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With the development of science and technology and industry's requirement for higher measurement precision, more and more researchers have entered the field of precision measurement research. New measurement methods, technology, and instruments are being developed for modern industry. Precision optical measurements are the most active research field for geometrical and mechanical quantities. The advances of optical measurements enable noncontact sensing with high precision, as well as measurement capability ranging from micro scale to large scale. The measurement accuracy has been improved to micrometer and, in some cases, even nanometer levels, regardless of the scale. In this special section, we present a collection of selective papers that represent, to a certain extent, the recent advances in precision optical measurements and instrumentation and the related technologies.

Absolute distance metrology has gained great prominence both in accuracy and resolution. G. Shi et al. present a method for improving the measuring resolution of FMCW laser ranging for absolute distance metrology. The resolution achieved is better than the pulsed time-of-flight system. The system is also applicable in large-scale precision industrial metrology. Y. S. Jang et al. revisit the method of synthetic wavelength interferometry (SWI) for absolute measurement of long distances using the radio-frequency harmonics of the pulse repetition rate of a mode-locked femtosecond laser. They extended the non-ambiguity range (NAR) of the SWI method by using a coarse virtual wavelength synthesized by shifting the pulse repetition rate. The NAR extension has been experimentally verified by measuring a $\sim$13-m distance with repeatability of 9.5 μm, thus demonstrating that this is a very high standard method applicable for large scale and even space missions in the future. Y. Li et al. explore absolute distance measurement based on femtosecond frequency comb with wavelet transform. The wavelet transform is reported to be a reliable technique that provides good performance and noise resistance for spectrally resolved interferometry data analysis. A unique absolute length measurement method is proposed and demonstrated by D. Wei et al. by using two-color absolute length measuring method based on pulse repetition interval lengths. The proposed method takes advantage of both the high-accuracy measurement capability of a pulse train interference method and the ability of a two-color method to compensate for environmental changes which may open up the possibility of a universal, easily distributable standard for absolute length measurements.

J. Flugge et al. from the Physikalisch-Technische Bundesanstalt (Germany) describe recent improvement of their reference measuring instrument for length graduations, i.e. so-called nanometer comparator, which is intended to achieve a measurement uncertainty in the domain of 1 nm for a length up to 300 mm.

A new optical sensor, referred to as a multiprobe surface encoder, for precision measurement of six degrees of freedom (DOF) planar motions was presented by X.H. Li et al. The experimental results verified that this kind of surface encoder could provide measurement resolutions at subnanometer levels and better than 0.1 arc sec for three-DOF translational motions and three-DOF angular error motions, respectively.

L. D. Yu et al. develop a combined optical measurement method comprised of a laser tracker (LT) and articulated coordinate measuring machine (CMM) to accurately obtain the position of inner key components in the Experimental Advanced Superconducting Tokamak (EAST). Their technology is suited for an inspection of the reconstruction of the EAST. The measurement uncertainty analyzed by the Unified Spatial Metrology Network (USMN) can reach 0.20 mm at a confidence probability of 95.44%. L. Q. Zhu et al. propose a coordinate measuring method with two operation modes, based on the adjustable articulated arms, to keep measurement capability in global space and improve the measurement precision in local space.

The measuring accuracy of laser optical sensors gradually degrades over time as a result of geometrical fluctuations of the laser beam. C.S. Liu and K. W. Lin focuses on stabilizing the laser beam by means of a rotating optical diffuser. Their research confirms that, by an appropriate setting, the proposed system can reduce the variation of the image centroid position and improves the measuring accuracy of the laser optical sensor.

The Nyquist criterion is a well-known theory in optical measurement that states that the sampling frequency of the digital sensor should correspond to at least twice the cut-off frequency to avoid aliasing artifacts. In the paper titled "Subpixel edge localization with reduced uncertainty by violating the Nyquist criterion," P. Heidingsfelder et al. analyzed the subpixel uncertainty of the detected position of a step edge, the edge of a stripe with a varying width, and a periodic rectangular pattern for varying pixel pitches of the sensor, thus also in aliased conditions.

H. L. Fu, K. C. Fan et al. summarize their contributions on a full-scale three-dimensional profile measurement system with an innovative optical setup for measuring the geometric shape of large wind-turbine blades with high accuracy and low cost. The system is capable of measuring any full-scale wind blade profile up to several meters in length.

Q.H. Tian et al. propose a strain measurement method based on a laser mark. The experimental results demonstrate the reasonability of the laser mark design and the advantages of the proposed method, including high accuracy, high repeatability, and its compact structure.

L. Yang and L. Lei present a new noncontact surface roughness measurement technique based on the computer texture analysis which is capable of capturing significant intrascale and interscale statistical dependencies between the wavelet coefficients as well as building the corresponding parameters.

It is hoped that this collection of papers will facilitate readers in understanding the state of the art of the subject and that it serves as a forum for exchanging ideas among researchers in this field.

Finally, we would like to thank all of the authors for their contributions and the reviewers for their valuable comments and efforts to ensure the high quality of the publications. We would also like to thank OE's editor-in-chief and the staff of the OE editorial office for providing both the opportunity and technical support for publishing this special section.

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