Influence of Signal Parameters in LIDAR Technology used for Sensing Through Dispersive Media

Ana Vazquez Alejos* [(1)], Muhammad Dawood [(2)]
(1) Dept. of Teoria de la Señal y Comunicación, University of Vigo, Vigo, Spain
(2) Klipsch School of ECE, New Mexico State University, Las Cruces, NM, USA

In a pulsed LIDAR some parameters depend on the pulse width and the refractive index of the medium. This is the case for the minimum range resolution or range uncertainty which improves with the smaller laser pulse or sample rate. However, the velocity resolution is inversely improved with the smaller width of the pulse. Additionally, the backscattered power received from a target directly depends on the pulse width and inversely on the transmitted pulse energy.

For dispersive media, the pulse width is altered due to the appearance of the precursor waveforms (H.U.R. Mohammed, M. Dawood and A. V. Alejos, IEEE Trans. on Geosc. and Remote Sensing, 50(2), 436–445, 2012), leading to a broader pulse that worsens the LIDAR link budget. We can however think of transmitting a pulse suitable to produce large backscattered energy such that it compensates the spreading of the pulse width.

In case of a precursor formation, the distortion undergone by the transmitted signal through or reflected from a dispersive medium basically consists of amplitude level modifications and spreading of the pulse width, thereby making the information retrieval difficult and inaccurate. However, the formation of the precursor fields can improve the signal propagation within a given medium by offering significantly better signal-to-noise ratio to achieve an enhanced sensing capability. At lower frequencies, the predominant precursor is the Brillouin precursor, whereas the Sommerfeld precursor becomes prominent at higher frequencies. In either case, the carrier frequency component has significantly attenuated when compared with the precursor fields.

These precursor fields may arise in certain frequency bands, subject to the selected shape of the transmitted pulse. On the other hand, the bandwidth and the shape of the transmitted pulse are a critical part of the system governing its performance. Therefore, a judicious choice of these parameters must be undertaken to either aid in forming the precursors or suppressing them altogether.

In this paper we introduce an analysis of the parameters of various waveform shapes propagating through naturally dispersive media: vegetation and water. We analyzed the effect of the precursor field formation on the LIDAR range and velocity resolution. For a LIDAR system we have estimated theoretically in the near IR band and experimentally in the 220-330GHz band that precursors can occur in a different way according to the input pulse setting.(Grant EMR2012/138)