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IMPROVING THE PERFORMANCE OF FBG SENSING SYSTEM

**A thesis submitted in fulfillment of the requirement for the award of
the degree of**

Master of Engineering Research

from

University of Wollongong

By

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CERTIFICATION

I, Xingyuan Xu, declare that this thesis, submitted in partial fulfillment of the requirements for the award of Master of Engineering Research, in the School of Electrical, Computer & Telecommunications Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not be submitted for qualifications at any other academic institution.

Xingyuan Xu

26 June 2006

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ABSTRACT

The Fiber Bragg Grating (FBG) is a periodic perturbation of the refractive index inside the fiber formed by exposure of the fiber core to an intense optical interference pattern. The most important property of FBG is that it will reflect the incident light with particularly predetermined wavelengths, while passing all the other wavelengths of light at the same time. As the wavelength of the reflected light varies with the strain, temperature and other environmental factors, detection of the wavelength will yield information about these quantities. Recently, FBG has attracted much research and development effort due to their potential enormous potential of strain and temperature sensing in smart structures and polymeric materials, thereby several FBG sensing systems have been developed.

This research aims to develop new approaches to improve the performance of FBG sensing system. Firstly, we have demonstrated a novel demodulation system based on wavelength-multiplexed FBG sensors and the Fabry-Perot (FP) tunable filter for measurement of vibration/dynamic strain. By using such a system, the restricted scanning frequency of FP tunable filter is overcome. Furthermore, signal processing methods are proposed to achieve more reliable and accurate measurement. In the experiment, program controlled multipoint dynamic strain detection is successfully implemented by this system. The second task involved in this research work is to develop signal processing methods for improving the measurement precision of FBG sensing system. In practical applications, various types of noise will occur that significantly limit the accuracy of wavelength detection. Therefore, proper signal processing method is required, especially for long-term applications. In this thesis, classical digital filter, adaptive digital filter and neural network were investigated to solve this problem.

The last issue of this thesis is to improve the performance of the FBG sensing system

which using intensity and wavelength-division multiplexing (IWDM) technique. IWDM technique has the advantages of low complexity and enabling the system to contain twice the number of FBGs as the conventional WDM technique. However, this technique requires long processing times to get high detection accuracy. In this chapter, three optimization algorithms: gradient algorithm, tabu search algorithm and tabu-gradient algorithm are developed to improve the performance of IWDM based FBG sensing system.

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Xingyuan Xu, Jiangtao Xi, and Joe Chicharo, “Improving the Measurement Accuracy of FBG Sensor Using Adaptive filters,” Submitted to *Proceeding of international topic meeting on microwave photonics*. France, 2006.