

## REGISTRATION OF TIME OF FLIGHT TERRESTRIAL LASER SCANNER DATA FOR STOP-AND-GO MODE

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#### ABSTRACT:

Terrestrial Laser Scanners (TLS) are utilized through different data acquisition techniques such as Mobile Laser Scanning (MLS) and the output can be used in different applications such as 3D city modelling, cultural heritage documentations, oil and Gas as built, etc... In this paper, we will compare between two TLS modes of mobile mapping operations; namely continuous mode and stop-and-go mode. In continuous mode, Global Positioning System (GPS), Inertial Measurement Unit (IMU), and motion compensator are integrated with the TLS for georeferencing purposes. All sensors are mounted on-board a moving vehicle while the laser scanner collects data continuously. In the Stop-and-Go (SAG) mode the vehicle stops at certain locations for TLS data collection. Unlike the continuous mode, the Stop-and-Go mode does not require the use of IMU to estimate the TLS attitude and thus in-turn it has an overall reduction in the system cost. Moreover, it decreases the time required for data processing in comparison with the continuous mode. SAG mode has one problem which is that some parts of the data are not covered (measured) due to occlusion occurred by objects such as vehicles or trees. This problem arises with the continuous mode as well. However, the occlusion increases in the SAG mode since the vehicle is stationary, while in the continuous mode the moving vehicle reduces the occlusion by scanning a covered scene from different angles. Some authors tried to solve the problem of occlusion via the integration between SAG and continuous modes. In this paper we are going to address this problem in a different way.

For successful use of SAG mobile mapping in urban areas, it is preferred to use a long range time of flight laser scanner to cover long distances in each scan and minimize the registration error. That comes with the price of low-density point cloud and the occlusion of some parts in the scan areas by other objects. In this research paper, we are using a Time of Flight (ToF) Terrestrial Laser Scanner to perform Stop-and-Go scanning. Since no IMUs are going to be used in the Stop-and-Go scanning mode, another method of orientation determination should be implemented.

After performing the SAG scans, point cloud registration should be implemented in order to build a 3D model of large urban areas. The problems facing the registration are: a) inaccurate orientation determination, in case of tilted or misaligned scans, b) the loss of parts of data due to occlusions and c) the low resolution of the ToF laser scanner data. We address these problems via a plane/surface detection algorithm. This algorithm is based on the segmentation of the point cloud before the registration process in order to detect the planar surfaces in the scene. There are several segmentation algorithms, such as edge detection algorithms, region growing algorithms and Principal Component Analysis (PCA). The segmentation process in this research is based on the fusion between optical images captured by the laser scanner and the point cloud.

The planar surfaces detection is used to determine an accurate estimate of the orientation of the scans. For the registration process, the planar surfaces will be used in the registration to get coarse points matching from which initial transformation parameters are estimated. These transformation parameters are fed to the Iterative Closest Projected Point (ICPP) algorithm and the iteration continues until we have best fit of the parameters.

The loss of some parts of the scans due to occlusions is treated with an interpolation algorithm of the planar surfaces behind the occulting objects. The same interpolation algorithm is used to densify the point cloud in order to overcome the low density problem associated with the ToF scanners.

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