

Editorial: Special issue on smart optical instruments and systems for space applications

Guest Editor



XING Fei, born in 1979, is currently an associate professor in Tsinghua University, China. He received his Bachelor degree from Tongji University in 2002 and Ph.D degree from Tsinghua University in 2007. His current research interests focus on novel optical attitude

sensors for space, remote sensing and celestial navigation systems.

Email: xingfei@tsinghua.edu.cn

Optical systems are playing more and more important roles for space applications, such as high accurate attitude determination and remote sensing systems etc. Innovations in optical systems have brought great advantages, some even revolutionary for the space applications. Accordingly, in this special issue of Smart Optical systems and instruments for space applications, eight research articles are published to present recent advances in the state-of-art optical systems and their applications, which involved Nano Star TRacker (NSTR), eXtreme Performance Sun Sensor (XPSS), Realtime Attitude and Position Determination based Intelligent Payload and some typical applications in orbits and effect evaluations. Besides these, some key technologies and instruments for system manufacture, calibration also be introduced to make this issue integrate.

The advanced optical attitude sensors have reaped the great benefits during the last decade, especially at accuracy, miniaturization and update rate, which make them more flexible and suitable for integration with optical payload and nano/pico satellites. The micro star tracker has normally worked on orbit

more than 3 years. The nano star tracker from Tsinghua University has reach the accuracy with 4" and the update rate with 100Hz, and the optical head of pico star tracker has only 30g in mass with almost same level in accuracy, which is even smaller than the predictive products from JPL^[1]. As for sun sensor, a novel system called extreme performance sun sensor with 1000 Hz update rate and 1" accuracy class has been proposed, which employed the technologies of multiplexing image detector and Electrical Rolling Shutter (ERS) combined^[2]. During last decade, this kind of optical sensors have been entirely validated from laboratory to orbit, which lay the solid foundation for wide applications^[3]. Based on Pico Star Tracker (PSTR), a novel system called smart optical payload has been designed and test in lab, which employed auto-collimation principle to monitor and calibrate the inner orientation elements and outer orientation elements simultaneously^[4]. Some evaluation methods or progresses on image processing, including geometry and spectrometry, also have been introduced in this special issue based on the user perspectives^[5-6].

Besides, some basic technologies such as nano particles^[7] or liquid crystal (LC)^[8] for smart optical system also been discussed for next-generation applications.

References

- [1] LIEBE C C, ALKALAI L, DOMINGO G, et al. Micro APS based star tracker[C]. Aerospace Conference Proceedings, 2002. IEEE. IEEE, 2002, 5: 5-2285-5-2299 vol. 5.
- [2] WEI M, XING F, YOU Z. An implementation method based on ERS imaging mode for sun sensor with 1 kHz update rate and 1" precision level[J]. Optics Express,

- 2013, 21(26):32524–32533.
- [3] WEI MI XING F, YOU Z, et al. Multiplexing image detector method for digital sun sensors with arc-second class accuracy and large FOV [J]. *Optics Express*, 2014, 22(19): 23094–23107.
- [4] WANG C, YOU Z, XING F, et al. Optical Flow Inversion for Remote Sensing Image Dense Registration and Sensor's Attitude Motion High-Accurate Measurement [J]. *Mathematical Problems in Engineering*, 2014, (2014): 432613.
- [5] SHEN Z, BAI Z G. HJ-1A/1B Satellites In-orbit Performance Evaluation [J]. *Spacecraft Engineering*, 2009, 18(6), 17–22.
- [6] ZHU B, WANG X H, LI Z Y, et al. A new method based on Spatial Dimension Correlation and Fast Fourier Transform for SNR estimation in remote sensing images[J]. *Geoscience and Remote Sensing Symposium*, 2013 IEEE International, 4114–4117.
- [7] NEDIC S, CHUN Y T, HONG W K, CHU D and WELLAND M. High performance non-volatile ferroelectric copolymer memory based on a ZnO nanowire transistor fabricated on a transparent substrate[J]. *Applied Physics Letters*, 2014(104):033101.
- [8] CHENG P, BAI H, ZAWACKA N K, et al. Roll - Coated Fabrication of Fullerene - Free Organic Solar Cells with Improved Stability[J]. *Advanced Science*, 2015, 2.