

## Semester Thesis

# Handheld Augmented Reality for Robotic Excavators

**Autumn Term 2023**



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**Robot Localization using Visual Features on LiDAR Data**  
is original work which I alone have authored and which is written in my own words.<sup>1</sup>

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# Preface

The aspiration for this project was to contribute to the process of making use of new technology in order to assist humankind.

# Abstract

My endeavour in this thesis was to combine state-of-the-art computer vision methods with the new possibilities that the denser LiDAR sensors provide us with in order to achieve motion estimation. To do so I made use of detected 2D visual features on projected LiDAR data in order to establish point correspondences on subsequent frames. These matches could then be used for the closed form solution to solve the point cloud alignment problem. I also put emphasis on researching different feature extraction and descriptor methods (ORB, BRISK, KLT..) and the comparison of their performance on the projections of the different kinds of complementary data considered.

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# Appendix A

## Additional Plots

### A.1 ORB Comparison Plots

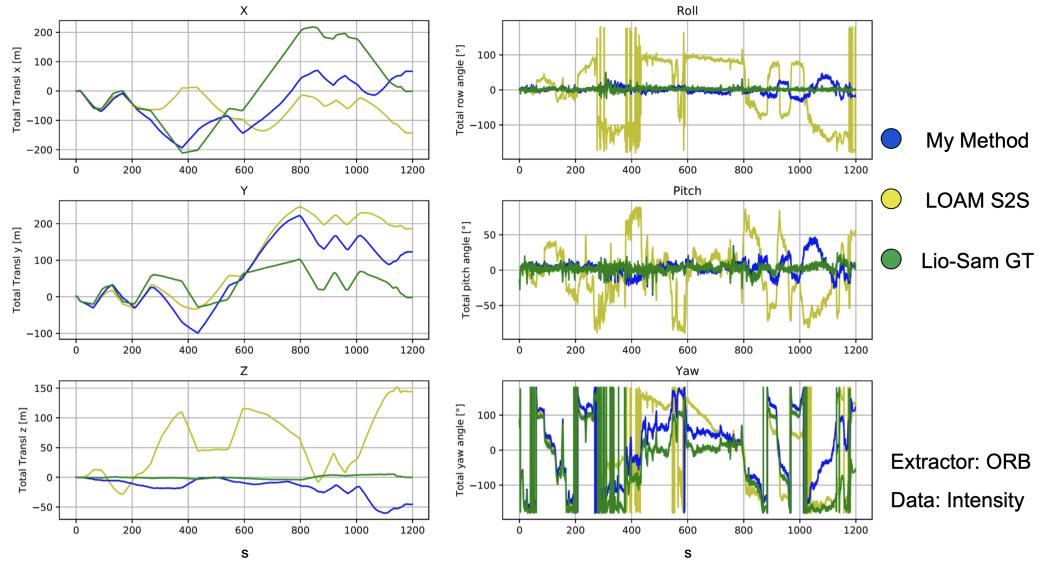


Figure A.1: Pose comparison orb

### A.1. ORB Comparison Plots

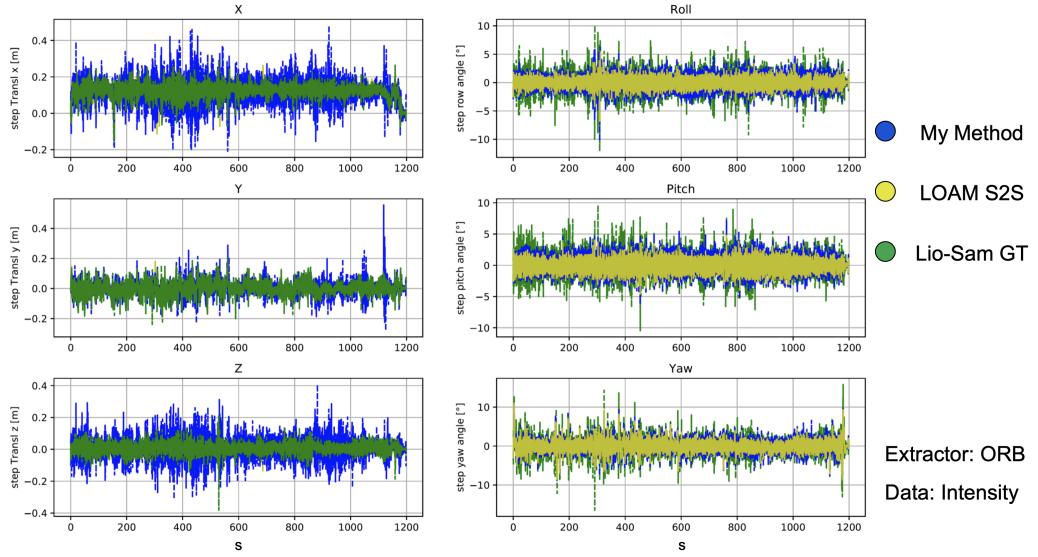


Figure A.2: Step comparison orb

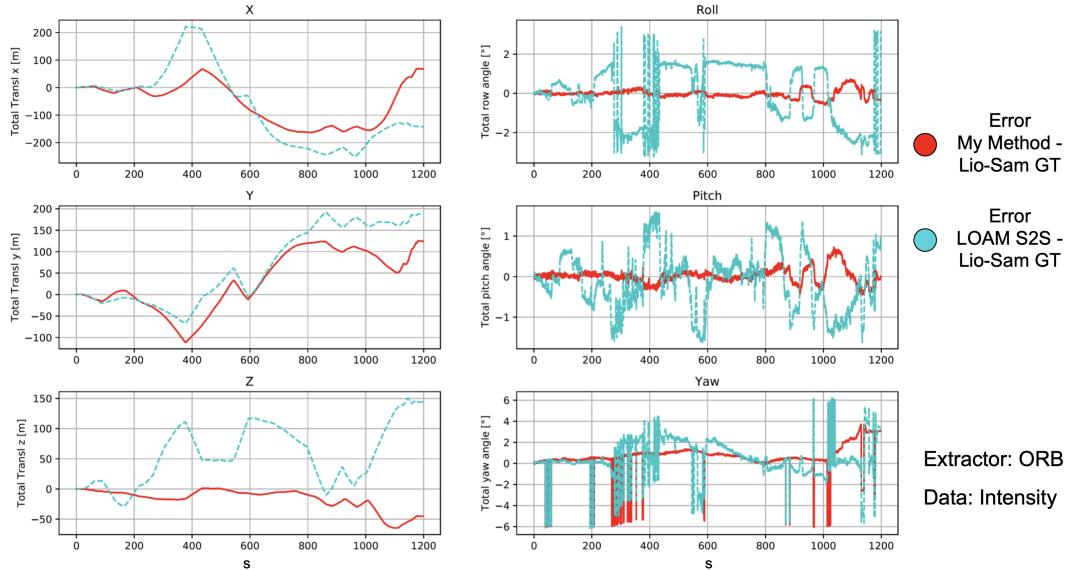


Figure A.3: Pose error comparison orb

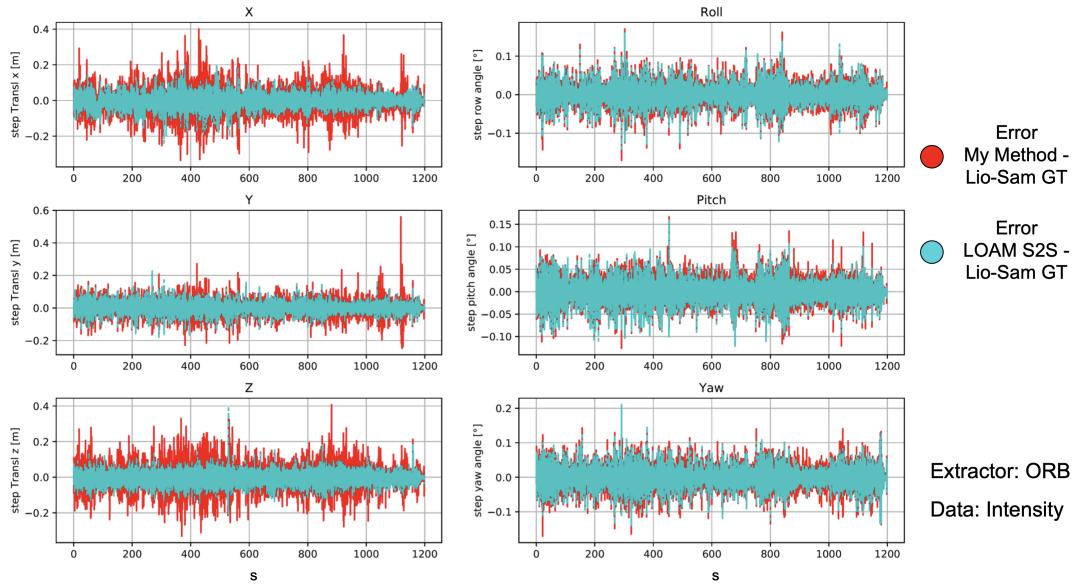


Figure A.4: Step error comparison orb

## A.2 BRISK Comparison Plots

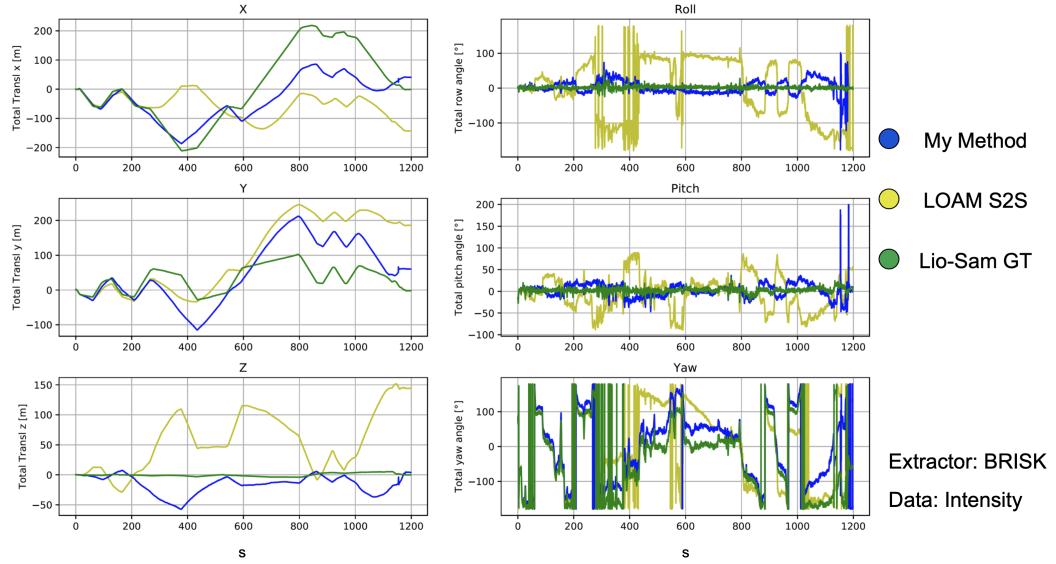


Figure A.5: Pose comparison brisk

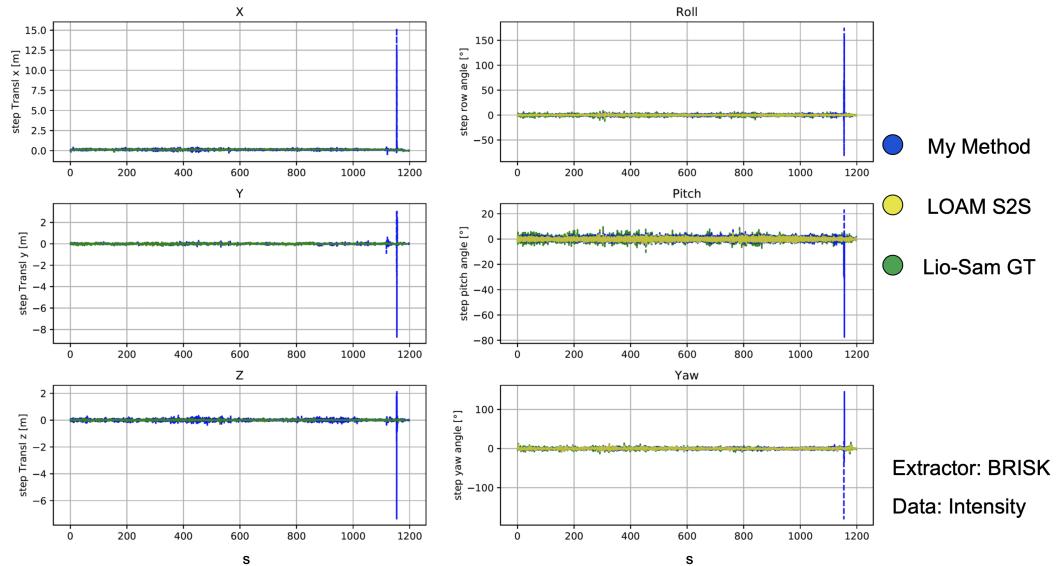


Figure A.6: Step comparison brisk

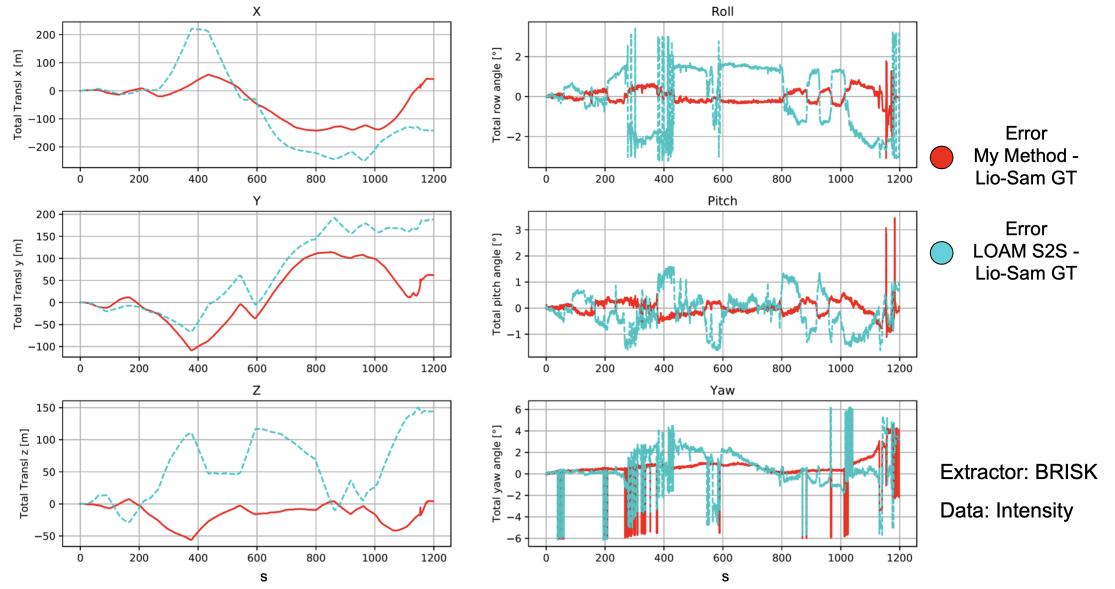


Figure A.7: Pose error comparison brisk

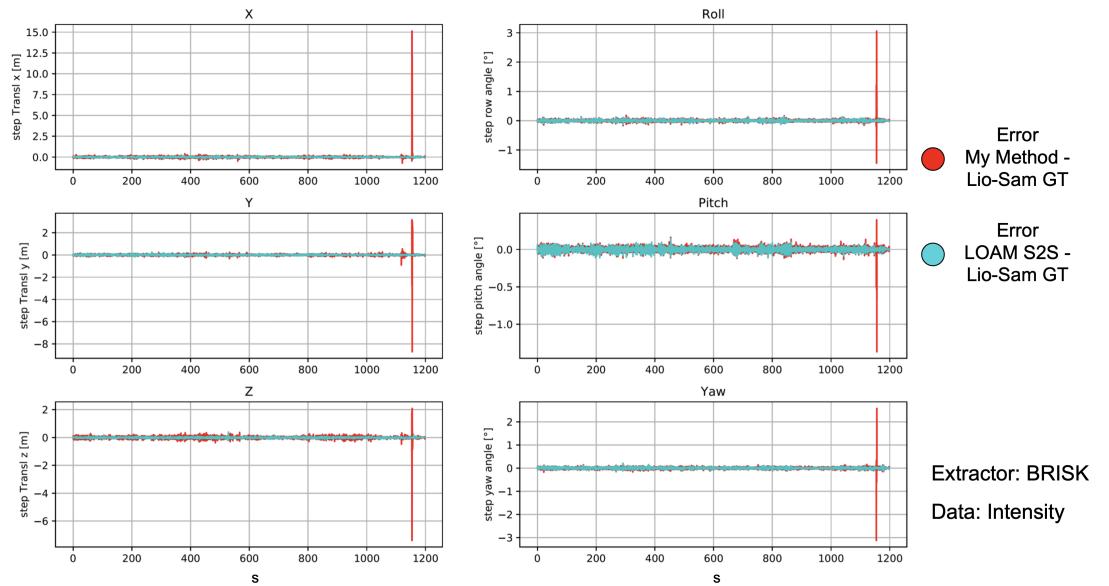


Figure A.8: Step error comparison brisk

### A.3 KLT Comparison Plots

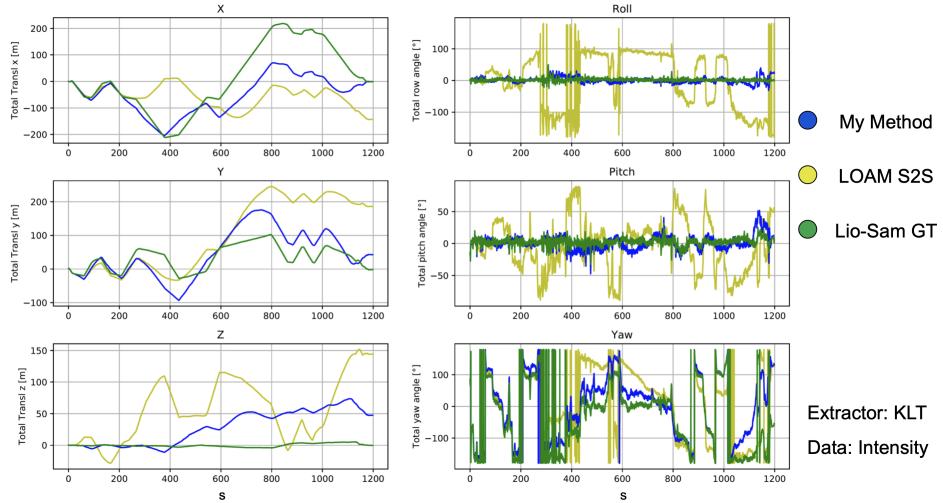


Figure A.9: Pose comparison klt

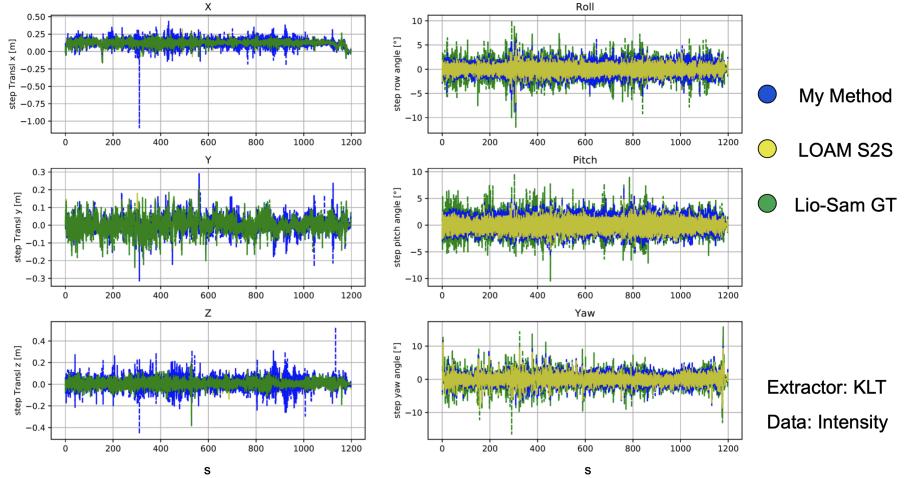


Figure A.10: Step comparison klt

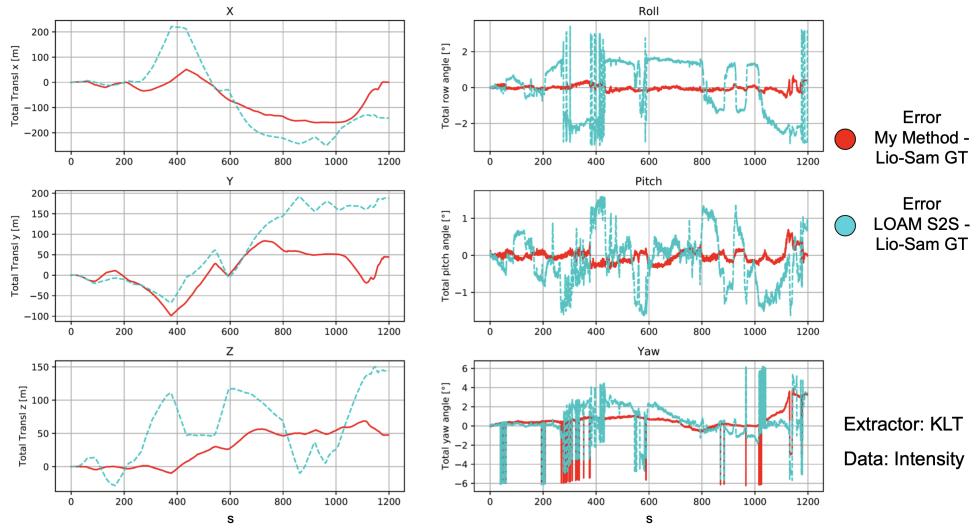


Figure A.11: Pose error comparison klt

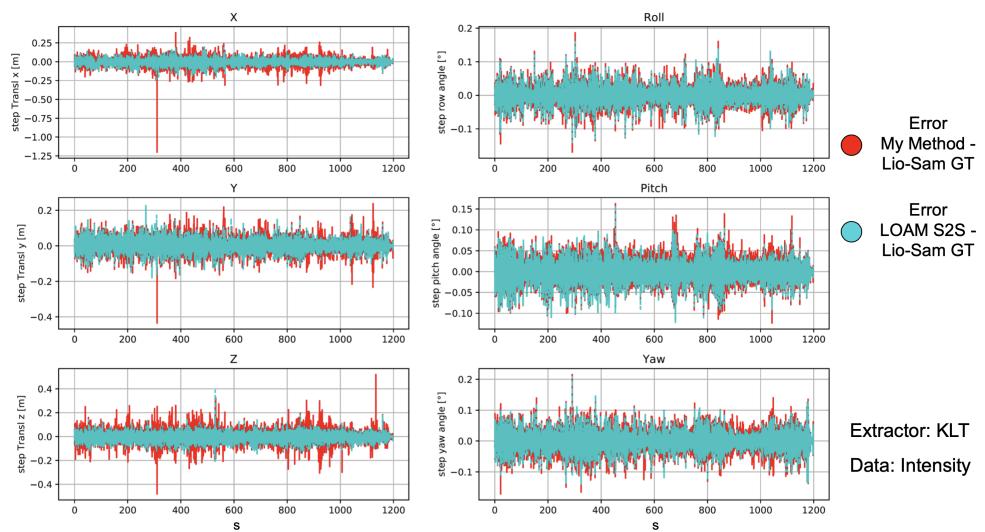


Figure A.12: Step error comparison klt

## A.4 Intensity Data Comparison Plots

For the intensity data consider appendix A.1 as the comparison base was intensity and ORB and they are thus the same.

## A.5 Ambient Data Comparison Plots

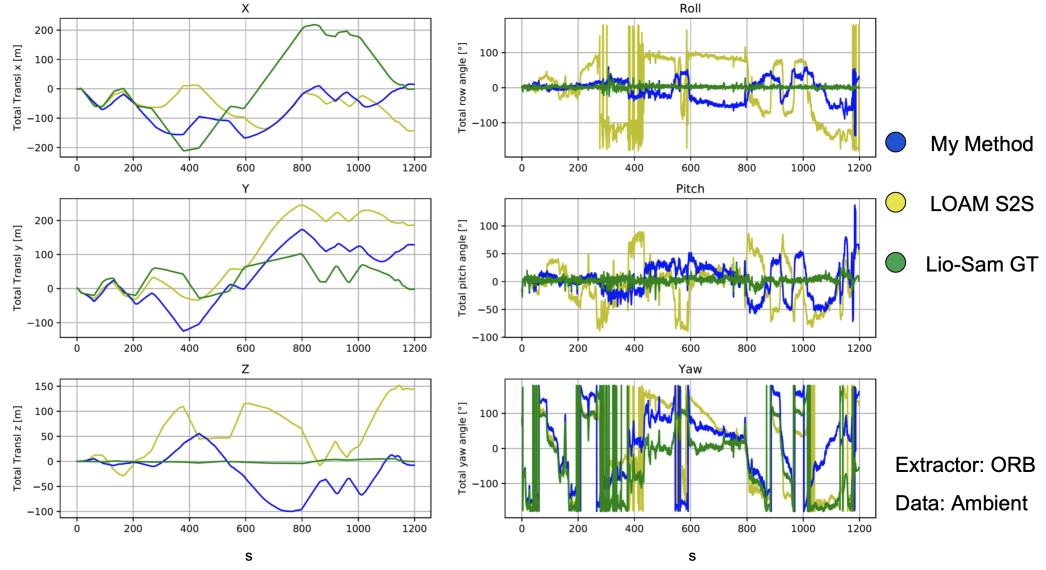


Figure A.13: Pose comparison ambient

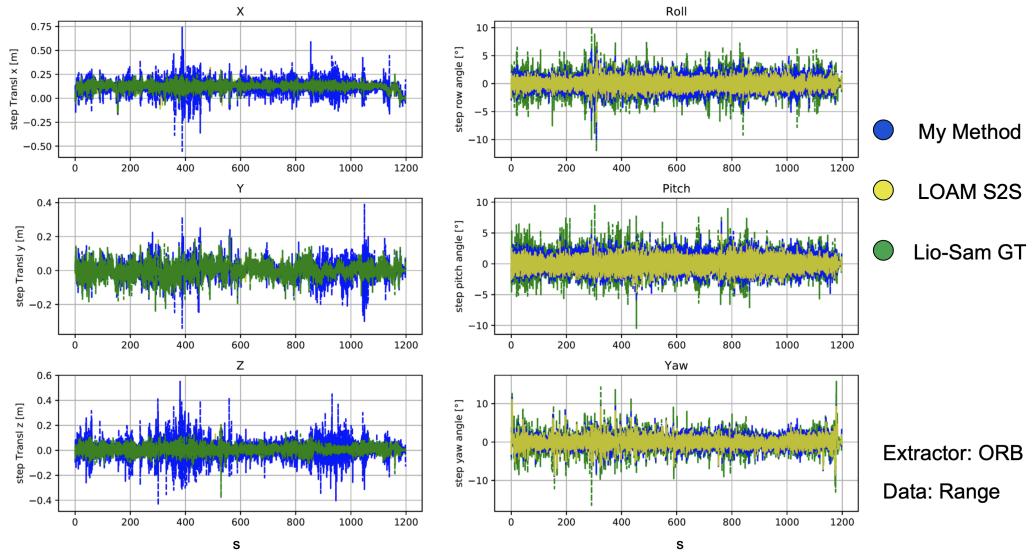


Figure A.14: Step comparison ambient

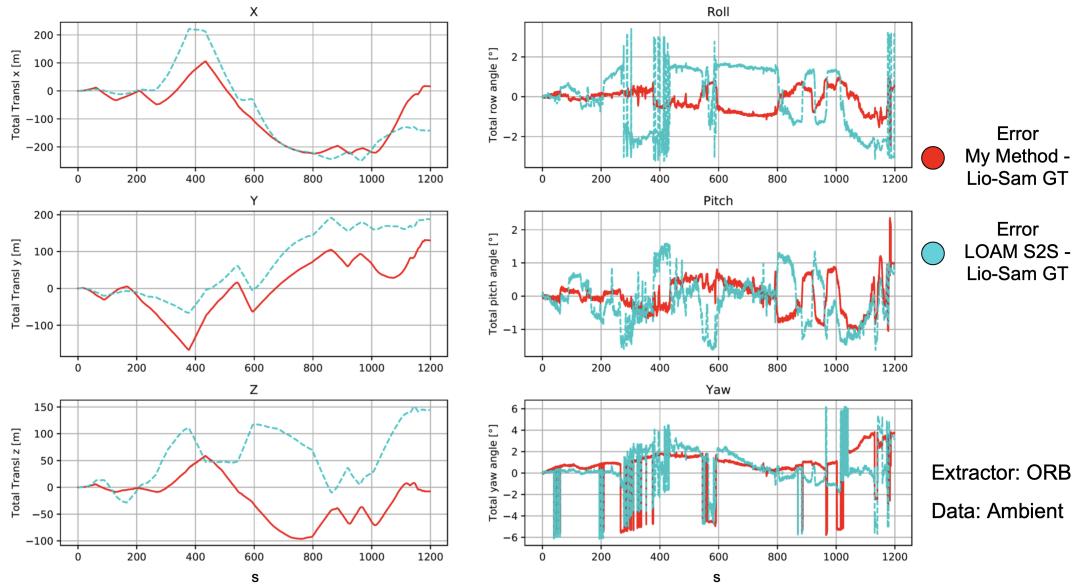


Figure A.15: Pose error comparison ambient

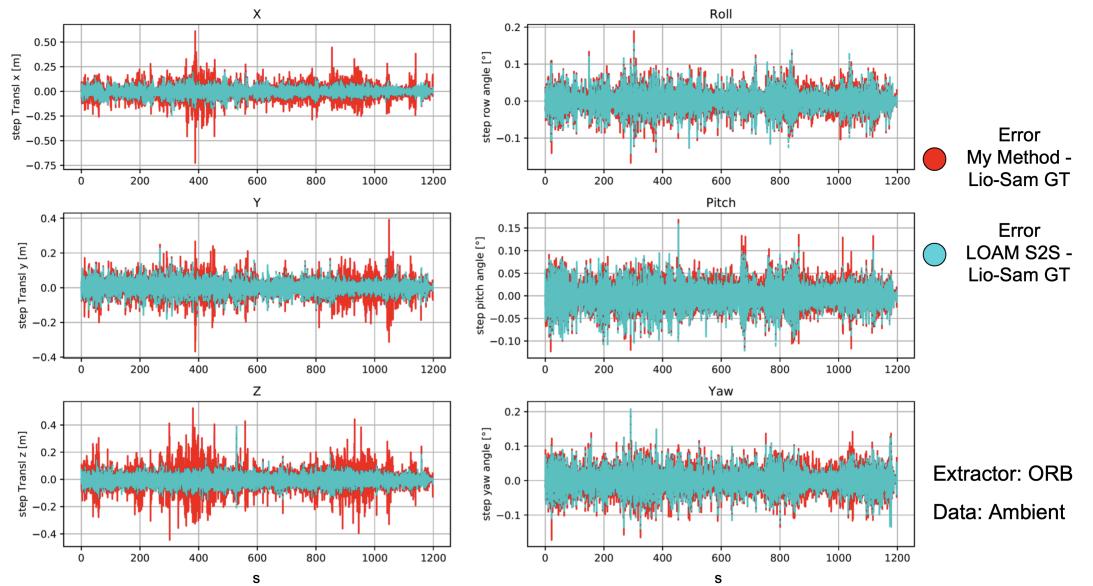


Figure A.16: Step error comparison ambient

## A.6 Range Data Comparison Plots

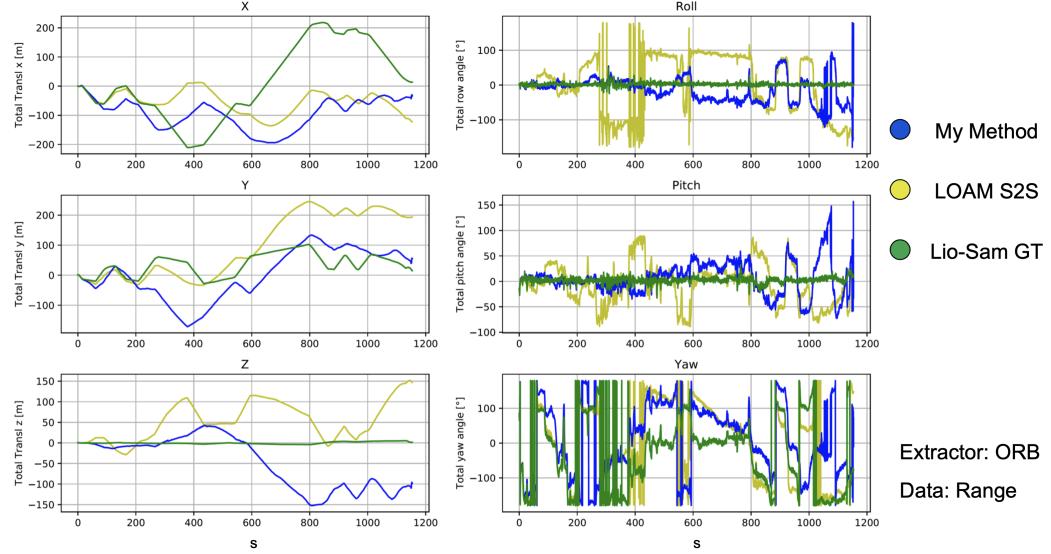


Figure A.17: Pose comparison range

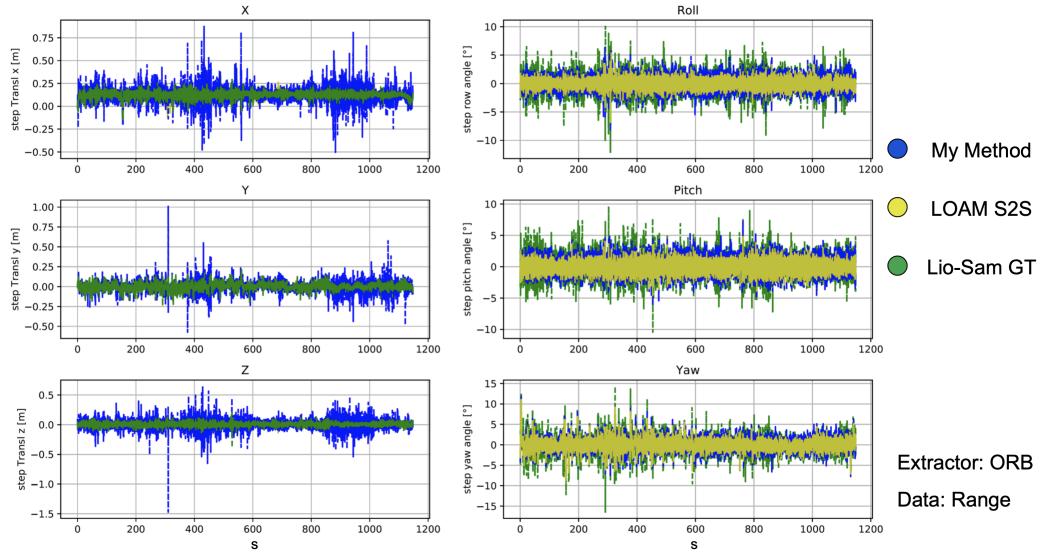


Figure A.18: Step comparison range

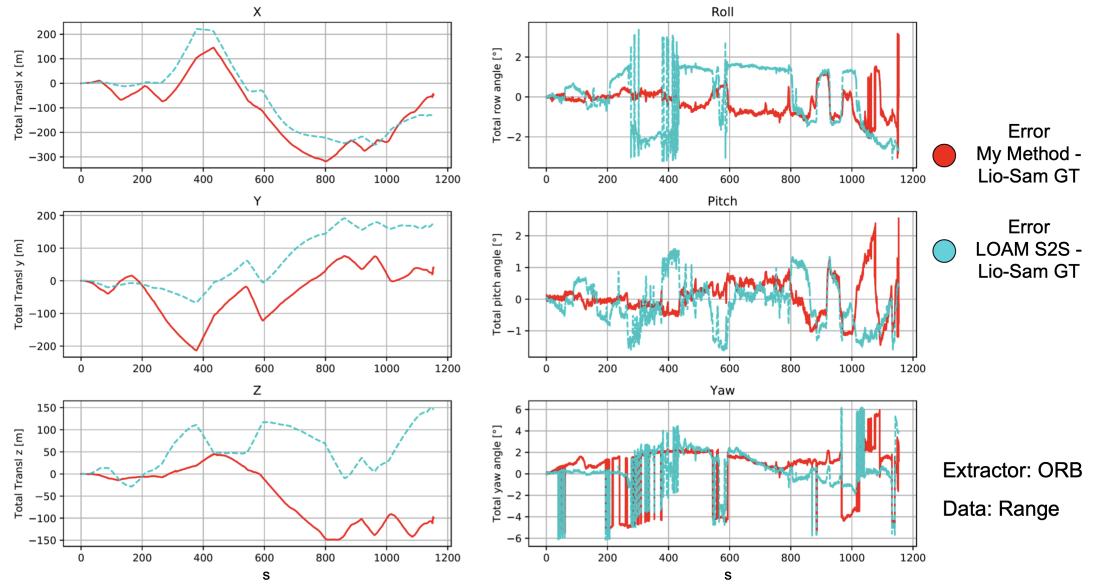


Figure A.19: Pose error comparison range

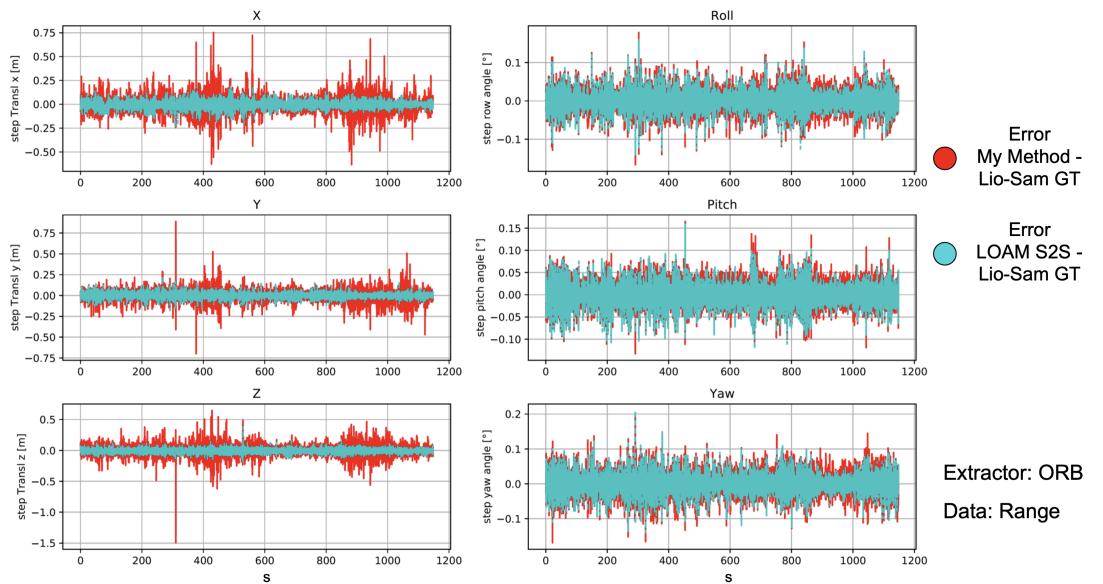


Figure A.20: Step error comparison range