Information Processing for Foliage Penetration LiDAR

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1. Abstract

Discrete return LiDAR systems provide a series of echoes (first/last or multi-echo) that reflect targets in a scene. On the other hand, a Full-Waveform (FW) LiDAR system measures the intensity of light that reflects targets continuously over a period of time. Research relating to FW-LiDAR is fairly new and barely scratched for target detection, surveillance and combat identification using Multi-Spectral (MS) FW-LiDARs. This ongoing work addresses the following problem: How best to combine and filter point cloud data acquired from ground based/aerial spectrally enhanced FW-LiDAR sensors to create detailed situational awareness.

In particular we are interested in extracting structural and physiological properties from targets hidden in clutter. We wish to detect and classify such partially/completely occluded targets. A special attention is paid to multi-sensor systems and spectrally enhanced LiDAR systems developed at Heriot-Watt University. This project aims to: i) Maximise information capture of LiDAR sensors in order to support effective foliage penetration and provide operative situational awareness; and ii) Develop Cueing algorithms to reduce target search space in Automatic Target Recognition (ATR) applications.

To date we have developed a real-time multi-beam MSFW-LiDAR simulator in order to model backscattered waveforms for complex surfaces reflecting off man-made and natural objects. The modeller allows flexible manageability of sensor characteristics, ambient light, 3D environment and dynamics of the sensor platform. We have designed a 3D point-based feature descriptor called Local Region Histogram (LRH) in order to characterise geometric properties of a target. We show improved results under immense occlusion and sparse data when compared against a robust point-feature extraction algorithm, Spin Images. Finally, we present a cueing algorithm composed of a three step approach to reduce target search space in a cluttered forest scene.