Lidar

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This special section on lidar provides a snapshot of a variety of ongoing and future lidar applications and developments. It is by no means all inclusive because the field of lidar has grown too large in the almost 30 years since its inception to be treated comprehensively in a single issue. However, the topics covered by the authors do present a fairly broad overview of current lidar technology and highlight several interesting new system designs and sensing approaches. Although more by fortune than design, the contributed and invited papers do complement one another rather well to provide both enhanced and contrasting topical coverage.

The first two papers present innovative "spectral scattering" sensing applications. The Grund and Eloranta paper describes the High Spectral Resolution Lidar (HSRL) technique and system developed at the University of Wisconsin. This technique separates the Rayleigh (molecular) and aerosol backscatter contributions by spectrally separating the much wider Doppler-broadened molecular signal from the quite narrowly broadened aerosol signal, thereby permitting more direct retrieval of aerosol/cloud extinction and backscatter cross-section profiles. Application of the HSRL approach is technically very demanding, requiring both a very narrow, stable laser output line and a receiver with sophisticated spectral filtering, but the results reported by Grund and Eloranta appear very promising. The second paper, by Bills, Gardner, and She, describes a new sodium resonance fluorescence lidar for measuring mesospheric Na temperature profiles. They outline a two-frequency technique and present preliminary results for retrieving vertically resolved temperature by ratioing the lidar signals for wavelengths at the minimum and peak of the temperature-sensitive Na D_2 Doppler-broadened fluorescence spectrum. They also discuss an extension of the technique to include measuring wind profiles in the Na layer.

The next three papers are on differential absorption lidar (DIAL), a technique which, by ratioing lidar signals for wavelengths in and out of gaseous absorption lines, permits range-resolved retrievals of important minor atmospheric constituents such as O_3 and H_2O. The paper by McDermid et al. describes the new Jet Propulsion Laboratory Table Mountain lidar facility for ozone profiling. The facility actually includes two lidars, a Nd:YAG-laser-based system for lower altitude profiling and an excimer-laser-based system for stratospheric profiling. The next paper, by McGee et al., describes a mobile stratospheric ozone lidar developed at NASA/Goddard Space Flight Center, which employs both excimer and third-harmonic Nd:YAG lasers to generate the on- and off-line wavelengths. In addition to summarizing this system, they discuss experimental implementation and data analysis and present comparison results from measurements made alongside the JPL Table Mountain lidar. The last paper of this trio, by Grant, reviews and assesses both DIAL and Raman lidar approaches for retrieving atmospheric water vapor. The paper reviews measurement theory, sources of error, and progress in lidar technology over the past 20 years, including possible improvements for future systems.

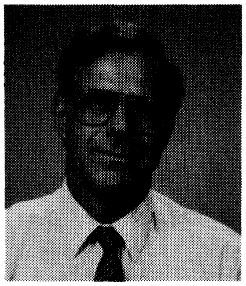
The next two papers deal with moving target measurements, but not in the conventional Doppler lidar sense which, currently, implies CO_2 Doppler lidar. The paper by Chan and Killinger investigates the merits of a short-pulse, coherent Nd:YAG lidar (1.06 μm) for highly range resolved Doppler measurements of high-velocity targets, both hard and distributed. Results of noise measurements are presented for both heterodyne and direct detection detectors, and experimental results are contrasted with theoretical predictions. The paper by Knight et al. examines two detection techniques for retrieving 2-D and 3-D images of macroscopic targets illuminated by short-pulse laser radiation. The 2-D imaging approach employs range tomography and a 1-D detector, while the 3-D approach achieves angle-angle imaging through a 2-D fiber optic array converter.

Airborne lidar is the topic of the next two papers, although they each address a quite different type of application. The paper by Uthe summarizes airborne lidar experiments to map atmospheric motions and structure with lidar signals received from tracers injected into the atmosphere. Examples are given for elastic scattering, fluorescent scattering, and DIAL tracer applications. The paper by Bufton et al. describes a state-of-the-art airborne laser altimeter system for profiling surface topography. The system features a diode-pumped Nd:YAG laser transmitter and silicon avalanche photodiode detector similar to what has been proposed for spaceborne laser altimeter systems.

The next paper, by Roberts et al., is unique in both topic and instrument size. They describe the design and present demonstration measurements for a 100-in. receiver "Megalidar" system capable of sensing Rayleigh (molecular) backscatter returns from heights up to 90 km.

The last two papers address spaceborne lidar applications. The paper by Couch et al. describes the mission plan and hardware for the Lidar In-Space Technology Experiment (LITE), scheduled to fly on the Space Shuttle in mid-1993. The paper highlights the engineering aspects of the design, fabrication, integration, and operation of the LITE instrument. The final paper, by Reagan and Zielinskie, describes approaches for using the anticipated strong lidar return signals from ground and sea reflections to enhance the information that can be retrieved from spaceborne lidars operating at both shuttle and free-flyer satellite heights.

I would like to thank all of the authors for their excellent efforts in submitting papers for this special section, particularly in view of the rather tight time schedule under which they had to work. I also extend thanks to the reviewers for their prompt responses and many helpful comments. They play a vital role that is too often overlooked, and I am very appreciative of the dedication they displayed in discharging their reviewing tasks.



John A. Reagan received his BS degree in physics and MSEE degree from the University of Missouri at Rolla in 1963 and 1964, respectively, and his Ph.D. degree in electrical engineering from the University of Wisconsin in 1967. Since 1967, he has been with the University of Arizona, Department of Electrical and Computer Engineering, where he is now a professor. His areas of interest and research include atmospheric optics, optoelectronics, and atmospheric remote sensing techniques and instrumentation. Dr. Reagan is a Fellow of the IEEE and a member and current president of the IEEE Geoscience and Remote Sensing Society. He is also a member of the American Meteorology Society, where he has been an active participant in the AMS Laser Radar Conference series, and is now a member of the AMS Committee on Laser Atmospheric Studies. He has recently become a member of SPIE and is also a member of the Tau Beta Pi, Sigma Pi Sigma, and Phi Kappa Phi honorary societies and a registered Professional Engineer in the state of Arizona.