Fast Ground Filtering of Airborne LiDAR Data Based on Iterative Scan-Line Spline Interpolation

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Abstract Over the last two decades, a wide range of applications have been developed from Light Detection and Ranging (LiDAR) point clouds. Most LiDAR-derived products require the distinction between ground and non-ground points. Because of this, ground filtering its being one of the most studied topics in the literature and robust methods are nowadays available. However, these methods have been designed to work with offline data and they are generally not well suited for real-time scenarios. Aiming to address this issue, this paper proposes an efficient method for ground filtering of airborne LiDAR data based on scan-line processing. In our proposal, an iterative 1-D spline interpolation is performed in each scan line sequentially. The final spline knots of a scan line are taken into account for the next scan line, so that valuable 2-D information is also considered without compromising computational efficiency. Points are labelled into ground and non-ground by analysing their residuals to the final spline. When tested against synthetic ground truth, the method yields a mean kappa value of 88.59% and a mean total error of 0.50%. Experiments with real data also show satisfactory results under visual inspection. Performance tests on a workstation show that the method can process up to 1 million points per second. The original implementation was ported into a low-cost development board to demonstrate its feasibility to run in embedded systems, where throughput was improved by using programmable logic hardware acceleration. Analysis shows that real-time filtering is possible in a high-end board prototype, as it can process the amount of points per second that current lightweight scanners acquire with low-energy consumption.

Palabras chave airborne LiDAR point clouds, ground filtering, scan-line processing, Akima spline interpolation, field-programmable gate array (FPGA)

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