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A digital moiré fringe method for displacement sensors

Key words: Digital moiré fringe, Displacement measurement, Grating

Corresponding author: Bo Yuan
E-mail: yuanbo@zju.edu.cn
ORCID: http://orcid.org/0000-0002-3185-2690

Introduction

- Displacement measuring technologies with the accuracy of submicron or nanometer based on gratings have received great attention.
- To resolve the problem that it is not easy to install and adjust in the traditional moiré fringe technology by using two gratings, the digital moiré fringe method by using only one grating is proposed.
- A displacement measuring system based on digital moiré fringe has been presented in this work.

The systemic configuration

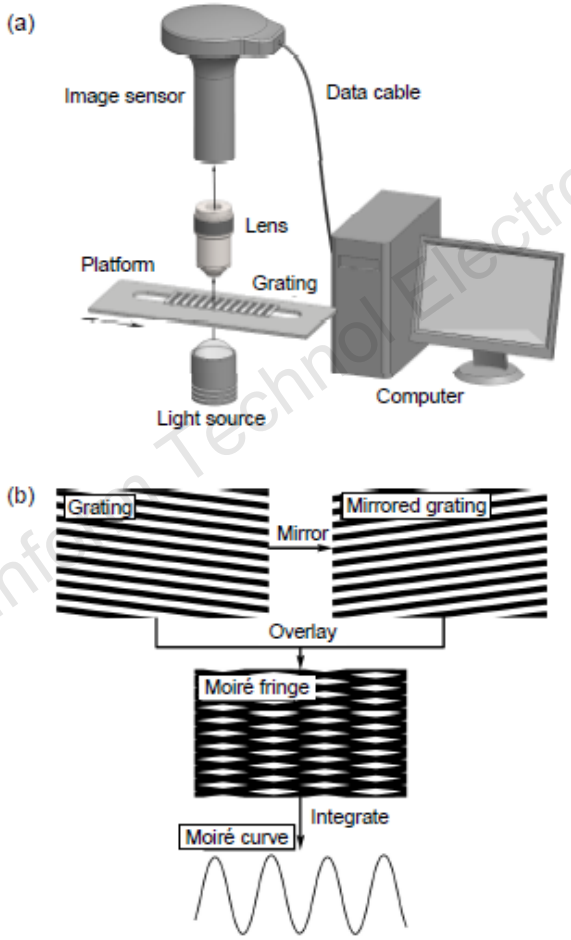

Fig. 1 Systemic configuration: (a) optical system; (b) formation of digital moiré fringes

Phase estimation

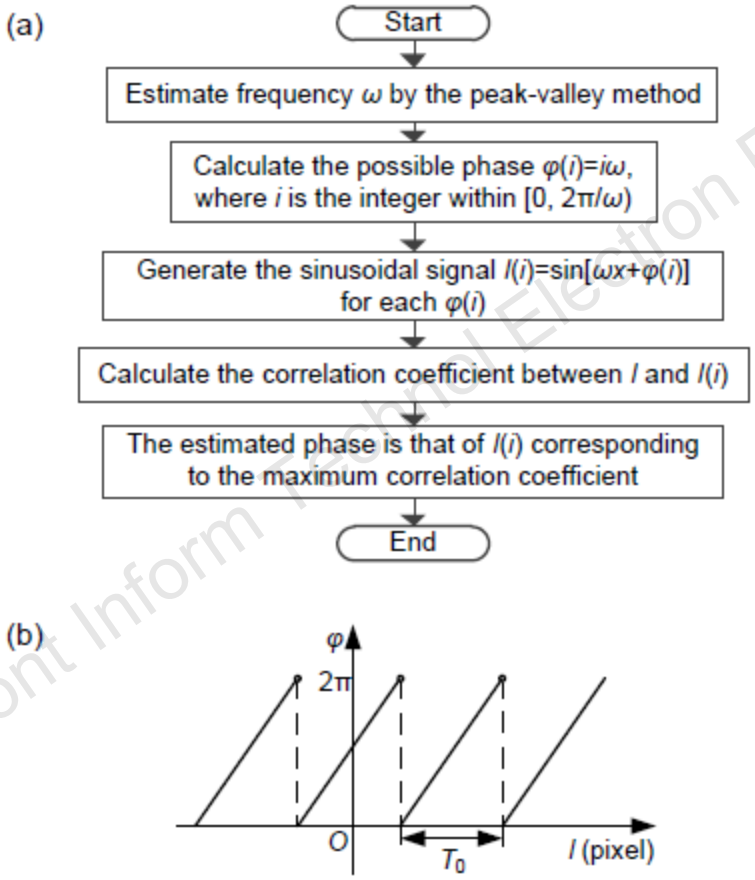

Fig. 3 Phase estimation (a) and the phase variation with the displacement of the moiré fringe (b)

Displacement measuring system

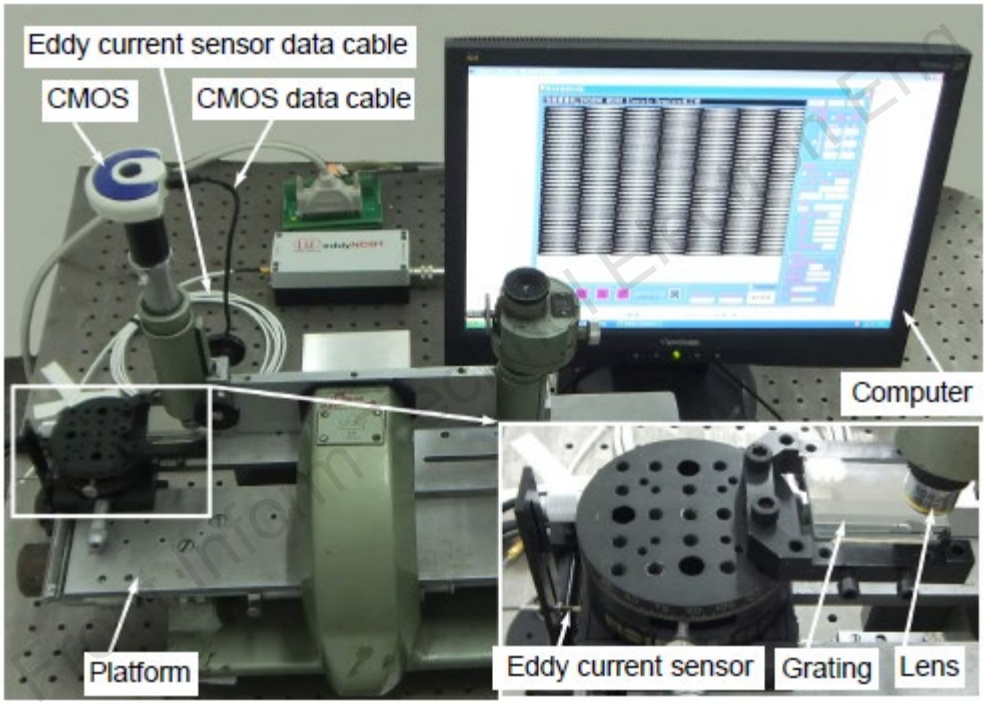

Fig. 4 The displacement measuring system

Measurement results (1) – signal quality

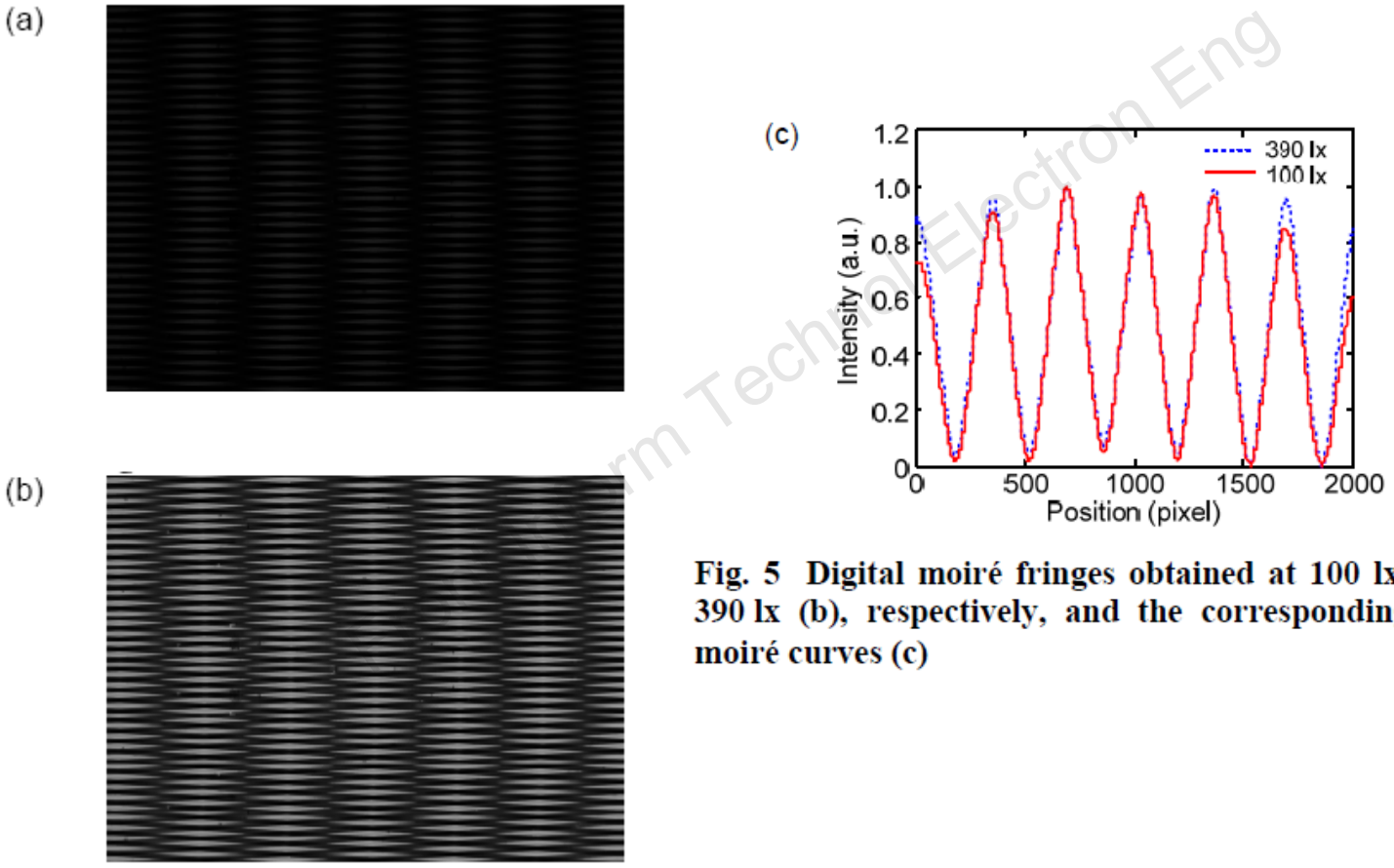

Fig. 5 Digital moiré fringes obtained at 100 lx (a) and 390 lx (b), respectively, and the corresponding digital moiré curves (c)

Measurement results (2) – stability and sensitivity

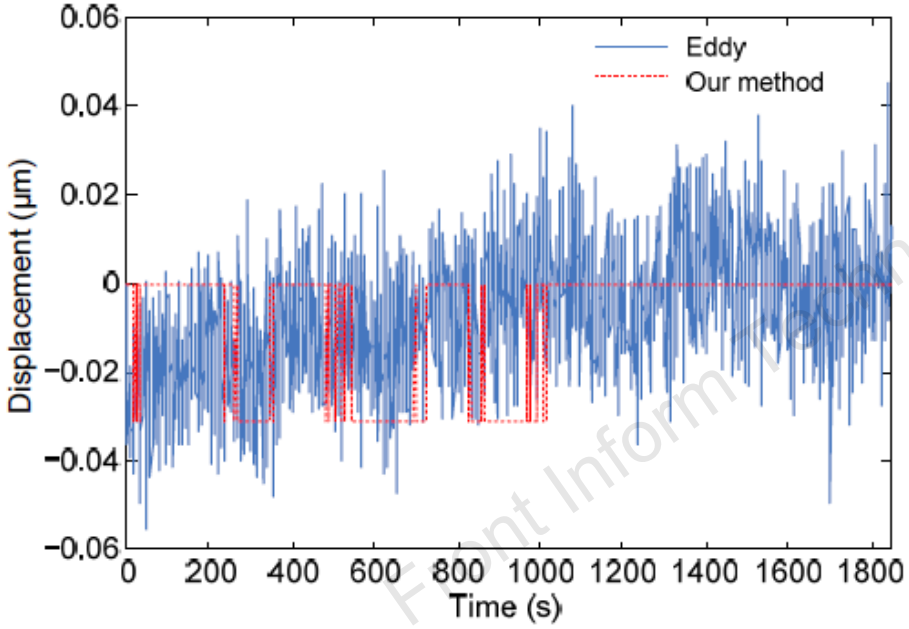

Fig. 6 Results of the stability test

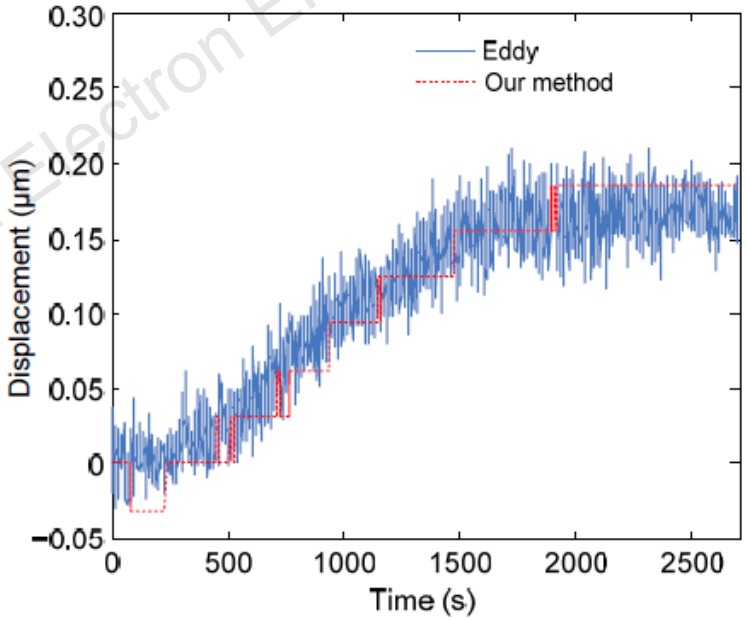

Fig. 7 Results of the sensitivity test

Measurement results (3) – accuracy

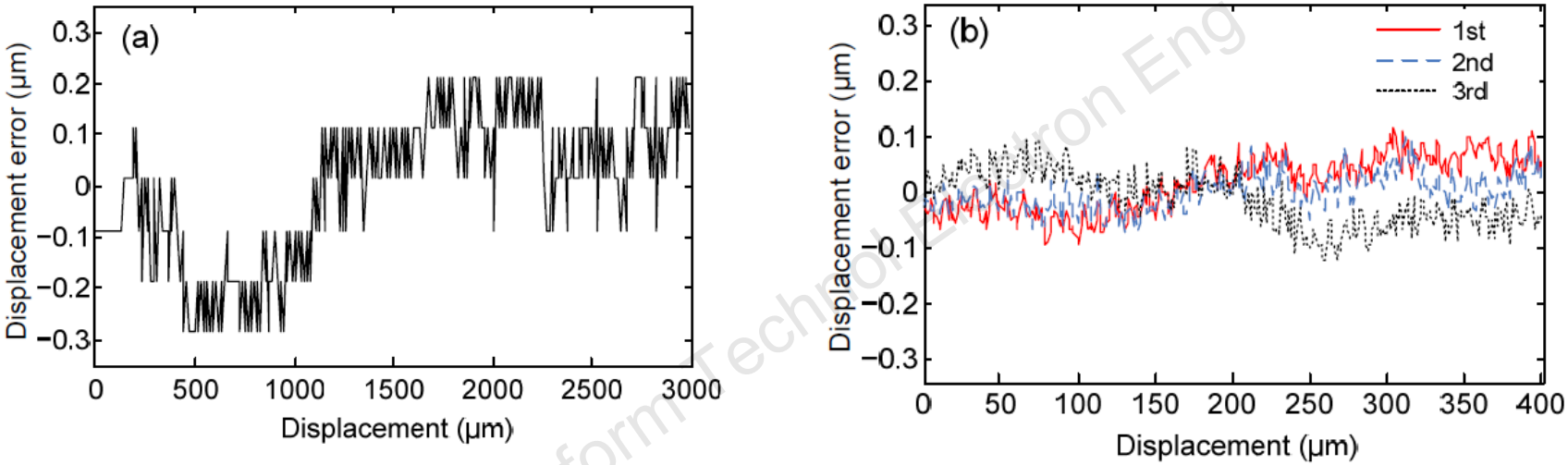

Fig. 8 Displacement error between the grating ruler and the measuring system with 0.1 μm resolution (a) and between the eddy current sensor and the measuring system with 0.03 μm resolution for each of the three measurements (b)

Conclusions

- A digital moiré fringe method using one grating was proposed and experimentally tested in the present study.
- The proposed method has the advantages of the traditional moiré fringe technology, and it is easy to install and adjust resolutions.
- The proposed measuring system is simpler and costs less compared to the systems with the same resolution.