Ground point labeling in a terrestrial laser scanning configuration with utilization of scanner-centered coordinate system

Eetu Puttonen[1], Harri Kaartinen[1], Antero Kukko[1], Sanna Kaasalainen[1]

[1]*Department of Photogrammetry and Remote Sensing, Finnish Geodetic Institute*
Geodeetinrinne 2, P.O. Box 15, 02431 Masala, Finland
firstname.lastname@fgi.fi

Terrestrial laser scanning (TLS) has developed rapidly over the recent years allowing collection of high resolution geospatial data from close-range targets.

Close-range scanning means that the intrinsic point cloud densities vary significantly when compared to more established airborne laser scanning (ALS) data. Moreover, scanning distances and angles differ from airborne scanning. Scanner location within the target area also means that completely occluded viewing directions are probable. Also, the noise point number and distribution differ from those in ALS. Finally, spatial distribution of collected points is heavily concentrated around the immediate vicinity of the scanner. This can lead to excessively high point cloud densities that become detrimental for the point cloud processing.

Terrestrial point clouds are usually processed so that their spatial coordinates are first transformed into reference coordinates. Transformed point cloud information is then combined with point clouds measured in other scannings. Common ways to create a ground model over the whole combined data are a) laser point binning into a grid and then searching for the lowest bin heights, and b) creation of a Triangulated Irregular Network (TIN) from low points in the data. These approaches result in good quality ground models when distance variance of laser returns is relatively small compared to the scanning range, i.e. in ALS. However, in a terrestrial scanning configuration the point distance variance has the same scale as the scanning range. Moreover, a large number of noise points may occur below ground level in terrestrial scanning configurations. Presence of below-ground noise points complicates ground determination with binning and triangulation techniques.

This presentation introduces a novel approach for ground level determination in a terrestrial laser scanning geometry. The new technique uses scanning geometry information in ground level determination. The technique uses an assumption that high point density close to the scanner can be used for accurate initial ground level determination. When the point cloud is represented in scanner-centered coordinates, the ground level can be estimated with iterative binning. The iterative binning uses three preset parameters: bin width, rising angle, and layer height. The parameters prevent inclusion of extreme height changes in cases where height distributions of bin points change drastically.

The technique offers potential advantages over previous ground detection approaches in a terrestrial scanning geometry. Firstly, the ground detection algorithm allows pseudo/quasi-realtime data processing (ground classification can be performed during measurement or shortly after it, well before actual analysis). Secondly, the use of scanner-centered coordinates makes it straightforward to remove distant points and to decrease amount of noise coming behind partially penetrable targets. Thirdly, distance-dependent errors are easier to account for in scanner-centered coordinates. Finally, ground label information can be transferred directly to a reference coordinate system with proper indexing.

We present the working principles of the ground detection algorithm in this article, and test its performance in determining ground level in a forest site, which is scanned with a TLS setup.