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Editorial

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Active Imaging

The principle to improve optical imaging by employing a dedicated illumination source is as old as the utilization of fire when early humans used torches to enhance vision in the absence of sunlight. Later on, passive and active means like illumination mirrors and lamps were developed to distribute light energy over an optical sensing area. These first approaches aimed at bringing light to shadows or darkened areas. Nowadays, the controlled interaction of illumination and optical sensing takes a major role in active imaging to analyze a scene with all available optical measures and to gain a detailed multi-dimensional (time, space, spectrum, and polarization) view of the observed objects.

The origins of active imaging date back to the invention of sensitive electro-optical imaging equipment, powerful solid-state and semiconductor light sources, and fast modulation devices during the late 20th century. Since then, active imaging has become a versatile sensing technology, predominantly focused on defense and security applications due to the constraints in size, weight, power, and cost. The recent advances in gated CMOS imagers, laser diodes, fast electronics, and computer graphics pave the way for active imaging systems to penetrate into civilian sectors, such as law enforcement, automotive, or medical imaging. In order to spur the exchange of knowledge between these diverse fields we proposed a topical issue on *Active Imaging* to the Publisher and the Editor-in-Chief of *Advanced Optical Technologies*.

On the following pages, experts from the defense research community share their views on the current and future developments of active imaging systems and related optical device technologies. A perspective related to a product development of general interest is introduced in a tutorial on the use of active gated imaging systems in automotive applications.

We suggest to start the reading with the in-depth introduction to the field of Active Imaging by Ove Steinvall. His paper entitled *Active Spectral Imaging and Mapping*, reviews the recent scientific achievements and international programs mainly in the defense area. The article explains that the progress in device technologies, especially in multi-line and tunable lasers, opens up new capabilities in spectral imaging and chemical sensing.

Important issues in active imaging are the control of laser peak power to ensure eye safety and the reduction of size, weight, and electrical power (SWaP). Photon counting LADARs are candidates to cope with these system aspects. The research article of Lars Sjöqvist, Markus Henriksson, Per Jonsson and Ove Steinvall on *Time-Correlated Single-Photon Counting Range-Profiling and Reflectance Tomographic Imaging* reports on the recent advances in TCSPC laser radars with sub-centimeter range resolutions even under daylight conditions.

Active chemical and medical imaging requires tunable infrared light sources with high spectral power densities. The tutorial of Quankui Yang, Frank Fuchs, and Joachim Wagner about *Quantum Cascade Lasers for Hyperspectral Active Imaging* presents an introduction to the QCL device technology and to the application of widely tunable external-cavity QCLs to stand-off detection of hazardous substances.

Besides eye safety and SWaP a major design driver for active imaging systems are compact laser modules which illuminate the sensor's field-of-view efficiently and homogeneously, i.e., speckle-free. The review on *Beam-Shaping of Laser Diode Stacks for Compact and Efficient Illumination Devices at the French-German Research Institute of Saint-Louis* by Yves Lutz and Martin Laurenzis lightens up the design and realization of beam-shaping optics for auto-stack, mini-bar stacks, and standard laser diode stacks for Laser Gated Viewing systems.

This small collection of topical papers is rounded off with a tutorial of Yoav Grauer on *Active Gated Imaging in Driver Assistance System*. The paper highlights the introduction of active imaging devices and methods into automotive safety and driver assistance systems. General design challenges and configurations are discussed which provide versatile capabilities to realize day/night-time imaging, detection, and warning function.

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In conclusion, we express our gratitude to the authors who devoted their time to share some of their knowledge on *Active Imaging*. Of course, we are deeply indebted to the AOT team for their excellent support in preparing this topical issue.

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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.

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