Abstract

Digital lock-in technique based on photon counting for multichannel parallel detection in optical imaging

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Introduction

Near infrared optical imaging (OI) has been widely used in imaging of breast, neonatal cerebral oxygen status and blood oxygen kinetics because of its non-invasive nature, security and other advantages. OI needs the measurement of the surface distribution of the output photon flow produced by more than one driving source, which means that source coding is necessary. The most currently used source coding in OI is time-division multiplexing (TDM) technology, which utilises an optical switch to switch light into optical fibres at different locations. However, in the case of many source locations or using multi-wavelengths, the measurement time with TDM and the measurement interval between different locations within the same measurement period will become too long to capture dynamic changes in real-time.

Materials and Methods

A frequency division multiplexing source coding technology is developed which uses light sources modulated by sine waves with different frequencies incident to the imaging chamber simultaneously. A signal corresponding to an individual source is detected with photon counting technology and obtained from the mixed output light using digital phase-locked detection (DPLD) technology at the detection end. A DPLD for a measurement system is implemented on a FPGA development platform. A dual-channel DOT photon counting experimental system is initially established. A series of experimental measurements are taken to validate the feasibility of the system.

Results and discussion

The results indicate that the signal-to-noise ratio (SNR) of the detection of the reflected diffuse light reaches 24dB, the measurement errors of light induced by two different frequency-modulated sources reach 1.59% and 1.04% respectively and the measurement error of light induced by different modulating amplitudes is no greater than 9.13%.

Conclusion

A digital lock-in detection circuit for a photon counting measurement system implemented in a FPGA development platform has been built and verification experiments are reported in this paper. Experiments have demonstrated that the system developed achieves identification of the target source with good measurement accuracy which is very important to parallel detection.

Reference paper as:
H. Zhao, Z. Wang, H. Guo and F. Gao (2012).Digital lock-in technique based on photon counting for multichannel parallel detection in optical imaging (abstract), in: Proceedings of the 15th International Conference on Near
Infrared Spectroscopy, Edited by M. Manley,C.M. McGoverin, D.B. Thomas and G. Downey, Cape Town, South Africa, p. 248.