

Evaluation of the Cartographer accuracy using the ViCON system

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February 2022

1 Translation and Rotation estimation

In order to calculate the difference between Cartographer and ViCON localization, the transformations must be found. The transformation is from the ViCON coordination system to the Cartographer coordination system.

1.1 Rotation

The line experiment has been arranged in such a way that the rotation angle is easily computable. From this measurement, the first and the last point were taken for both systems, and then the difference angle ϕ was calculated using the *atan2* function. Finally, the rotation matrix R was constructed using the computed angle.

1.2 Translation

The translation T was found by rotating the ViCON data and subtracting the mean value of the ViCON data from the mean value of the Cartographer data.

2 Experiments

Four experiments were conducted, of which two were calibration ones. Apart from the stationary (first) one, the distance error and RMSE were calculated by comparing the Cartographer value with the ViCON closest value.

2.1 Stationary

The car is stationary the whole time during this experiment. This experiment nicely demonstrates the dispersion of both localizations. The distance error and *RMSE* were calculated by comparing the Cartographer value with the ViCON mean value.

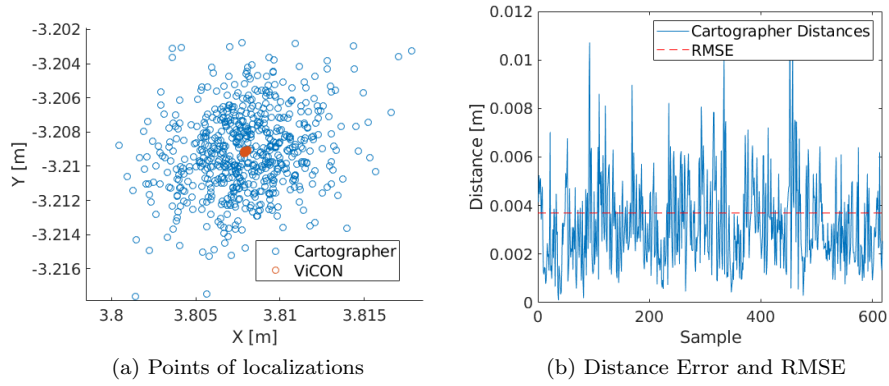


Figure 1: Stationary Experiment

The RMSE for this experiment is 3.7 mm . As this is just the calibration experiment, the RMSE value is relatively small.

2.2 Straight Line

This experiment is the second calibration one. During this experiment, the car is driving in a straight line.

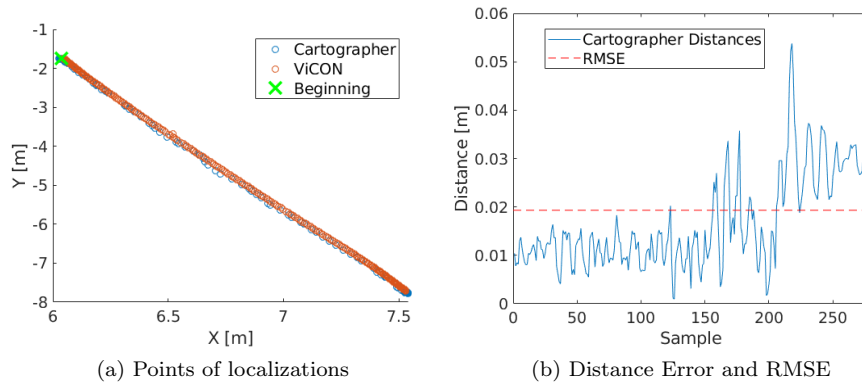


Figure 2: Linear Experiment

The RMSE in this experiment is 1.9324 cm . This value is more substantial, even though there was no turning in this experiment. The maximal distance is 5.378 cm .

2.3 Random Driving 1

The random driving should fittingly demonstrate everyday scenarios for the localization.

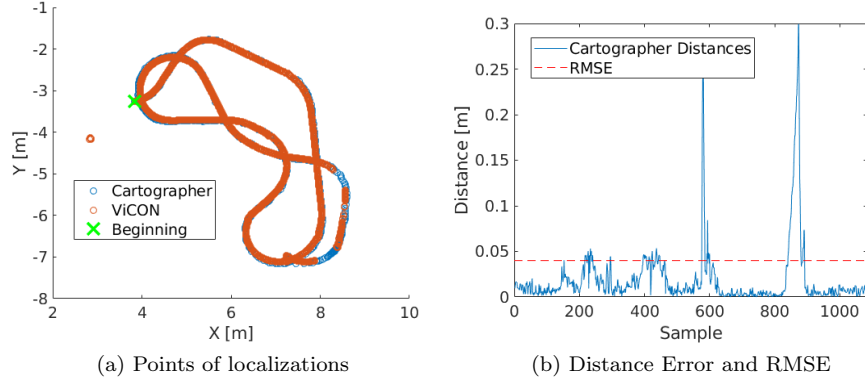


Figure 3: First Circuit

The RMSE in this experiment is 4.002 *cm*. Unfortunately, the ViCON system for a quick while lost connection, so there are two significant spikes on the distance chart influencing the RMSE. Not taking those two spikes into account, the RMSE is 1.674 *cm*. The maximal distance is 5.34 *cm*.

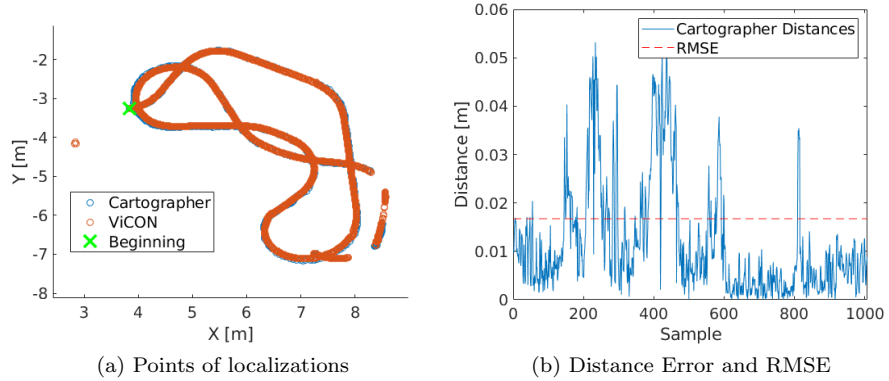


Figure 4: First Circuit Adjusted

2.4 Random Driving 2

Again the ViCON system lost connection, so the spike was removed. Without the correction, the RMSE was 14.159 *cm*. With the spike removed, this experi-

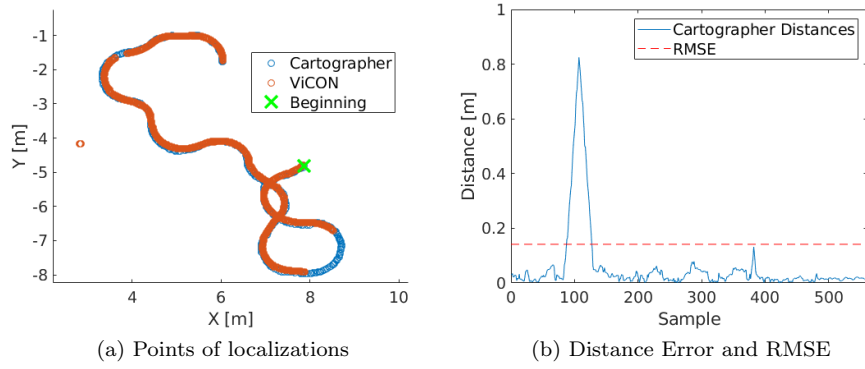


Figure 5: Second Circuit

ment yields similar results as the previous one, and the RMSE is 2.99 cm . The maximal distance here is slightly higher 13.227 cm .

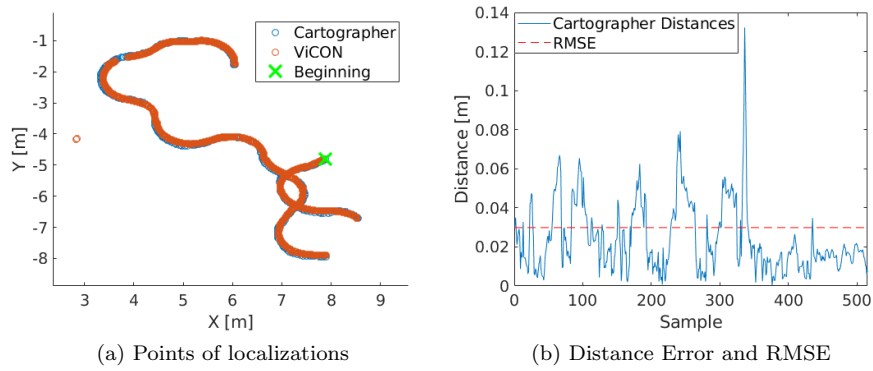


Figure 6: Second Circuit Adjusted

3 Conclusion

This work tried to determine the localization error of the Cartographer. Three main experiments were conducted; the straight line and two random drives. The general RMSE value is 2.2 cm , which is surprisingly accurate. This value is taken from the corrected datasets. All three experiments were carried out while driving at roughly 3 ms^{-1} ; for different speeds, experiments may yield slightly different results. Also, the initial calibration (determining transformations) may have negated any offsets the Cartographer may have. Passing mention should also

go to determining the distance itself, as this work utilized the closest reference point method.