Experimental verification of range estimation for a dark-field entomological passive LIDAR

S.S. Abeywickrama[2]*, H.E. Perera[1], H.H.E. Jayaweera[1]

[1]Department of Physics, University of Colombo, Sri Lanka.
[2]University of Ruhuna, Matara, Sri Lanka.

Application of dark-field passive LIDAR in entomological studies has been an emerging technology which is capable of identifying insects and detecting their activities in situ. With the use of simplistic instrumentation, passive LIDAR is capable of producing results comparable to more sophisticated technologies such as RADAR and Active LIDAR, although range resolving in passive LIDAR is a challenging task. Moreover, it has a minimal impact on the targeted flora and fauna, and no associated health hazards. One promising method of range estimation is to use a passive LIDAR range equation developed based on ray tracing. The objective of this study is to experimentally evaluate the passive LIDAR range equation (under its linear mode). The intensity variation of the probe volume was recorded by using a quadrant photodetector (QPD) attached to the image plane of a Newtonian telescope (f=1200 mm, $\emptyset_{tel}$ = 20 cm). The system was calibrated by observing the time domain parameters of the intensity variations of adjacent QPD segments corresponding to a pendulum oscillation. These were conducted at different locations along the probe volume with 10 m increments. System parameters were adjusted to comply with the passive LIDAR range equation's linear mode. This was done by matching the width of the QPD image on the dark terminator with the diameter of the telescope aperture. It was observed that the range can be estimated with an accuracy of ± 3.29 m for a maximum range of 80 m. The observations were aligned with previously published simulated insect signal-based retracing. It was also noted that the deviations in range estimation accuracy is due to the finite thickness of the pendulum and it can be minimized by using a thinner pendulum. This method can be applied to resolve the range information on daytime insects.

Keywords: Dark-field, LIDAR, passive LIDAR, passive range equation, QPD
*sisila@phy.ruh.ac.lk