INTENSITY BASED FIBER OPTIC DEFLECTION SENSOR

M.Sumathi, R.Pratheep,
Professor and Head, Department of ECE, Sona College Of Technology, Salem, India
Project Associate, Department of ECE, Sona College Of Technology, Salem, India
E-mail: nnsuma@yahoo.com, pratheep.r@rediffmail.com

Abstract: In this work, a low cost intensity based intrinsic fiber optic deflection sensor has been developed. This can be used to measure or detect angular displacement of articulated arm. Experimental results show that the sensor output is linear up to a certain degree of angular displacement and constant beyond that. The deflection sensor finds its application in office equipments, medical equipments, general automation, locking mechanisms, positioning systems and robotic arm control systems.

1. INTRODUCTION

Optic fibers are used for both communication and sensing applications. In communication application, the geometrical properties (size and shape) of the fiber are unperturbed; retaining its optical properties so that the signal transmission and reception is reliable. In sensing applications the changes in geometrical properties by external influences is enhanced and the resultant change in its optical properties can be used to appraise the external influence on the cable. Hence optic fiber acts as a transducer.

The following are the advantages of optic fibers when used as sensors:

a) Allows access into normally inaccessible areas due to non-electrical nature.
b) Offers potential resistance to ionizing radiations, hence offers secured signal transmission.
c) Immune to Radio Frequency Interference (RFI) and Electro Magnetic Interference (EMI).
d) Passive in nature due to the dielectric construction.
e) Low attenuation allows transmission of signal over long distance.

Specially prepared fibers can withstand high temperature and other harsh environments.

Fiber optic sensors are classified as follows:

a) Based on place of sensing, they can be classified as Extrinsic and Intrinsic sensors. If the sensing takes place in a region outside the fiber, it is known Extrinsic sensor, in Intrinsic sensor one or more physical properties of the fiber undergo a change.
b) Based on modulation and demodulation process, a sensor can be called as intensity (amplitude), phase, frequency or a polarization sensor. The detection or interrogation techniques are simple for intensity based sensors while the other types of sensors require complex design and calls for interferometric techniques; hence they are also referred as interferometric sensors.
c) Based on their application, they are also named as:
   Physical sensors: - for measurement of temperature, stress, pressure etc.
   Chemical sensor: - for measurement of pH levels, gas analysis and spectroscopic studies.
   Bio-medical sensors: - for medical applications, etc.,

In this paper, Intensity based Intrinsic deflection sensor in which the amplitude of light passing through the fiber is altered according to the deflection or angular displacement of the fiber has been discussed.

2. PREVIOUS WORK

Deflection sensors based on Fiber Bragg Grating (FBG) have been discussed in [1] and [2]. The deflection causes a shift in the Bragg wavelength which is measured. Ping Lu et al [1] detail on water flow rate measurement using the deflection sensor. Alexandar and Rui [2] discuss on deflection sensors for measurement of deflection of structures under external load.

Deflection sensors based on measurement of cantilever bending using optical fiber sensors is discussed in [3], sensors based on Mach-Zehnder interferometric method [4], Sagnac interferometric principles[5], Reciprocal interferometry[6], Gaussian interference technique [7].

Sensors based on reflectometric principles [8], [9] and wave guides [10] are useful in detecting displacements with good precision with limited applications due to complexity.

Majority of displacement sensors require an expensive interrogation technique to detect the wavelength shift which limits its use in simple and less precision applications. In our work, a simple and cost effective intensity based deflection sensor has been developed. They can be used in office equipments, medical equipments, general automation, locking mechanisms, positioning systems and robotic arm control systems, etc.,

3. PROPOSED WORK

Many applications require information about the degree of inclination or bending. We propose a simple intensity based sensor for this purpose. When the fiber is bent, it results in bending losses and thereby the intensity of light propagating in the fiber reduces. The loss depends on the degree of bending of the fiber. Therefore, a measure of the intensity of light transmitted through the fiber can be related to the extent of deflection.
In this work, an optical fiber embedded on two articulated arms pivoted at one end to provide a rotary displacement was used to study the deflection characteristics of the fiber figure 1. One end of the fiber was illuminated using the optical source and an optical detector was used on the other end to sense the intensity variation.

The angle between the two arms was varied and the corresponding output voltage at the detector due to change in light intensity has been studied.

4. RESULTS

<table>
<thead>
<tr>
<th>Angular Displacement (deg)</th>
<th>Sensor Output (Volts)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180</td>
<td>5.08</td>
</tr>
<tr>
<td>170</td>
<td>5.08</td>
</tr>
<tr>
<td>160</td>
<td>5.07</td>
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<tr>
<td>150</td>
<td>5.06</td>
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<td>140</td>
<td>5.01</td>
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<td>120</td>
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</tr>
<tr>
<td>80</td>
<td>3.9</td>
</tr>
<tr>
<td>70</td>
<td>3.67</td>
</tr>
</tbody>
</table>

Table 1 Experimental Results

Fig.2 Sensor output versus Angle of deflection

Table 1 represents the experimental values recorded between the angular displacement of one arm with respect to the other and the corresponding output voltage measured at optical detector.

Figure 2 represents the graph plotted between angle of deflection and sensor output of Table1. From the results it is noted that the sensor output is nearly constant for angles greater than 140 degrees. The output varies linearly between 70 and 140 degrees.

The proposed sensor can be used for applications were angular displacement is to be measured and also for applications that require knowledge of the binary state with reference to a certain position of angular displacement. Based on the increase or decrease of the sensor output with respect to a reference value, the direction of deflection can also be determined. Hence, this can also be used in applications which require the above parameters.

5. CONCLUSION

In this paper, a simple low cost intensity based fiber optic deflection sensor has been developed. The output of the sensor is found to be nearly linear for a certain range of angular displacement.

REFERENCES

