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Computational Approaches to Imaging LADAR

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LADAR (also referred to as LIDAR or laser radar) technology has advanced significantly in the last several years resulting in compact sensors with fine resolution capabilities and high area coverage rates. These advances have been enabled by improved performance of components such as lasers, detectors, and processors. Increased capabilities of lasers and detectors have increased data collection rates and fidelity, while processing capabilities have enabled greater data exploitation at higher rates. Another important enabling factor in the advancement of LADAR sensors has been the development of computational algorithms for image formation and data exploitation.

Computational approaches have been used with both coherent and direct detection/flash LADAR sensors. Applications are of interest in many fields including defense, biomedical research, homeland security, nondestructive test and evaluation, mapping, and 3-D metrology. While in many cases the computational techniques used are inherent to the sensor design, there are a host of LADAR sensors where such techniques can be used to measure phenomenology outside of the scope of the original system design. In general, approaches seek to maximize the extraction of the information content from data collected and can allow for imagery with increased resolution with shot noise–limited imaging performance. The field will continue to be an area for growth as the physical limitations of sensor systems are mitigated through additional algorithm development exploiting growing processing capabilities.

The papers presented in this special section cover several aspects of computational approaches to imaging LADAR. X. Lu and Y. Hu discuss the accuracy of land surface elevation data from the CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations) LIDAR sensor. The analysis compares CALIPSO measurements with those from other measurement systems and illustrates the effect of sensor parameters such as ground footprint.

Adaptive spatial filtering as applied to digital holographic microscopy is evaluated in a paper by J. Li et al. Their results show improvement obtained using the adaptive method over conventional filtering methods.

W. R. Babbitt et al. consider the computational imaging technique of feature-specific imaging. They have developed a method for three-dimensional adaptive feature-specific imaging that takes into account the obstruction of distant objects by closer objects. Simulations and proof-of-concept demonstrations are presented.

The creation of 3-D images by fusing LADAR and digital imagery is addressed by S. E. Budge et al. They present a method to create macro 3-D images that uses the unique properties of pixel-fused LADAR and digital images to improve the quality and robustness of the macro 3-D images. Because the LADAR and digital images are generated by the same sensor, they are naturally fused and their combination allows more accurate merging into larger 3-D images.

The final paper by G. Tsagkatakis et al. considers multireturn compressed gated range imaging. The method employs a random gating mechanism and reconstruction algorithms for estimation of object distances. Results show the ability to detect multiple range reports from a small number of measurements in conditions for which previous methods have failed.

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