Pointclouds Integration from Aerial and Ground Exploiting Normal Vector and Pose Graph Optimization

Reference

[1] G. Kim, S. Choi, and A. Kim, “Scan context++: Structural place recognition robust to rotation and lateral variations in urban environments,” IEEE Trans. Robot., vol. 38, no. 3, pp. 1856–1874, 2022.

[2] B. Kim, M. Kaess, L. Fletcher, J. Leonard, A. Bachrach, N. Roy, and S. Teller, “Multiple relative pose graphs for robust cooperative mapping,” in Proc. IEEE Intl. Conf. on Control, Automat. and Robot., 2010.

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Summary

Integration of pointcloud maps from different platforms

- Pointcloud Integration requiring two maps and one trajectory
- Compatible with any algorithms if requirements are given as a result

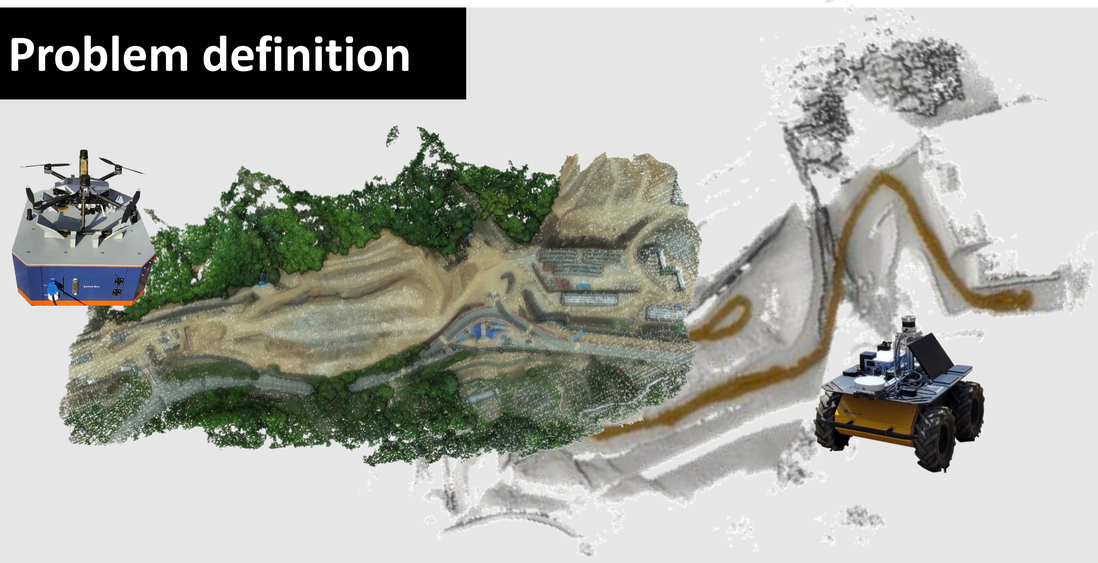
One Point Matching by Scan-Context[1] based on Normal Vector

- Searching only a pair of loops in an unstructured environment

Pose Graph Optimization(PGO) for two graphs[2];
The Virtual trajectory of UAV and actual trajectory of UGV

- PGO to locate the UGV trajectory on the UAV map

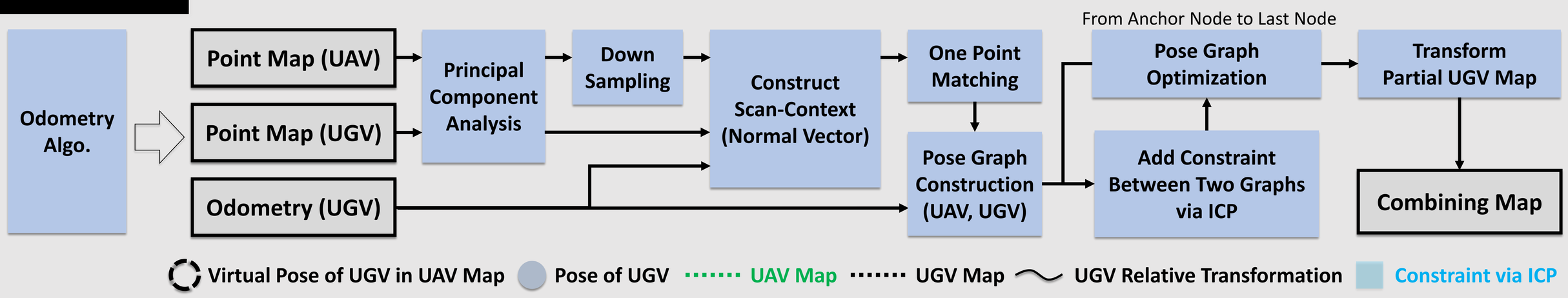
Problem definition

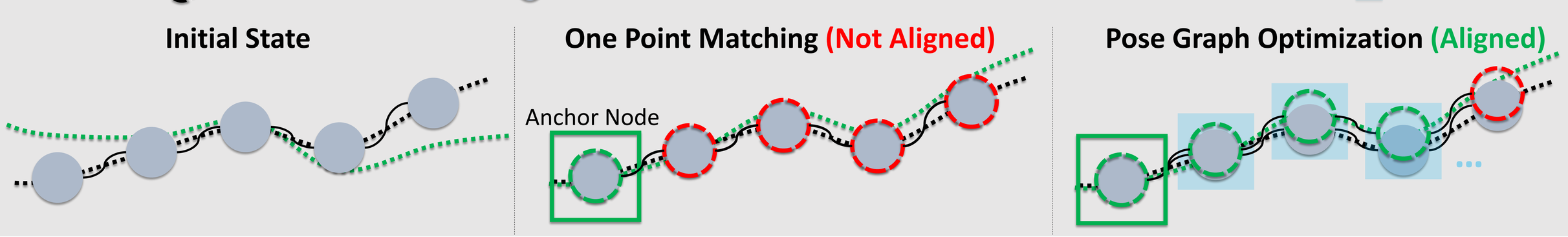


Input : Two Pointclouds and One Trajectory

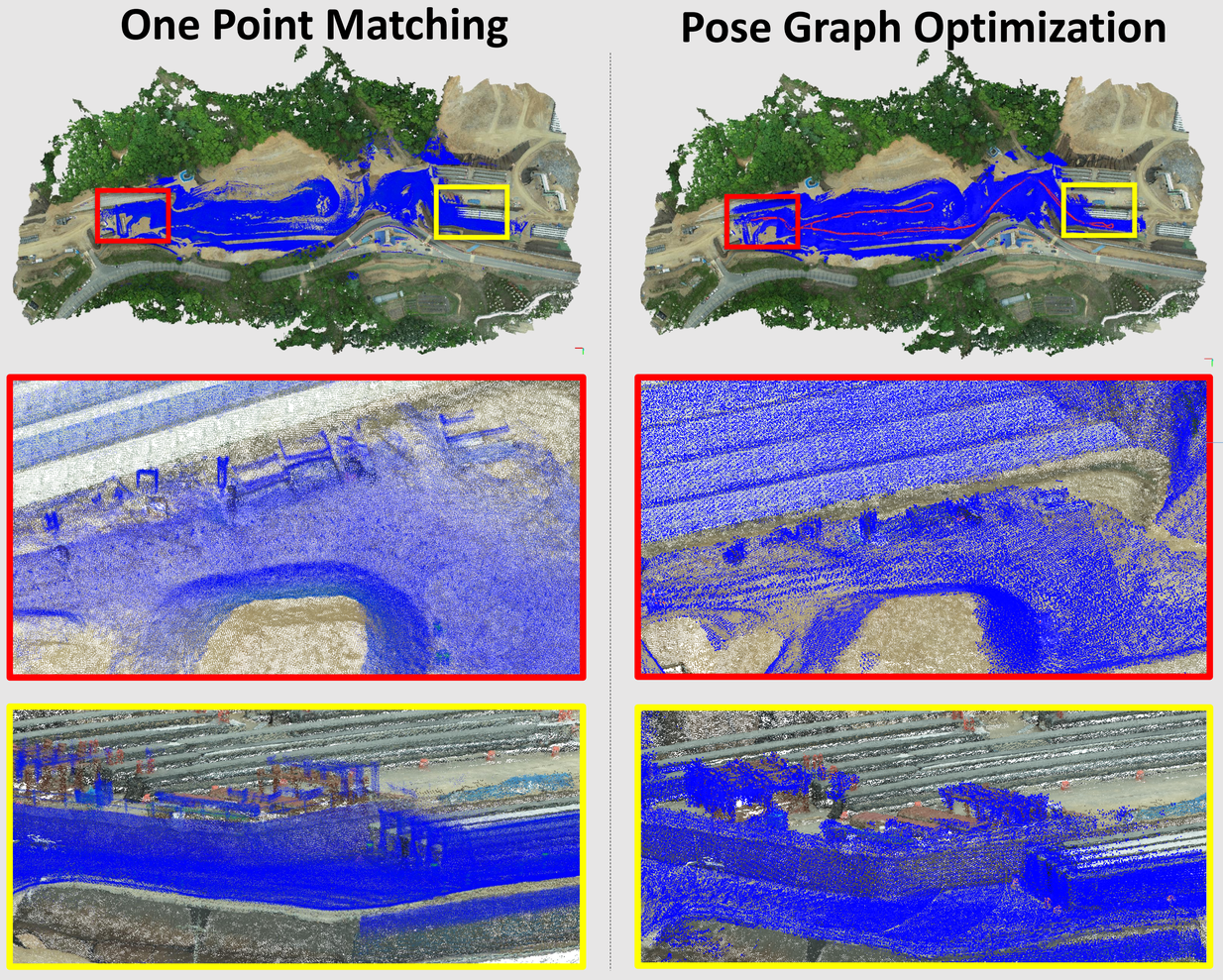
Output : Integrated Pointcloud Map

Method





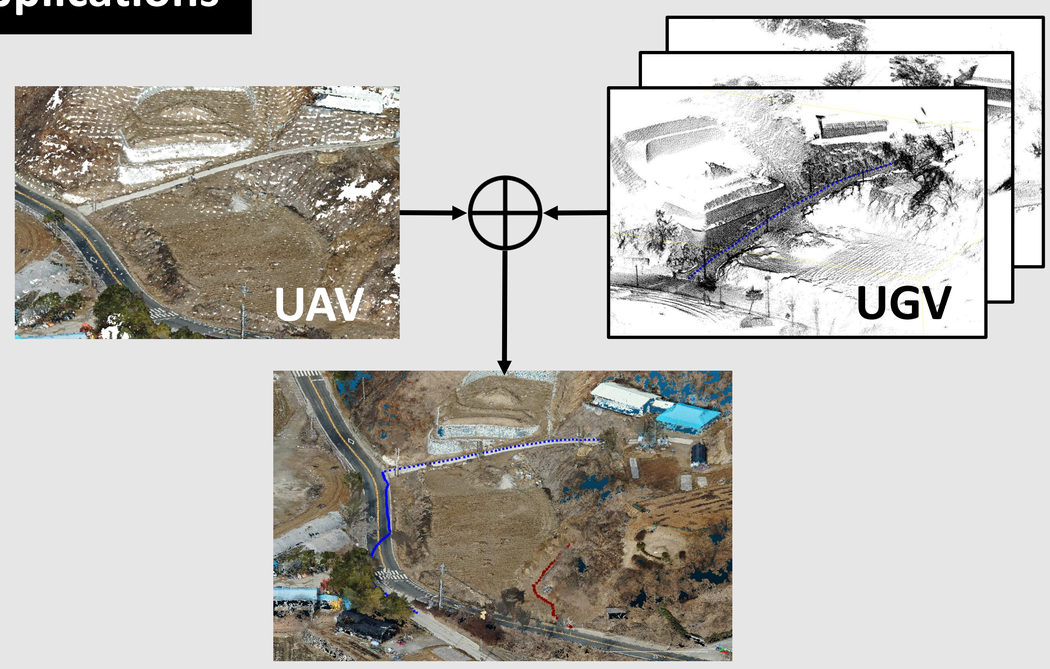
Results



Integrated Pointclouds After One Point Matching and PGO

- Induced a large error at ends of the map by One Point Matching.
- Aligned each pointcloud maps by PGO, not only on the whole but also on the details.

Applications



Colorized UGV point exploiting nearest UAV point

- Combined the camera based map with UGV maps
- Possible to colorize the UGV points

Conclusion

- Introduced the system to integrate pointcloud maps acquired by different platforms entirely.
- Constructed scan-context based on Normal Vector, being robust for unstructured environment and different FOV.
- Located the UGV trajectory on the UAV map utilizing PGO.