Title

Point cloud based improvement of the trajectory of a Railway Mobile Mapping System

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Abstract

Absolute accuracy plays a crucial role in most geospatial applications. Particularly in the case of mobile mapping systems (MMS) where large amounts of data are collected, it comprises a key factor that can sometimes be dangerously underestimated. Within the scope of mobile laser scanning, the accuracy of the measurements is mainly ruled by the quality of the navigation solution. Commonly, as for the MMS that Fugro employs to capture 3D measurements from railway surroundings, called RILA, the trajectory of these mobile systems is determined by integrating data from positioning sensors, such as GNSS and IMU. Due to their complementary characteristics, the accuracy and robustness of the navigation solution can generally be considered sufficient. Nevertheless, in certain challenging environments where GNSS positioning conditions are limited, the trajectory results attained may not yet be accurate enough. Therefore, this study presents an alternative procedure to enhance the navigation solution of this MMS, making use of the point cloud data already acquired and georeferenced. Multiple runs or passes of the mapping system over the same problematic area take place at different times and some might possess satisfactory outcomes. Hence, after employing this dataset as reference, the quality of the others could be improved by means of point cloud matching methods. Next, the computed registration values are also applied to the trajectory, accordingly. Results over the area of interest selected show that applying Iterative Closest Point (ICP) using just a few feature points can already enhance the results. ICP iteratively finds the optimal rotation and translation to match two point clouds, minimising the differences between them. Furthermore, trajectory accuracies increase with the implementation of ICP utilising all points, without leading to extra processing times. However, GNSS/INS errors are not constant throughout time and space, which means that the application of a single rigid transformation may not be adequate. For that reason, an interpolated ICP-based method has been introduced and tested. An increasing number of point cloud sections was considered and among all, the solution with a relatively high number of sections performed better. This algorithm comprised a division of the point cloud data into 1000 contiguous sections or slices along the trajectory, each approximately 60 cm wide. The RMSE of the resulting absolute trajectory error and its standard deviation were greatly improved, with their values decaying from 41.1 cm and 18.1 cm to just 4.1 cm and 2.4 cm, respectively. In addition, provided a good reference dataset is available, the method proposed can be executed completely automatically and independently of the type of data captured and environment conditions. Even though these results might not yet reach the desired accuracy of around 1 cm to correctly georeference RILA's LiDAR data, it has been proven that this method has the potential to yield much more accurate, consistent and reliable outcomes. Further research should be directed at generating an accurate reference dataset when none is initially available, by collectively and statistically combining the results of multiple surveys.