Optical Remote Sensing and Image Processing

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Optical remote sensing and image processing systems eventually end up processing all kinds of signals. Accordingly, the scope of the corresponding research involves not only the process, but also the systems. At this time, the field encompasses both defense-related and commercial applications. The nineteen papers of this special *Optical Engineering* section on optical remote sensing and image processing summarize the works of 46 different researchers from Canada, Germany, Israel, Mexico, Russia, and the United States, with backgrounds that encompass defense, academia, and industry fortuitously categorized into four subareas: remote sensing, image processing, pattern recognition, and imaging systems.

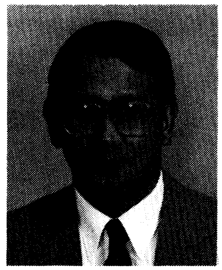
The first four papers deal with optical remote sensing in general. In the first paper, Goers describes the optimization of the wavelength pair to be used in differential absorption lidar measurements of tropospheric ozone. Ozone lidar verification measurements with a uv-photometric analyzer confirm that ozone concentration uncertainties due to aerosol effects are insignificant under visibility conditions like those in a deciduous-coniferous mixed forest canopy. This is followed by a paper by Werner where the author uses a Doppler lidar to measure wind profiles in the atmosphere. The next paper authored by Masters, Mark, and Duncan discusses improvements in range resolution using a modulated waveform and a matched filter receiver. Finally, in the fourth paper, Jacob, Mark, and Duncan analyze a heterodyne ladar system incorporating a single-mode fiber receiver in terms of the coupling and mixing efficiency, as they relate to the overall system carrier-to-noise ratio.

The next six papers deal with image processing. In the first paper, Gillette, Stadtmiller, and Hardie develop a sampling model and analyze microscanning techniques for the reduction of aliased signal energy in a staring infrared imaging system. In the second paper, Broessel, Dominic, and Hardie use liquid crystal arrays to steer the field of view of a broadband imaging sensor. They use the beam-propagation method to find the wavelength-dependent impulse response and, therefore, determine the appropriate Wiener filter to extract restored images. Next, Hardin and Long assess tropical forest degradation and its potential impact on earth's climate by correctly classifying scatterometer images into broad classes of equitorial forest, degraded woodland/forest, woodland/savanna, and caatinga. In the fourth paper, Wilson, Rogers, and Myers demonstrate a perceptual-based multiresolution fusion technique using the Airborne Visual and Infrared Imaging Spectrometer hyperspectral sensor data. In the fifth paper, Barnard and Watson analyze the submicroscan interpolation image processing technique to determine the effects of additive noise on the quality of the output imagery. For the case of fixed-pattern noise, submicroscan interpolation causes a spectral redistribution of the noise power spectrum that tends to improve image quality. In the sixth paper, Schilling and Poon use optical scanning holography that uses active optical heterodyne scanning to generate holographic information pertaining to an object. They propose a holographic edge extraction technique as an important example of real-time preprocessing of holographic information, which utilizes alternate pupils in the recording stage.

The third group of papers, five in all, concerns pattern recognition. Shen and Sheng in the first paper achieve pattern recognition by matching the noncentral moment vector of reference with that of the input image, using an exhaustive search in the set of feature vectors of the input image. In the second paper, Ahmed, Karim, and Alam use a novel wavelet-based joint transform correlator for rotation-invariant pattern recognition and applications in optical image processing and remote sensing. An optimal set of filter parameters and a mother wavelet filter are selected to extract features at different resolution from a set of rotationally distorted training images. Next, Iftekharuddin et al. propose a hybrid recognition system that uses a feature extraction method. The features are extracted using a wavelet transform, preclassified using a *k*-nearest neighbor-based neural net, and subsequently postprocessed using an optical correlator. Next, the article by Yu et al. synthesizes a spatial-domain bipolar composite filter suitable for implementation in a joint transform correlator using a simulated annealing algorithm. Then, Alam proposes a generalized fringe-adjusted joint transform correlator, which employs a new family of real-valued filters called the fractional power fringe-adjusted filters.

The final subarea, consisting of four papers, deals with the supporting imaging systems used in remote sensing and image processing. First, Feng and Ahmad designed a novel low f-number, wide field-of-view imaging spectrometer for measuring the day-glow spectrum over the wavelength range of 260 to 870 nm with spectral resolutions of 0.5 and 0.3 nm. This is followed by a paper authored by Scholl and Wang proposing an imaging concept that includes an optical camera and a survey strategy for remote landing-site certification. With the sensor at 350 km above the 10×10-km Martian site, this push-broom imaging configuration incorporates only five sensor passes over the site. The mission time is decreased by nearly 100% over the previously proposed concept for the site certification imaging. Next, Vorontsov, Ricklin, and Carhart discuss a technique based on nonlinear and adaptive optics for simulation of phase distortion effects in imaging systems. This technique uses a nonlinear two-dimensional optical feedback system to produce a controllable spatially and temporally varying chaotic intensity distribution. In the fourth paper, finally, Sadot et al. use models describing meteorological dependencies of both C_n^2 and coarse aerosol size distribution to predict turbulence modulation transfer function (MTF), aerosol MTF, and overall atmospheric MTF according to weather. Their experimental verification with two different imaging systems supports the model that the "practical" aerosol MTF is very dependent on instrumentation.

In conclusion, this special section is well balanced and reports the many ongoing research efforts on optical remote sensing and image processing at different government, university, and industrial laboratories. We would like to thank the many contributors and reviewers for their dedication. Without their help and timeliness, this special section would not have been possible.



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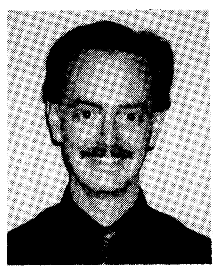

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