Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(6):1151-1155

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Application of optical fiber sensor technology in building Internet of things

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ABSTRACT

Optical fiber sensor is mainly composed of light source, optical fiber, photo detector and signal processing part. The Internet of things is based on Internet with RFID technology, infrared sensors, GPS and laser scanners and other information sensing equipment items and Internet connection. Optical fiber sensor for its many advantages of light weight, high sensitivity, strong anti electromagnetic interference ability, and it is the security of data transmission, etc. This paper analyzes the application of optical fiber sensor in Internet of things.

Keywords: Optical fiber sensor, Internet of things, RFID.

INTRODUCTION

The Internet of things technology relates to the modern electronic technology, communication technology and network technology and other new technologies, but the key technology mainly has: the radio frequency identification technology, it is a non-contact transmission of information to identify the purpose of technology the use of a radio frequency signal; sensor technology, as a key component to obtain information, sensor information acquisition the tools of modern information system.

The optical fiber sensor and technology has advantages compared with other sensor can not match, so in recent years, the development of optical fiber sensor and measuring technology has become a new direction for the development of the field of instruments and meters, and a new type of optical fiber sensor is nothing more than has the following characteristics: Optical fiber sensor has good light transmission performance, optical transmission loss is very small, the loss of energy achieve ≤ 0. The level of 2dB/km. Optical fiber sensor of wide frequency band, and it is for ultra high speed measurement, sensitivity and good linearity.

Many types of optical fiber sensors, optical fiber according to the sensor in the role, can be divided into intrinsic type (also known as the sensor type, function type) optical fiber sensor and non intrinsic type (or light transmission type, function type) optical fiber sensor [1]. The syndrome type optical fiber sensor using fiber itself to the outside information light sensitive effect, including external factors (such as temperature, pressure, sound, electric field) resulted in the change of the optical transmission properties (such as strength, phase, polarization and so on) change. Through detecting the change of optical fiber transmission property, can measure the change of external environmental factors.

2. Application of optical fiber sensors

Light emitting device of light transmitted through the optical fiber to the sensitive element, the sensitive element on the sphere, partly through, while the rest of the light is reflected back. When the sensing element is in contact with the liquid, compared with the air contact, light transmission ball face increases, while reducing the amount of reflection. Therefore, the sensitive element is in contact with liquid by the amount of reflected light can be know [2]. Rate and the measured material refractive index of refraction reflection light depend on the sensitive element of glass. The measured material refractive index is smaller, the amount of reflected light. Reflected light from the

sensing element, and it is through the transmission fiber photoelectric conversion by a phototransistor optical device output.

Optical fiber sensor can be divided into sensing (intrinsic) and light transmission (non eigen) two categories. The characteristic parameters by external factors change in optical fibers, which are measurement and data transmission to the outside factors, known as the sensing fiber sensor; it has the sensing characteristics of unity, information acquisition and transmission in optical fiber. Light transmission type optical fiber sensor is a characteristic quantity measured by other sensitive components; data transmission by optical fiber, its characteristic is to make full use of existing sensor, convenient popularization and application, as is shown by equation (1).

$$C(k) = E\left\{[a(k) - \mu_{\mathrm{m}}(k)][a(k) - \mu_{\mathrm{m}}(k)]^T\right\} \quad (1)$$

The light source used for fiber Bragg grating sensing system with LED, LD and light rare earth ions doped with different concentrations, different kinds of. LED light source with wide bandwidth, can reach several tens of nanometers, high reliability, but lower output power of light source, and it is very difficult with the single-mode fiber coupling. LD light source has the characteristics of good monochromaticity, coherence, high power. But the stability of LD spectral difference (4 × 10-4 / C). Therefore, the 2 light source disadvantages restrict the application of them in the optical sense.

Optical fiber sensor is mainly composed of light source, optical fiber, photo detector and signal processing part [3]. The basic principle is that the light from the light source passes through the optical fiber to the sensing head (modulator), the measured parameters and enter the modulation light interactions, leading to optical properties of light (such as light intensity, wavelength, frequency, phase and polarization etc) change, become the signal modulation, and then after the fiber into a photoelectric detector, the optical signal into electrical signal, the signal processing after the reduction of the measured physical quantity.

$$\begin{aligned} Z(l) &= \{Z(l,1), Z(l,2), \cdots, Z(l,M)\} \\ &= \{Z_1(l), Z_2(l), \cdots, Z_{N_0}(l)\} \end{aligned} \quad (2)$$

In the measurement of physical quantity, need to overcome the adverse environmental factors including high temperature, high pressure, strong corrosion and electromagnetic interference etc.. For the traditional electronic sensors, overcome these factors are very difficult or need extra cost and technical input, and the optical fiber sensor with their own characteristics can overcome these extreme environments, and because the fiber sensor can realize distribution measurement.

This sensor is essentially the wedge path under the surface of the difference of the job, so it's vibration and optical parameters on the environment is not sensitive. Optical wedge (TFFI) is generally used in manufacturing is not sensitive to the temperature of the material, no lens in optical fiber sensor, the installation does not require the strict alignment, so it can work in harsh environments.

Optical fiber sensor current can be measured directly or indirectly nearly a hundred kinds of physical and chemical and biomass, is widely used in various defense, electric power, petroleum, construction, medical science and other fields. In the national defense, optical fiber sensors can be used in underwater acoustic detection (fiber optic hydrophone), detection of structural damage of fiber optic guidance, attitude control, aerospace aircraft (smart skin) and battlefield environment (electromagnetic environment, biological environment detection, as is shown by equation3.

$$F(\phi, \theta; \phi_0, \theta_0) = \sum_{n=0}^{N-1} A_n e^{j\kappa R[\cos(\phi_0 - \phi_n)\sin\theta_0 - \cos(\phi - \phi_n)\sin\theta]} \quad (3)$$

Optical fiber sensor has advantages of anti electromagnetic interference, so it can be applied in electric sensor is not easy to use the occasion, in the national defense, optical fiber sensors can be used in underwater acoustic detection (fiber optic hydrophone), damage detection and battlefield environment structure of fiber optic guidance, attitude control, aerospace aircraft (electromagnetic environment, biological environment etc.) detection and so on; in the power system, can be used to measure large motor rotor, stator current and voltage transformer, voltage and temperature.

The optical fiber liquid level alarm device, the optical fiber liquid level alarm is based on light refraction and reflection principle, fixed-point liquid level detecting instrument developed by the application, fixed liquid level detection and control, high pressure resistance, anti pollution, safe and convenient, long service life. On the software, the operating system can use Windows Series platform; monitoring software available configuration monitoring software.

With the continuous AC voltage in the experiment by Du and fiber optic current sensor output is compared with the current measured by the standard device, and the voltage value is equivalent to the current value of the optical fiber current sensor. The use of standard device in the experiment is a current transformer.

Bulk filtering method is WDM components. The working principle is two radiation such as light intensity is divided into from the coupler, a beam with the wavelength of the filter; the other beam as a reference beam, two beams of light shot through the photoelectric detectors into electrical signals, processed to eliminate the impact of changes in optical power, finally, get the output associated with the center wavelength of FBG values. The method can realize the dynamic and static parameters. Resolution 375x10-6, dynamic strain measurement response speed of not more than 100Hz grating matching method is the use of other FBG band-pass filter or optical devices, to track changes in the wavelength of FBG the role of components in the drive.

3. Application of optical fiber sensors in Internet of things

A vast network of the Internet of things is the various information sensing equipment combined with Internet and the formation of it. Specifically, the Internet of things is through the radio frequency identification (RFID), infrared sensors, GPS, laser scanners and other information sensing device, according to the agreed protocol articles connected to the Internet for information exchange and communication, so as to realize a network intelligent identification, location, tracking, monitoring and management.

A IOT technology mainly includes four levels: the A. sensor network, which is composed of many sensor nodes wired or wireless communication network, nodes densely deployed inside or around the object or thing concerned with, connect, sensing and monitoring of material; B. data transmission network, through the Internet, wireless communication network or some special communication network, to realize the control detection data and control information sensing network and distribution.

$$I = \left\| {}^{c}P(k \mid k-1) \right\| - \left\| {}^{c}P(k \mid k) \right\| \quad (4)$$

Environmental parameters requires a large number of sensors in the network to perceive various, providing the most original data information for the Internet of things, then the people needed results obtained by processing. So the sensor is the core of the Internet of things.

Optical fiber sensor is generally divided into two categories: one category is the light transmission, also known as non functional fiber sensor; another kind is the sensor type, or function type optical fiber sensor [4]. Most of the former use of multimode fiber, to transmit more light; and the fiber optic sensor, is the use of the object to be measured modulation or change the characteristics of optical fibers, so can only be used in single mode fiber.

Study on technology of sensor network, using new technology, new material, new method to study the intelligent sensor, RFID, embedded software and hardware, sensor technology, a sensor node technology standard system, the sensor nodes with sensing network integration technology, network security technology, positioning and tracking technology, dynamic network technology etc.. C. data transmission and processing technology of Internet of things, all kinds of sensor data collection, coding, fusion and transmission technology, research of mass data storage technology and cloud computing technology. The Internet of things is a new stage of normalization development, is the product of human, machine, material height with, IOT era, will make the goods and services have undergone a qualitative leap, these new features will bring the efficiency, convenience and safety for further to the user.

Optical fiber sensors can also be used for underground oil and gas mining process parameters of pressure, temperature monitoring, and pipeline leak monitoring and so on, all of these can be combined with the Internet, the formation of a strong Internet of things, to achieve safe production and management.

4. Simulation and Analysis

The optical fiber sensing system, the part of signal demodulation for optical signal processing, optical signal wavelength information to complete the conversion of electrical parameters; another part of signal processing, completion of the electrical parameters of the processing, extraction of external information, according to people

familiar to them [5]. Among them, optical signal processing, namely tracking and Analysis Center reflective wavelength sensor is the key of demodulation. Instrumentation Center reflective wavelength of FBG sensors is the most direct spectrometer. The advantage of this method is simple, easy to use. The disadvantage is that the accuracy of the bottom, the high price, large volume, but, can not be directly output electric signal corresponding to the wavelength change. Therefore, it can not meet the practical needs of automation.

With the rapid development of communication technology, optical fiber sensor to rise rapidly, the integration of the enormous achievements in multi domain optical technology, laser technology and optoelectronic detection etc., with its small size, light weight, high sensitivity, strong anti electromagnetic interference ability, the security of data transmission, transmission sensing Become, convenient to form the many advantages of distributed sensing network, in the network to promote this new technology revolution, the field is more and more widely used in the national economy and people's daily life, much to replace the electronic sensor potential. The optical fiber sensing system is mainly composed of light source, optical fiber, detector and signal processing part.

$$C\left(a(k)\mid \mathcal{R}_{k}\right) := \operatorname{cov}\left(a(k)\mid \mathcal{R}_{k}\right) = \sigma^{2}_{s.s_{0}}\,\beta\beta^{\mathrm{T}} + \Sigma_{\varepsilon} \tag{5}$$

Optical fiber sensor for its many advantages to more and more attention, and has been widely applied to different fields of national life. Sensor is the core of the Internet of things, with the rapid development of network and sensor technology, combined with the optical fiber sensing technology and the Internet of things will become the focus of attention.

Optical fiber sensor with its unique capability of anti electromagnetic interference, in the power system can be used to measure large motor rotor, stator and a high voltage transformer current, voltage, temperature and to improve the construction of micro optical cable outer sheath of degree of cure, but the range of increase beyond a certain degree has little effect. In the process of storage, within a certain period of time due to further improve the dark reactions will cause the special micro optical cable outer sheath of the curing degree, but then the chain radicals remaining basic depleted, curing degree gradually stabilized, as is shown by equation1.

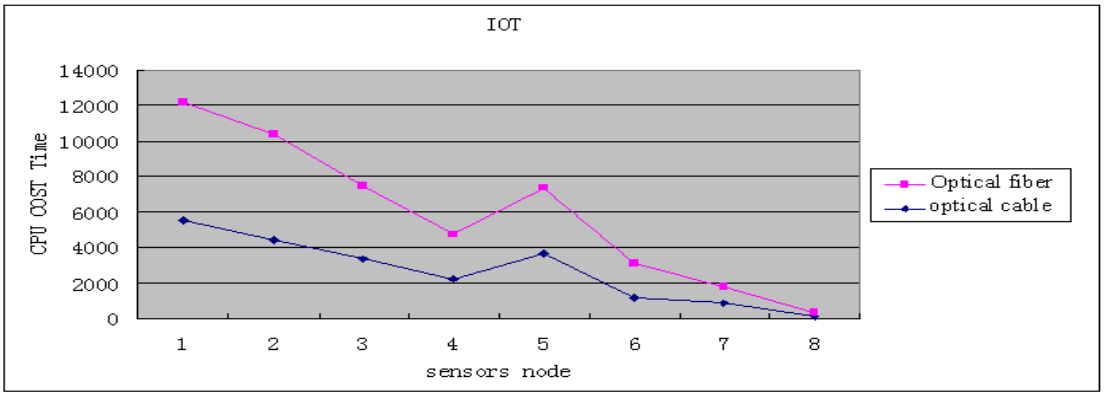

Fig. 1. Comparison results of Application of optical fiber sensors in Internet of things with optical cable

The above experiments, the system has good linearity and stability in small current test. In the high current test, the first test the saturation distortion, method second times with increasing angle B solves the distortion problem, and large dynamic range, short response time. Non intrinsic fiber optic fiber sensor in the transmission of light only, need to rely on other sensitive element for optical fiber transmission light is modulated, and change can perceive the external environment factors.

CONCLUSION

Many kinds of optical fiber sensors, can generally be divided into functional (sensing) sensor and non functional (light transmission type two kinds) sensor. Function type sensor is characteristic of using optical fiber with sensitive ability and detection ability to the outside information, the optical fiber as the sensing element, when the measured transmission in fiber, light intensity, phase, and frequency or polarization characteristics will change, so as to realize the modulation function.

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