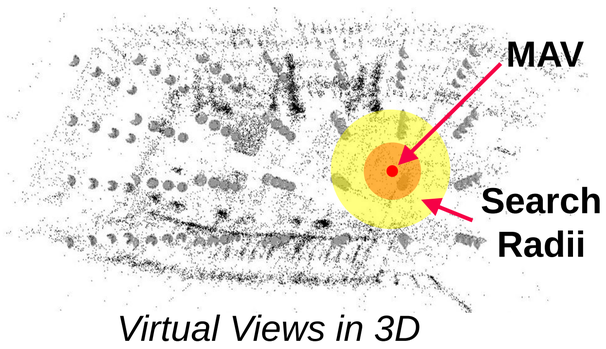
Digital Surface Model



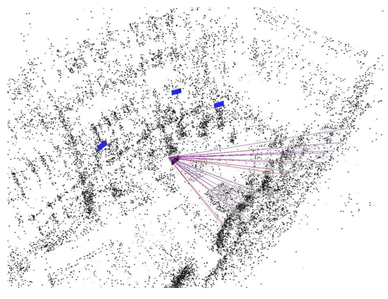
Two geo-aligned models

- Rough alignment to a Digital Surface Model using GPS
- Precise alignment by 2D correlation of the DSM height map and the SfM model height map

Fast Monocular Localization [4]



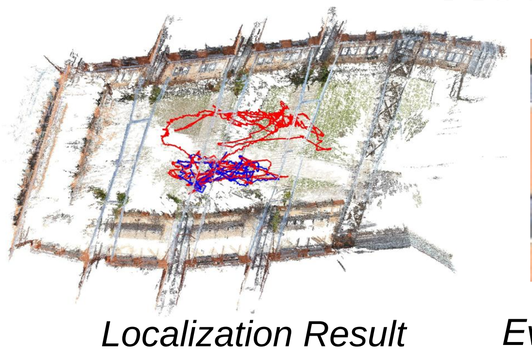
Virtual Views in 3D



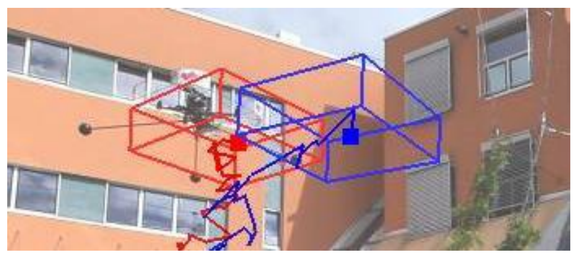
Absolute Pose

- Absolute pose estimation: online processing based on virtual views in 3D and motion-constrained matching (4 fps)
- Computation is only feasible on the ground using a GPU, so a trade-off is to use IMU data for short term localization and to incorporate the visual information as corrections

Results



Localization Result



Evaluation from an observer’s view

- In contrast to visual SLAM, our approach requires a model but is neither prone to drift nor bias
- We achieve a localization error < 0.5m in 92% of all frames, and our algorithm (red) outperforms PTAM [3] (blue) and customer-grade GPS systems

References

[1] Robotics Operating System. http://www.ros.org.
[2] A. Wendel, A. Irschara, and H. Bischof. Automatic Alignment of 3D Reconstructions using a Digital Surface Model. In Proc. CVPR Workshop on Aerial Video Processing, 2011.
[3] G. Klein and D.W. Murray. Parallel tracking and mapping for small AR workspaces. In Proc. of ISMAR, 2007.
[4] A. Wendel, A. Irschara, and H. Bischof. Natural Landmark-based Monocular Localization for MAVs. In Proc. of ICRA, 2011.

Acknowledgments
This work has been supported by the Austrian Research Promotion Agency (FFG) project FIT-IT Pegasus (825841/10397).

Supplementary material
Demo videos can be found at http://aerial.icg.tugraz.at