Single-Photon Counting Lidar for High Resolution Three-Dimensional Imaging at a Wavelength of 1550 nm

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Single-photon time-of-flight (ToF) distance ranging lidar is a candidate technology for high resolution depth imaging for use, for example, from airborne platforms. This approach enables low average power pulsed laser sources to be used while allowing three-dimensional imaging from significantly longer target ranges compared to conventional, analogue active imaging. The recent availability of Geiger-mode (Gm) arrays has revolutionised photon-counting lidar as they provide single-photon full-frame data in short acquisition times. This talk presents work on the design and evaluation of a re-configurable single-photon counting lidar which can accommodate either a single-element single-photon avalanche photodiode (SPAD) or a 32 × 32 Gm-array. By incorporating an inter-changeable lens, the two configurations provide identical pixel resolution which allows a performance comparison to be conducted between the single-pixel and the Gm-array configurations. Both detection configurations used InGaAs/InP single-photon avalanche diode detectors and operated at a wavelength of 1550 nm. The main benefits of operating within the short-wave infra-red (SWIR) band include decreased solar background, lower atmospheric loss, improved covertness, as well as improved laser eye-safety thresholds. The system estimates range by measuring the ToF using time-correlated single-photon counting (TCSPC) and was used to produce high resolution three-dimensional images of targets at ranges between 800 m and 10.5 km. The single-element system has the potential to provide improved depth resolution over the array due to a smaller timing jitter but requires longer acquisition times due to the need for 2D scanning. The acquisition time of the array configuration is up to two orders of magnitude faster than the single-element configuration.

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