

Optical Remote Sensing using Fiber Bragg Device for Load Measurement

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Abstract

This work is the feasibility study of the load sensors, using optical remote measurement scheme. The optical head is fiber Bragg grating. The light source from He-Ne laser is launched into the fiber coupler that is divided 2 parts: the first is transmitted to the sensing. The other part isn't use. The return signal is connected to detector.

A coherent light beam from a laser He-Ne with wavelength of 632.8 nm. It's launched into fiber coupler and the end is connected to a sensing unit i.e. fiber Bragg grating. The return signal from applied load is detected by a detector and seen on the oscilloscope monitor. The change in output signal intensity relating to the applied loads is measured.

The measurement relationship between the applied loads and output light intensity are detected, where the long length of single mode fiber is shown the remote sensing sense. This advantage is use in the dangerous place of human, to develop to small load sensing, is remote sensing.

Keywords: optical sensor, remote sensor

1. INTRODUCTION

Optical devices have been widely used either in sensors and communications [1-3]. An optical device known as fiber grating has also been investigated and used in both areas [4]. The use of such a device for temperature sensor has been reported [5], where grating was attached between two different materials where their thermal expansion effect the change in grating period introducing the temperature measurement. The simultaneous measurement of temperature and strain was investigated [6], where two different physical parameters could be observed and measured using such a simple and low cost technique. The use of fiber grating for the measurement of alternative current (ac) was reported by [7], the multimode laser diode was employed to relatively measure the change in modulated frequency respecting to the change in drive current. Fiber grating was also used in communication and signal processing system, to complement the idea

of all fiber communication and networks [8].

The measurement relationship between the applied load and output light intensity is detected by detector, where the long length of single mode fiber is shown the remote sensing sense [9].

2. OPERATING PRINCIPLES

When coherent light from source enters into an optical system and sensing element as shown in Fig. 1, the coupled light from one end of the sensing fibers is reflected into the launching source, the other is reflected to the optical detector, P_r , which is expressed as [9]

$$P_r = \sin^2 \left[2 \int_0^z C(z) dz \right] \quad (1)$$

The coupling coefficient from equation (1) is given as

$$C(z) = 3.26 \delta^{1/2} / a(z) [V(z)]^{5/2} \quad (2)$$

$$V(z) = a(z) k (n_1^2 - n_2^2)^{1/2} \quad (3)$$

$$\delta = 1 - (n_2/n_1)^2 \quad (4)$$

and $k = 2\pi/\lambda$. Where a is the coupling fiber radius, n_1 and n_2 are core and cladding refractive indices of the coupling fibers, respectively. λ is light source wavelength.

The change in grating period, Λ , is formed the change in Bragg wavelength as

$$\lambda_B = 2 m n_c \Lambda \quad (5)$$

where λ_B is Bragg wavelength, $m = 1, 2, 3, \dots$ is the reflection grating wavelength order. n_c is fiber optic refractive index and G is Bragg grating period.

When force is applied on the sensing unit that the change in grating period occurs inducing the change in output reflected light, P_r , which is observed by detector.

3. EXPERIMENT

The experimental system is shown in fig 1. A coherent light from a laser He-Ne with wavelength of 632.8 nanometers is employed then launched into a fiber coupler, before entering into a sensing unit i.e. fiber Bragg grating. The return signals either from the applied loads or fiber end itself is detected then seen on the oscilloscope monitor. The change in output signal intensity relating to the applied loads is observed respecting to the sensing head position. The reflected light output from sensing unit is split and observed by using monochromator before entering into a detector.

4. DISCUSSION AND CONCLUSION

The experimental system set up is shown in figure 1. We measured intensity and wavelength that is changed depending on applied load by detector and displayed below.

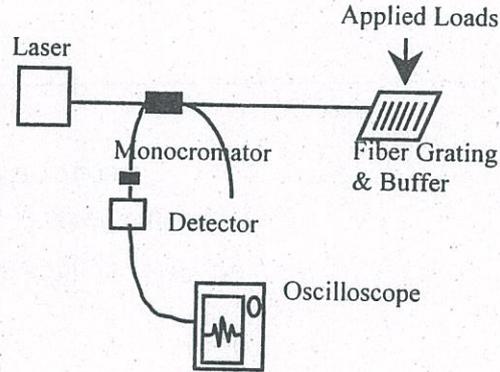


Figure 1 Illustrates of the experimental system use for load measurement.

Load (gram)	ΔV (mV)	Wavelength (nm)
50	3.8	635.3
100	3.4	635.2
200	3.4	635.0
400	3.4	634.9
500	4.4	634.8

Figure 2 is shown the graph of voltage, wavelength and weight variation

Regarding the experimental results, fiber Bragg grating load sensor can be generated wavelength and light intensity variation by loading the various weights. Wavelength, light intensity and weight have a relationship in accordance with the following formula (1) – (5).

The continuing work is focussed of the remote sensor scheme for dynamic load measurement, the return signal of the scheme obtained from the moving vehicle can be used to utilize the measurement. The change in signal or detected wavelength using monochromator may be realized the practical application. The sensor head design and use are the major problems have to be taken care for the future works.

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