Advances of optical metrology in the transportation industry

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Optical metrology is a highly interdisciplinary technology, which integrates optics with mechanics, electronics, computer science, informatics, mathematics, and many other disciplines. Consequently, every innovation in another field of science has the potential to drive new developments in optical metrology. For example, the invention of the laser in the 1960s opened vast new possibilities for optical measuring. Sensor technology such as video cameras in the 1970s and charge-coupled-device sensors in the 1980s replaced observation by eye and made optical measurement data accessible to computers. Since optical technologies typically produce millions of data points simultaneously, computer power has always been a central issue, and each new generation of computer technology gives engineers the opportunity to use well-known principles in new and innovative applications. During the first decade of this century, new light-emitting diode and complementary metal-oxide semiconductor technologies will revolutionize optical metrology. On-chip preprocessing of photon information enables massive parallel processing of data and perfect adaptation of lighting situations to the sensitivity of the photo sensor. Field-programmable gate arrays allow direct, very fast, and parallel processing of these data without the use of a personal computer. The rapid development of optimized mathematical routines for data treatment is increasingly important because it opens new doors for optical measuring principles in modern applications.

The transportation industry has always been a driver of innovative measurement techniques. In fact, optical metrology has been an indispensable technique that enables the transportation industry to make products more innovative, enhance quality, reduce cost, and accelerate time to market. Precise measurements of behaviors for materials and structures with advanced optical technologies allow engineers to design new lightweight vehicles, introduce new materials, and validate complex computational models. Therefore, optical metrology has experienced a great escalation in research, development, and applications within the transportation industry.

Three special sections on optical metrology in the automotive and transportation industry were published in *Optical Engineering* in 1998, 2003, and 2007, respectively. These special sections served as a forum for exchanging ideas among researchers in the field at that time. We feel that it is time for some subjects to be updated. This fourth special section highlights some different optical measuring principles in new applications and configurations. The focus has been laid on full-field optical measuring techniques in the areas of nano/microdisplacement measurement on microelectromechanical systems and microdevices, shape and displacement measurement on discontinuous surfaces, vibration measurement under running conditions, dynamic strain measurements of rotating tires, etc. If the described principles and applications stimulate our ideas to improve development and production in the transportation industry, this special section will have reached its goal.

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