INFLUENCE OF VARYING LANDFORMS AND FLIGHT GEOMETRY ON ECHO ATTRIBUTES OF FULL-WAVEFORM AIRBORNE LASER SCANNING DATA

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Abstract: Small-footprint waveform airborne laser scanning systems that store the entire waveform of each received pulse have become available to the commercial sector. Over the last five years, there has been a great interest in maximizing the potential of waveform data. Current studies of waveform data have shown that such data can provide additional information over discrete-return systems. Users can apply their own echo detection methods to overcome the shortcomings of the echo detection methods typically used. In addition, more details about illuminated targets are stored in the waveform than in discrete systems. It is expected that the waveform contain information about surface characteristics, which may help identify surface features or point clouds. Although the potential of using waveform attributes is increasingly found in different applications, several studies have urged that carrying out detailed analysis of waveform attributes (for example considering different landforms or flight geometry) is of fundamental importance for waveform applications. This research set out to investigate the effects of varying landforms, flight geometry and amplitude on waveform echo width. A factorial experiment is introduced to study the behavior of echo width in a statistical context.

Several reported studies have analyzed the relationship between waveform attributes and the factors of interest by simply observing the histogram or scatter plot of one factor against the attributes of interest and calculating basic statistics, such as the mean and standard deviation. Such approaches fail to consider the interaction between factors and do not offer the magnitude of the effect of a factor on the variable of interest. In contrast, a factorial experiment, based on statistical design and analysis, allows these requirements to be satisfied. Factorial design by Fisher in the 1920's and 1930's, is the most efficient and widely used method to investigate the effects of each factor on the response variable and the effects of interactions between factors on the

response variable. The factors investigated in this study are those related to scan geometry and the scanned surface, including range of the targets, scan angle, flight direction, linearized amplitude, surface slope and aspect. Echo width based on Gaussian decomposition of waveforms was regarded as a dependent variable in the experiment. Each factor was held at two-levels, which were two extremes of a factor.

This study utilized data from a Riegl LMS-Q680i full-waveform laser scanner. The data were collected from two campaigns over Taichung city of Taiwan, with different flying altitude: 1200m and 700m. The analysis showed that surface roughness was the most statistically significant factor influencing echo width, and Surface slope was the next most important factor, as expected. However, over relatively smooth surfaces, echo width was observed to be broadened when echo amplitude was extremely high, for example, in the location of white marking on an asphalt road during the campaign with flying height of 700m. It is suggested that caution must be exercised in utilizing echo width resulting from extremely strong amplitude.

Keyword : Full-waveform, Laser scanning, Lidar