© 2013 THOSS Media & DE GRUYTER DOI 10.1515/aot-2013-0056 — Adv. Opt. Techn. 2013; 2(5-6): 367–368

Editorial

Karin Stein and Hans Dieter Tholl*

Remote sensing

In the year 1608, Count Moritz von Nassau, Stadtholder and Admiral of the Provinces Holland and Zeeland, was informed in a letter about an advanced optical instrument, which allows him to see 'far-away things and places from nearby' [1]. This capability was of high value for the military user: he could detect the enemy a few hours in advance of the actual encounter. A commission was installed to assess the performance of the telescope invented by Hans Lipperhey. The examination was positive. Three instruments were ordered and delivered in 1609. The possibility of acquiring optical information about objects from a distance was so exciting that the news spread out quickly over Europe. Eventually, cheap telescopes were sold by traveling merchants.

During the following 400 years, remote sensing developed into a broad field combing mission planning, sensor technology, platform integration, data processing, and data dissemination. Optics plays an important role in providing the means to collect multispectral, hyperspectral, or polarimetric images and spectroscopic data during day and night. Advances in laser technology led to increased output power, improved beam quality, wavelength diversity, and spectral tunability. Laser remote sensing evolved from range finders and single frequency LIDARs into hyperspectral active 3D imaging systems. Distributed apertures and phased array beam steering concepts are around to facilitate the integration of passive and active remote sensing devices into unmanned platforms.

It is impossible to cover the advances in optical remote sensing technologies within a single special section. Several conferences and a couple of journals are dedicated to this topic and provide in-depth reviews addressed to a general audience. We decided to offer you a kaleidoscope of invited papers delineating specific aspects of optical remote sensing. A tutorial, two reviews, a research article, and two letters deal with laser remote sensing of diffusively reflecting targets in a turbulent atmosphere, laser-gated viewing, infrared detectors, telescope design, holographic wavefront sensors, and beam combining of quantum cascade lasers.

The tutorial of Mikhail Vorontsov about 'Target-In-The-Loop Laser Beam Propagation and Scattering' provides an in-depth analysis of coherent optical wave propagation in a turbulent atmosphere, assesses the generation of speckles through the interaction of the laser beam with a randomly rough target surface, and proposes the use of speckle-based metrics to drive an adaptive optics subsystem to overcome some of the optical distortions induced by the atmosphere. The analysis relies on the mutual correlation functions (MCF) of both the optical wave amplitude and the intensity. In addition to the theoretical elaboration, experimental evaluations of the described speckle metrics are discussed.

The succeeding review of Martin Laurenzis and Frank Christnacher discusses 'laser gated viewing,' which is an active remote sensing technique for long-range vision at day and night. The authors explain how the synchronization of a pulsed laser source with a gated camera allows for the acquisition of image sequences through smoke and under bad weather conditions. Employing proper coding and image processing techniques, the illuminated scenes can be reconstructed in three dimensions. In a polarimetric imaging mode, the difference in the polarization dependence of the reflectance of natural and artificial materials is used to discriminate between man-made objects and vegetation.

The review of 'Infrared Detectors for Space Applications' by Wolfgang Fick and collaborators introduces different sensor architectures for passive remote sensing of infrared radiation emitted by the earth toward space in the waveband between 0.9 and 14.7 μm. The application of linear and matrix focal plane arrays in satellite-based scanners, multi- and hyperspectral imagers, and Fourier transform spectrometers is explained. The key parameters governing the performance of the sensor systems in current and upcoming space programs are given.

A paper on the optical design of telescopes is indispensable in our compilation as these instruments are the oldest optical remote-sensing devices. Of course, the 'Alternative Design for Extremely Large Telescopes' reported by Mark Ackermann, John McGraw, and Peter Zimmer has only little resemblance with the instruments used by Galileo and others in the past. The authors review the developments of large (8-m class) and extremely large (30-m class) terrestrial telescopes for optical astronomy. As an alternative to the currently discussed concepts for the ELT, they propose and delineate a design comprising four mirrors in a combined Gregorian-type Mersenne configuration followed by aplanatic Cassegrain reimaging optics. They also introduce a concept on how to use the Vatican Advanced Technology Telescope (VATT) as an ELT pathfinder.

The aforementioned papers are accompanied by two letters. The first one, written by Andreas Zepp, Szymon Gladysz, and Karin Stein, investigates the performance of a 'Holographic Wavefront Sensor for Fast Defocus Measurement.' The Shack-Hartman wavefront sensor (SHS), often employed in adaptive optics systems integrated into astronomical telescopes, is not well suited for the measurement of wavefront deformations along a propagation path entirely emerged in the atmosphere. This is due to the limited bandwidth of the device and its high sensitivity against intensity fluctuations. These weaknesses of the SHS are the strengths of the holographic wavefront sensor. The authors explain the principle of the wavefront reconstruction process and assess the performance of a device experimentally.

Until recently, active sensing in the infrared spectral range relied on gas lasers such as the HF, DF, CO, and CO_2 lasers or on optical parametric generators (OPG) and oscillators (OPO). With the invention of the quantum cascade lasers (QCL), a versatile semiconductor laser source is available in the infrared waveband. The output power of commercially available QCLs is insufficient for remote sensing applications and needs to be scaled up by beam combining techniques. These are summarized in the letter by H. Tholl and J. Wagner.

In closing this editorial, we thank the authors, the reviewers, and the AOT team for their support in building this kaleidoscope of papers covering diverse aspects of advanced optical remote sensing. The instrument is on hand to be explored by you, the reader. Please take a few moments in looking through.

Reference

[1] H. van Onna, "The art of seeing far-away-things nearby", http://www.drebbel.net/ The Art of Seeing things nov 2008.htm (Accessed October 2013).

***Corresponding author: Hans Dieter Tholl,** Diehl BGT Defence, E-KO, Alte Nussdorfer Strasse 13, Ueberlingen 88662, Germany, e-mail: hans.tholl@hs-weingarten.de

Karin Stein: Fraunhofer IOSB, SIGNATORIK, Ettlingen, Germany

Karin Stein is the Head of the Department 'Signatorics' at Fraunhofer IOSB. She has been with the Institute (then named FGAN-FfO) since 1991. She obtained her Diploma in Physics and PhD in the field of laser-plasma interaction both from Technical University Darmstadt, Germany. Since 2003, she has been the conference chair of 'Atmospheric Propagation and Adaptive Systems' at SPIE Remote Sensing Europe. Since 2009, she has been in charge of the organization of all SPIE Remote Sensing symposiums as a co-chair, and since 2011 as the chair. Her research interests are in meteorology, impact of atmosphere on imaging systems, warning sensor technology, and remote sensing.

Hans Dieter Tholl received a Diploma in physics in 1985 and a PhD in Optical Physics in 1990, both from the Technical University (RWTH) of Aachen. He was awarded the Borchers Medal of the RWTH for his outstanding PhD Thesis. In the years 1990/1991 he was assistant research professor at the University of Nevada. From 1991 to 1995 he served as a coordinator for projects in optical metrology at the Technical University of Aachen. He joined Diehl in 1995 and became head of the Optronics and Laser Techniques section in 1998. At Diehl, H.D. Tholl serves as chief engineer and manager in national and European projects related to active and passive optronics. In addition to his industry position, H.D. Tholl lectures in Wave Optics, Laser Theory, and Laser Applications at the Technical University of Ravensburg-Weingarten in Germany.