Digital subdividing method and realization for non-orthogonal grating moiré signals

Shuliang Ye*, Yingkun Xu and Weibin Zhu

Institute of Industry and Trade Measurement Technique, China Jiliang University, Hangzhou 310018, China

**Abstract:** Grating is a kind of photoelectric sensor which is widely used in defense technology, industrial production and social life. In order to improve the measuring resolution, subdivision is used to deal with the grating moiré signals. Traditional subdivision methods such as phase-shifting resistance chain method, lock phase frequency method, carrier modulation method, amplitude segmentation method, etc., all require that the two signals output by the grating reading head are strictly orthogonal.

Actually, because of the influence of the precision of the grating and the adjustment error, the two signals usually cannot be completely orthogonal, and the phase difference is fluctuant. Therefore, the non-orthogonal deviation of grating moiré signal is a key factor affecting grating measurement accuracy. A subdividing method for non-orthogonal grating moiré signals is studied, and a circuit scheme of the non-orthogonal grating moiré signal digital subdividing system is proposed to complete 32–512 times signal subdivision on the FPGA platform.

In the process of subdivision, the amplitude of the two grating signals is collected to determine whether the interval of the signal sampling point is changed, and the dynamic tracking of the intersection of the signal amplitude is realized. And then according to the amplitude of the starting point and the end point of the measurement signal, the corresponding phase points are calculated and the interval is recorded. Combining the intersection of two signals, the phase change can be calculated.

Targeted to signal amplitude ratio and sampling rate parameters in the circuit system, mathematical modeling and quantitative analysis were performed, and the validity of the model was demonstrated by experiment. The results of the study are as following.

1) A circuit realization scheme based on signal collection, pre-processing and subdivision is presented, and the formulas for calculating the phase changing capacity of non-orthogonal grating moiré signals are given.

2) A model of signal amplitude deviance is constructed, and the quantitative relation is established between signal amplitude ratio $k$ and subdivision value $N$. Test results suggest that required compensation for signal amplitude deviance becomes higher steadily when the subdivision value $N$ grows.

3) A model of signal frequency/sampling frequency is constructed, and the quantitative relation is established between the quotient of signal frequency and sampling frequency $f/sf$ and subdivision value $N$. Test results suggest that required sampling frequency becomes lower steadily when the subdivision value $N$ grows.

Proved by experiment, the method has good adaptability to the non-orthogonal deviation in the actual working condition. The study results have guiding significance and reference value on design and realization of the grating moiré signal subdividing system.

**Keywords:** non-orthogonal deviance; grating moiré signals; digital subdividing; amplitude ratio; sampling frequency

**Citation:** Ye Shuliang, Xu Yingkun, Zhu Weibin. Digital subdividing method and realization for non-orthogonal grating moiré signals[J]. *Opto-Electronic Engineering*, 2017, 44(9): 903–911.

See page 903 for full paper.