

# The Difference of Ground Penetration between Full-waveform LiDAR and Discrete LiDAR in Forested Mountainous Terrain of Taiwan

Wei-Cheng Hsu<sup>1</sup>, Li-Wei Wu<sup>2</sup>, Jin-King Liu<sup>3</sup>

<sup>1,3</sup> *Civil Engineering Department, National Chiao-Tung University and LIDAR Technology Co., Ltd., Zhubei City 30264, Taiwan. {ianhsu,jkliu}@lidar.com.tw.*

<sup>2</sup> *GeoForce Technology Co., Ltd., Zhubei City 30264, Taiwan. liweiwu@geoforce.com.tw*

**Abstract:** The increment in ground penetration by using the full waveform exploitation technique compared to the discrete LiDAR pulses is evaluated. LiDAR systems that digitize and record entire echo waveform are available and applied in most of the surveys in Taiwan. By suitably exploiting the full waveform return pulses, very weak or buried signals that were not recorded as discrete return pulses could also be detected. And, thus, the quality of DEM (Digital Elevation Model) interpolated by ground points can be improved.

In this study, data acquisition was performed by using Leica ALS60 sensor with WDM65 full-waveform digitizer. WDM65 records the full waveform of the reflection from the surface. The study area is located in Tseng-Wen Reservoir Basin of southern Taiwan in a mixed forest mountainous terrain. Ground points are obtained by standard procedures given by National LiDAR Survey Guideline which adopts both automatic and manual editing. With the final products of point clouds, a sample unit of 200m by 200 m is used to obtain statistics of penetration rate, as defined by the ratio of total number of ground points and total number of all points. Subsequently, shaded-relief images are produced with both discrete and full-waveform ground points. Visual assessment of the quality for inspecting detailed features is carried out.

In total, 24 sample units are examined. The results showed that the technique used for the full waveform exploitation has effectively increased the ground penetration by 4.3%~120.78% compared to the discrete return pulses. Nevertheless, visual inspection of the quality shows that though the penetration rate of full-waveform does not increase in some sample units, the quality of DEM is still improved due to a better distribution of ground points in certain forested lands. In conclusion, by using full waveform return pulses, DEM constructed for forested mountainous terrain is substantially improved compared to the DEM generated from discrete LiDAR pulses.

Keyword : NSDI, airborne LiDAR, DEM Accuracy, forest structure, multiple discrete returns