A review on various measurement techniques of Fiber Optical Sensors

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***Abstract* – In the Modern development, Fibre optical sensors (FOS) have gained increased popularity and market acceptance. Fiber optic sensors are very important tools for Several Measurements. In this talk after a very brief introduction of the basic Fibre optic sensors the several measurements of Fibre optic sensor technology will be reviewed, several significant examples addressed and finally the conclusion summarized. However, in this paper we emphasize on all available Physical measurements such as force, pressure, stress/ strain, temperature, displacement, vibration, acoustics and acceleration. Current Sensor, Magnetic Sensor and Chemical as well as Biological Sensing Methods which is useful information for researchers and scientist who work in the area of Fiber optic sensor.**

***Index Terms*— Physical, Electro- Magnetic, Chemical and Biological Sensing Measurement of Fiber optical sensors.**

I. INTRODUCTION

Many of the measurement performed today using fiber optical sensors. An optical sensor is a device that converts light beam into electronic signals. Alike to a photo resistor, it measures the physical quantity of light and translates it into an appearance read by the instrument. Fiber optic sensors have a variety of uses. They can be found in everything from computers to motion detectors [1].

As shown in Figure 1, a fiber-optical sensor system consists of an optical source, optical fiber cable, and modulator element transducing the measurand to an optical signal, an optical detector and processing electronics. The origin of laser opens up a new world to researchers in the field of optics. Light sources used to support fiber-optical sensors produce light means frequently impact by either spontaneous or stimulated emission. A combination of these types of emission is also used for definite classes of fiber-optical sensors [2].

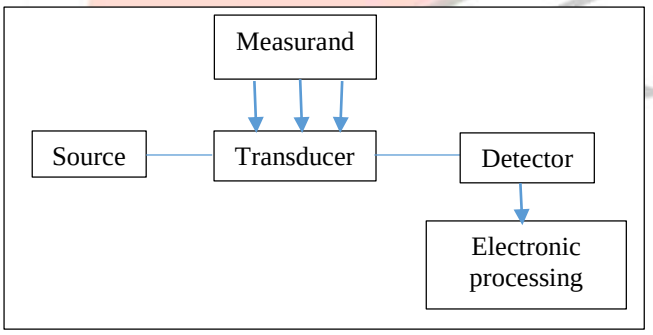

Fig.1.

Figure 1. Basic components of a fiber-optical sensor system [2]

There are two types of Optical fibre sensor Extrinsic & Intrinsic. In an extrinsic sensor, light has to leave the fiber and to reach the outside the sensing region, and then return again to that fiber. Here transducer acts as a fiber [2]. In an intrinsic sensor, the fiber has itself sensing element. In this light beam does not leave the fiber but its changed within it. Here fiber itself as a transducer [1].

Optical techniques for Physical, Chemical & Biological Sensing measurement have a large variety of uses and applications, as will be discussed in this paper. An optical-based technique may be employed to provide automated and very quick measurements [3].

II. PHYSICAL MEASUREMENTS

Physical measurements such as force, pressure, stress/ strain, temperature, displacement, vibration, acoustics and acceleration we will shortly discuss one by one.

Force: Now days, for the measurement of forces fibre Bragg grating (FBG) sensors have been developed. It is an optical device. This type of sensor are suitable for medical applications. The cost of FBG sensing system is an in expensive and very well organized device for force sensing measurement [4]. The basic idea behind an optical fiber force sensor is that superficial pressure exerted on the surface of that fiber will cause a distortion that can be measured by the resulting change of the light signal that moves through the fiber [5]. For example, for railway monitoring fibre Bragg grating (FBG) have been used [6].

Pressure: Recently, the pressure sensor has based on movable diaphragms, on the small Fabry Pérot interferometer, or on micro bending systems [7].The technology involved the use of physical change of an optical fiber to detect strain due to relevant pressure. The alternative technique utilizes an elastic film which constructed in layers that can modulate the reflected wavelengths according to the applied pressure. There are three main types of optical fiber pressure sensors are as Intensity based pressure sensors, FBG Sensors and Fabry Pérot pressure sensors. All these are suitable for various applications including medical disposable sensors [8].

Strain: Currently FBG technology seems to be measured strain sensors. There are several methods for strain sensors as Stimulated Brillion Sprinkling, Polarimetry in double refraction materials and Fiber Bragg gratings. The strain is sensed by observing the transmitted or reflected wavelength from the gratings as it is towards elongation. These gratings are easily produce and it is cost effective [9]. In the strain sensor accuracy and sensitivity of the sensors depends on the optical system [10].

Temperature: Fiber optic temperature sensor is simple and useful in many application for further growth. There are three familiar principle of fiber optic temperature sensor measurements are as Fiber Bragg gratings, Raman Scattering and interferometric point sensors [11]. One of the basic idea is that to terminate the fiber in a pellet at a reflecting surface. Another side of surface an air bubble. This will change the dimension along temperature, thus enabling thermosensitive cladding of the fiber for contract or expand. Accordingly, the weaker signal of light and the numerical aperture in the fiber will modulate with temperature [12].

Distance and Displacement: Recently, optoelectronic sensor has been used for distance sensor measurement have large variety of applications. There are six techniques used as intensity based, triangulation, and time of flight, confocal, interferometric sensor and Doppler sensing [3]. Some of the first Fiber Optic displacement sensing technique to be succeed in the early's 1980s. One of the micro bending concept to sense displacement by produce loss in a fiber due to indented plates variably pressing on the fiber [11].

Acoustic and Vibrational Sensor: Mostly, for fiber optic vibrational sensor we use hydrophones for naval applications. Similarly, for fiber optic vibrational senor we use microphones for audio apparatus manufactures [11]. Simple idea is that when light travels along an optical fiber, it experiences minute changes caused by any moderately vibration to the fiber. Using developed sensors we can measure and detect the sensitive optical fiber as a disperse microphone in order to identify the nature of disturbance [16]. For example, an extrinsic Fabry Perot interferometer device has been used for acoustic and vibrational sensor for airport ground traffic monitoring [13].

III. ELECTRO- MAGNETIC MEASUREMENTS

Electromagnetic sensing by using optical fiber sensor has been highly stable properties and flexible form. Faraday Effect has been used for the current sensor and Electro-optic effect has been used for the Voltage sensor. One of the basic idea is that, according to Faraday rotation current sensing has always in the optical fiber itself and voltage sensing always utilizes the electro-optic effect in a different crystal coupled to an electric field which can be measured both the effect are intrinsically very fast therefore measurements with bandwidths of gigahertz are reasonable.

There are many applications of electromagnetic optical fiber sensor such as power industry, Voltages, generators and turbines and Medical field [14].

IV. CHEMICAL AND BIOLOGICAL MEASUREMENTS

Chemical and biological sensor has a very vast field. Now we only overlook this two sensor. Optical fiber Chemical sensor includes Carbon dioxide, Ammonia, Hydrogen, Oxygen, Humidity sensors, Gas sensors, Cations and Anions as well as Organic compounds has different sensor sections. Fiber optic bio-sensors involves Antibodies, Enzymes, Nucleic acids and whole micro-organisms section.

There are many application of Chemical and Biological fiber optic sensor such as Clinical diagnostic for Food Control, Water Purification techniques, Fine Chemistry, Manufacturing and Petrochemical industries [15].

V. CONCLUSION

In this report we have discussed several measurements of Fiber optic sensors which has vital role in Physical, Current Sensor and Magnetic Sensor as well as Chemical and Biological Sensing Measurements. All these Fiber optic sensor measurements techniques will be very useful for Day to Day life.

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