*Available online at http://www.journalcra.com*

*International Journal of Current Research*
*Vol. 7, Issue, 11, pp.23167-23169, November, 2015*

**INTERNATIONAL JOURNAL OF CURRENT RESEARCH**

**ISSN: 0975-833X**

**RESEARCH ARTICLE**

# STUDY OF DISTANCE FACTOR IN DESIGNING OF AN OPTICAL FIBER SENSOR

**[*,1]Mahdi Mahjour and [2]Hossein Golnabi**

[1]Department of Physics, Faculty of Basic Science, Islamic Azad University, Tehran North Branch, Tehran, Iran
[2]Institute of Water and Energy, Sharif University of Technology, Tehran, Iran

**ARTICLE INFO**

*Article History:*
Received 20th August, 2015
Received in revised form
05th September, 2015
Accepted 17th October, 2015
Published online 30th November, 2015

*Key words:*
Optical fiber sensor,
Output power, Light.

**ABSTRACT**

Simultaneous with developing science and technology, increasing need to controller devices is felt more than before. Among these controller devices, those sensors preparing with optical fiber due to themselves advantages are very popular. In this study factor of distance in three main directions for an optical fiber sensor from 200 to 2700 micrometer has been studied and results was shown in two orders, microwatt and dBm. Accordingly, the maximum light reach to second fiber when two fibers be only fixed in a line (Z axis). Furthermore, increasing distance results in decreasing output power. In this paper the first stage of designing an optical fiber sensor which is increasing distance factor, has been performed and other dates will be published in future regarding the achievement.



***Citation:*** Mahdi Mahjour and Hossein Golnabi, 2015. "Study of distance factor in designing of an optical fiber sensor", *International Journal of Current Research*, 7, (11), 23167-23169.

## INTRODUCTION

These days, with developing of science and technology, the growing need for optical fiber is felt more than before. Among several applications of optical fiber (Mahjour, 2015), using the serve as sensors is very popular. Immunity in electrical, magnetic and noise, bandwidth to transmission of information from 400 MHz to 1.5 GHz, flexibility for a variety of layouts, low weight, small size, ability to function at high temperature and in presence of corrosive and flammable chemicals (Goure, 1992). Different reports on the design of optical fiber sensors contains humidity effect on the air (Golnabi, 2012), leakage sensor (Golnabi and Azimi, 2007), displacement sensor (Golnabi and Azimi, 2008), linear thermal expansion (Golnabi, 2002) and many of these have been given (Senior, 1992; Grattan and Sun, 2000; Haus, 2010; Crisp and Elliott, 2005; Krohn, 1998; Udd, 1991).

In this paper relating to my master thesis is to be paid to early stages of designing an optical fiber sensor. In the first stage of the thesis which is related to results of changing distance in three main directions has been examined, expressed here.

***Corresponding author: Mahdi Mahjour,**
*Department of Physics, Faculty of Basic Science, Islamic Azad University, Tehran North Branch, Tehran, Iran.*

## MATERIALS AND METHODS

An arrangement of two optical fibers has been provided in Figure 1. Light of LED after passing first fiber enters to the gap. Those groups of beams that are able to pass the gap and arrive to the of second fiber mouth, are guided to optical power meter (WG OLP-15B optical power meter Wandel and Golterman, precision in 0.001 micro Watt). The power of reached light to optical power meter be counted by the device. Volume and length of the gap is able to change with changing place of second fiber by XYZ device (FARANOOR, precision in 10 micrometer Figure 2).

## RESULTS AND DISCUSSION

As is showed in diagrams regarding X and Y axes, maximum light reaches to second fiber when two fibers only be fixed in a line completely. Furthermore, as is showed in diagram regarding Z axis, with increasing distance between fibers, inputted beams to second fiber decrease. As is showing in Figure 3 to 8. Absorption ($t_1$) and distribution ($t_2$) are two factors for the reduction:

$T = t_1 + t_2$

Absorption of the gap molecules can be achieved from Beer-Lambert Low:

$$I = I_0 e^{-\beta d}$$

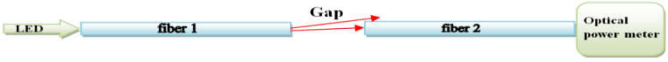


Figure 1. An arrangement of two optical fibers

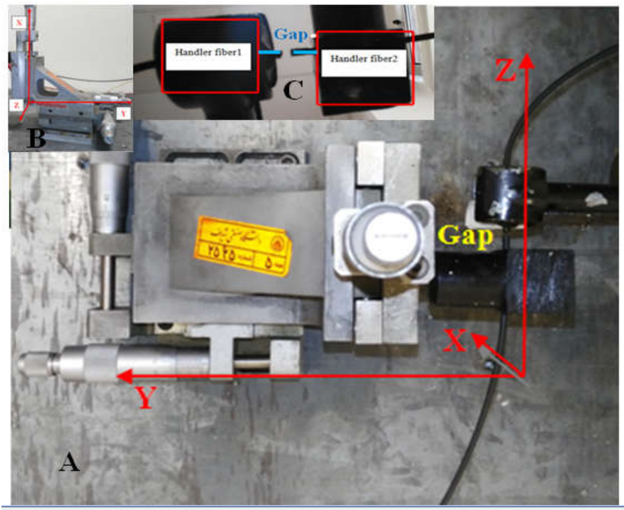


Figure 2. XYZ device, A) picture from top of the desk, B) beside the XYZ, C) from down of the gap

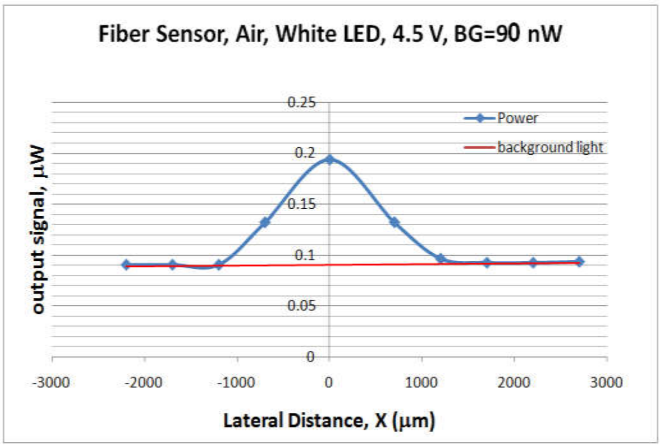


Figure 3. Output power in microwatt for changing lateral distance of X axis

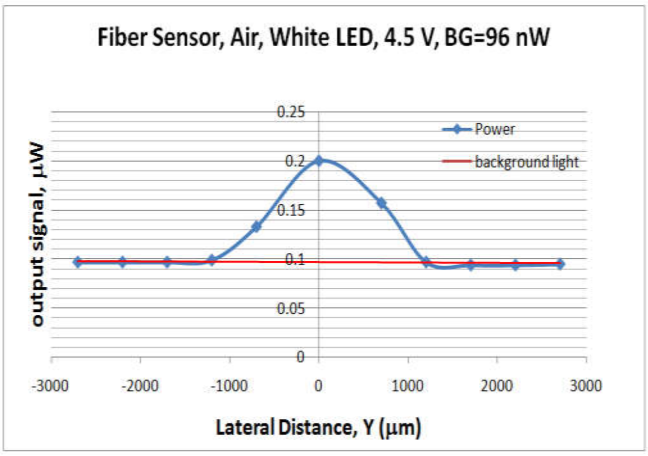


Figure 4. Output power in order of microwatt for changing lateral distance of Y axis

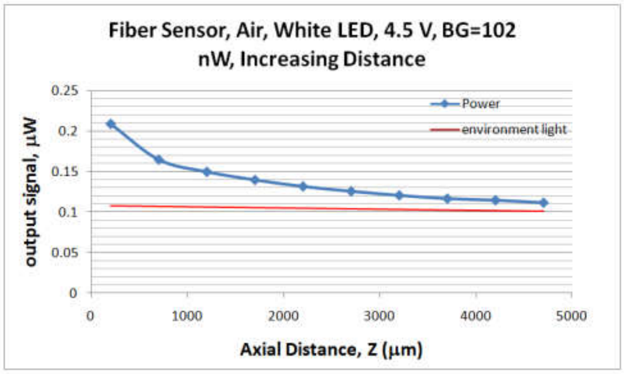


Figure 5. Output power in order of microwatt for changing axial distance of Z axis

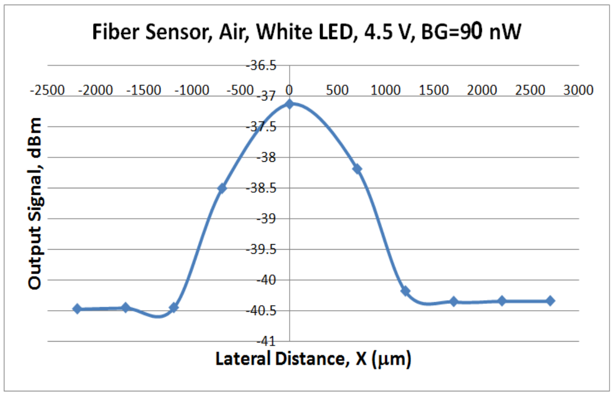


Figure 6. Output power in order of dBm for changing lateral distance of X axis

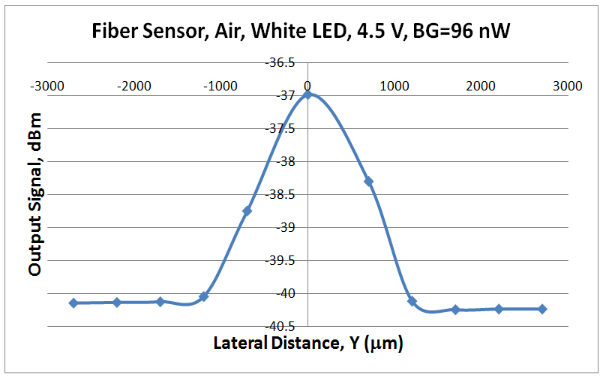


Figure 6. Output power in order of dBm for changing lateral distance of Y axis

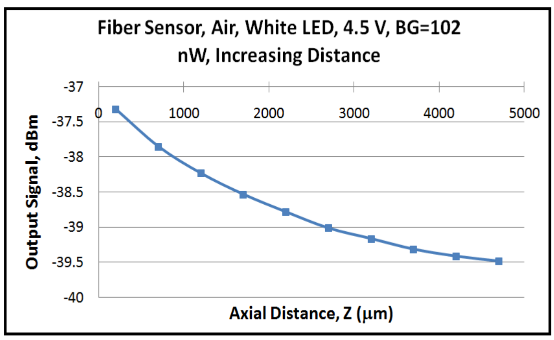


Figure 6. Output power in order of dBm for changing axial distance of Z axis

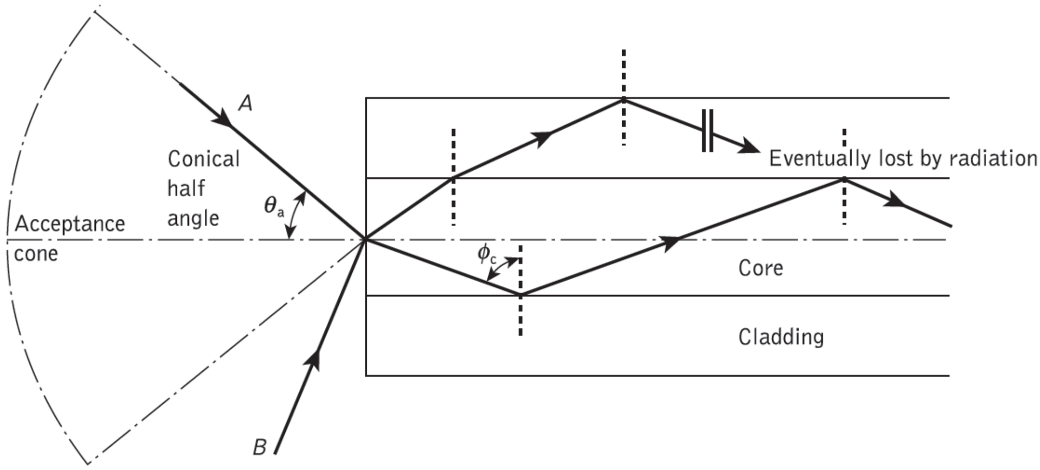


**Figure 9. Acceptance angle $\theta_a$ when a beam is entering to fiber (Senior, 1992)**

That ($\beta$) is achieved from beat of density ($\sigma$) and number of molecules ($N$) of gap. Furthermore, ($d$) is related to the length of gap.

Distribution factor in this way comes that the portion of whole beams only can pass the gap and reach to the second fiber. Other beams propagation in gap environment. This fact can be given by the following equations:

$$n_0 \sin \theta_1 = n_1 \sin \theta_2$$

The upside equation which named Snell's law can be written in:

$$n_0 \sin \theta_1 = n_2 \cos \varphi$$

Should be noted that $\phi = \frac{\pi}{2} - \theta_2$ :

The equation be changed by $sin^2\varphi + cos^2\varphi = 1$ :

$$n_0 \sin \theta_1 = n_1(1 - \sin \varphi)^{1/2}$$

In the limit case $\phi = \phi_c$, also in limit case $\theta_1 = \theta_a$ (a = acceptance angle), so:

$$n_0 \sin \theta_a = (n_1^2 - n_2^2)^{1/2}$$

$$NA = n_0\, sin\, \theta_a = (n_1^2 - n_2^2)^{1/2}$$

Numerical Aperture (NA) is the equation that determines the volume of entrance light to the fiber with specify refractive index ($n_2$). (Senior, 1992)

**Conclusion**

In the paper the fact was showed that maximum light reaches to second fiber when only two fibers be fixed in a line completely. Furthermore, decreasing of output power due to increasing distance in three main directions was expressed. It is important to note that the paper expressed the first stage of designing an optical fiber sensor that the stage was checking distance factor in reduction of output power. In future, papers will be published regarding carrying out such these experiments with changing gap environment to rate changes to detect parameters.

**Acknowledgment**

The author likes to thank from dear teacher: Dr H.Golnabi regarding his helps and advisors in performing these experiments.

## REFERENCES

Crisp, J., Elliott, B.J., 2005. Introduction to fiber optics. 3rd ed. New York: Elsevier

Golnabi, H., 2002. Design of an optical fiber sensor for linear thermal expansion measurement, Optics & Laser Technology 34, 389 – 394

Golnabi, H., 2012. Using three different optical fiber designs to study humidity effect on the air refractive index, Optics and Lasers in Engineering 50, 1495–1500

Golnabi, H., Azimi, P., 2007. Design and performance of a plastic optical fiber leakage sensor, Optics & Laser Technology 39, 1346–1350

Golnabi, H., Azimi, P., 2008. Design and operation of a double-fiber displacement sensor, Optics Communications 281, 614–620

Goure, J, P., 1992. Optical Sensors: fiber optic sensors, international chemical engineering, vol 32, no 4, October

Grattan, K.V., Sun Dr. T., 2000. Fiber optic sensor technology: an overview. Sensors Actuators A, 82 (1-3):40–61

Haus, J., 2010. Optical sensors; basics and applications, New York: Wiley-VCH; p. 189

Krohn, DA., 1998. Fiber optics sensors-fundamentals and applications, NC: Instrument Society of America

Mahjour, M., 2015. Do Carbon Nanotubes (CNTs) Play The Role of Optical Fibers in Transmission Light from Throughout Themselves, *International Journal of Current Research.*

Senior, JM., 1992, Optical fiber communications, principles and practice. 2nd ed. New York: Prentice Hall; p. 281–367.

Udd E., 1991. Fiber optic sensors; an introduction for engineers and scientists. New York: Wiley Interscience

*******