Distributed Grating Sensor Stress Data Acquisition and Management System

Zhenhai Mu , Lizhen Jiang
Guilin University of Aerospace Technology ,Guilin,541004,China
muzhenhai@sohu.com

Absrtact—This paper points out the measuring principle of grating sensor for stress change. Firstly, the sensitivity of FBG wavelength to temperature or strain is utilized, then the corresponding waveform is drawn, and then the desired physical quantity is calculated through the specified formula, so as to realize the detection of the environmental parameters of FBG. At present, the data acquisition of remote strain measurement has been realized, but the data returned is the wavelength data which has changed, aiming at the needs of industry applications. Wavelength data are displayed with digital scales, and the data are replayed and analyzed. Finally, the expected goal is achieved.

Key words: distributed grating; sensor; strain force; waveform

INTRODUCTION

With the development of the times, the application of distributed grating sensor technology is more and more extensive, especially in the stress field. It has been widely used in many fields such as aerospace, civil engineering, petrochemical industry, etc. The high precision, fast real-time measurement and simplicity of distributed grating sensor make the grating sensor complete repetition rate instead of some old electromechanical sensors. Extremely high complex tasks and then data acquisition and playback functions become the trend of the times, greatly improving work efficiency, effectively avoiding the mistakes that may be brought by traditional equipment. Some traditional measuring and sensing tools only describe the wavelength simply, and complete the testing work by internal simple scheduling, but we do not know the reason why, the level of function achieved is relatively low, but grating sensors can tell us that the grating wavelength is caused by strain caused by temperature. This advantage has been applied to many modern devices.

At the same time, with the development of economy and the emergence of a large number of measuring and sensing tools, the measured data and collected data become more and more complex, so the old sensors are increasingly unable to meet the needs of social development. Facts have proved that traditional sensors are no longer suitable for the development level of today's

society. It has become the trend of work in various fields to replace traditional measurement and scheduling methods with distributed grating sensing system. This system is a data acquisition, management and analysis system developed for distributed grating sensing stress change. The purpose is to make the modern society more advantageous.

SYSTEM INTRODUCTION

A. Structure and Characteristics of Distributed Grating Sensors

As a popular measuring tool, grating sensor should be used.The range of application is more and more extensive. The advantages of high-precision data measured make it a promising development prospect at home and abroad. At the same time, the system design of this subject needs to combine hardware and software. The premise is that the corresponding data must be collected from hardware. Therefore, in order to collect accurate data more conveniently and quickly, the structure of the system should be studied. And characteristics.

The grating sensor consists of grating pair, light source, photoelectric receiving element and lens, as shown below.

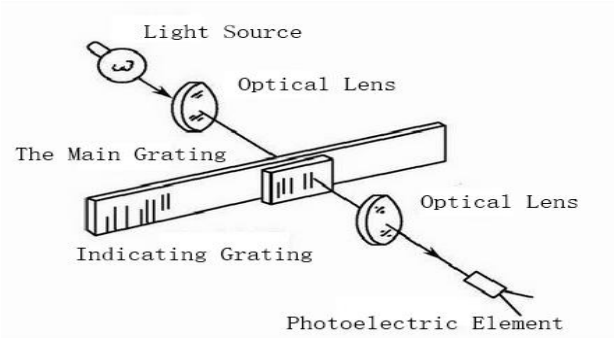

Figure 1. Structural diagram of distributed grating sensor

Its characteristics are:

1) Good reliability.

Unlike other sensors, FBG sensors are vulnerable to geographical or environmental factors. When the temperature or strain occurs, FBG sensors can generate wavelength, and will not cause system consumption. So FBG sensors are particularly reliable and stable.

2)High measurement accuracy.

Using different measuring tools under the same conditions, the data obtained by grating sensors are much more accurate.

3)It can be used for dynamic measurement.

*4)*It has strong anti-jamming ability, such as using grating sensor in some unstable environment, and the result is better than some sensors.

5) Compatibility is strong, in the same place with a number of grating sensors, they are compatible with each other, constitute a network.

B.Principle of System Design

The central reflection wavelength (Brag) of FBG is lambda B= 2nef f, in which Nef is the mode effective refractive index and is the period of Brag g grating. Neff and_will change when the fiber strain or temperature changes, which will cause the change of Bragg wavelength lambda B. Distributed fiber Brag g grating

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sensors contain a large number of sensing gratings, so it is necessary to ensure that each grating can be "addressed", that is, each grating can be identified according to the independent Brag wavelength. Therefore, the Bragg wavelength of each grating is required to be lambda 1, lambda 2,... Lambda N and its working range lambda 1, lambda 2,... Lambda n does not overlap with each other, as shown in figure 3.1.1-1. Moreover, the Bragg wavelength of all gratings must work within the spectrum width of the broadband light source, or the free spectrum of the tunable devices (such as tunable light source, tunable filter, etc.). Then we can draw the corresponding waveform diagram through the change of the wavelength, and get a part of the digital quantity we want. The next step is to calculate the final data according to the waveform diagram and formula. Come out. The whole process of wavelength change is shown in Figure 2 below.

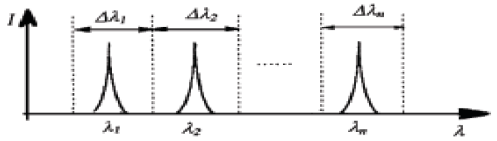

Figure 2 The whole process of wavelength change

C. Contents of System Research

Distributed grating sensing principle of stress change is to use the sensitivity of FBG wavelength to temperature and strain (strain simultaneously causes FBG coupling wavelength shift) to realize direct measurement of strain and other related physical quantities. At present, remote data acquisition of strain measurement has been realized, but the data returned is the wavelength of change.

Data, according to the needs of industry applications, the wavelength data should be displayed in digital scale, and the data can be replayed and analyzed. Therefore, this topic is to design a software analysis system to analyze the collected wavelength data and display the change of the relevant wavelength in real time with corresponding digital quantities, so as to achieve the purpose of strain monitoring.

D. System Function and Objectives

1) UI interface design: Complete the design of MMI (human-computer interaction) interface of multi-point FBG, including wavelength display interface design, corresponding stress digital display and control interface design, acquisition data storage and playback analysis control interface design;

2) Raster data acquisition is simulated by RS232 interface.

3) Achieve timely storage and playback of collected data;

*4)*Implementing the function of data preliminary analysis.

SYSTEM DESIGN REQUIREMENTS

A. System Requirement Analysis

In the design of distributed grating sensor stress change data acquisition and analysis system, Microsoft Visual Studio 2010 development environment is adopted. Firstly, the data organization model is analyzed, the data structure is designed, and the graph and attribute database is established. Then, the functions of the system are corresponded to the basic functions of the distributed grating sensor stress change data acquisition and analysis system. The design includes four functional modules: digital display of wavelength data, corresponding stress change display, data acquisition and storage, data playback and analysis. Among them, the system uses the data structure design of dividing, layering and thematic elements to realize data organization, separately manages graphics data and attribute data, designs database tables that meet the requirements, and through keywords, closes graphics database and attribute database.

1) System Functional Requirements

(1) Digital Display Function of Wavelength Data: Data acquisition of strain stress measurement remotely, so that the returned changed wavelength data can be displayed in digital quantities on the system.

(2) The corresponding stress change display function: through the processing of the wavelength data, the corresponding stress change can be displayed.

(3) Data acquisition and storage function: the system can effectively store the collected data to the database.

(4) Data playback function: The collected data can be pulled out from the corresponding database and displayed and analyzed again.

(5) Data analysis function: Analyse the collected data to obtain the functional relationship between the data, and provide a favorable basis for data display. Maybe this process is relatively short.

2) System Flow Analysis

According to the requirements of the system, the whole system flow is mainly through the login interface verification, enter the data analysis interface, select the corresponding data analysis mode, and then enter the control interface of data acquisition. The control interface includes three functions: data display, data storage and data playback. This system contains a part of the three functions. Data analysis function, and the data analysis function time is relatively short, so do not design a module to study it.

B. System Interface Design

In the design of distributed grating sensor stress change data acquisition and analysis system, Microsoft Visual Studio 2010 development environment is adopted; firstly, the data organization model is analyzed, the data structure is designed, and the graph and attribute database is established; secondly, the basic functions of the distributed grating sensor stress change data acquisition and analysis system are referred to. The functions of the system are digital display of wavelength data, corresponding strain force display, data acquisition and storage, data playback and analysis. Then, the function modules are programmed, the database is established and maintained, the whole system is realized, and the system function is tested.

The aim of the design of distributed grating sensor stress change data acquisition and analysis system is to establish an advanced, efficient, safe and reliable information database management system which can be effectively applied to distributed grating sensor stress change data. The overall function module design of the system is shown in Figure 3.

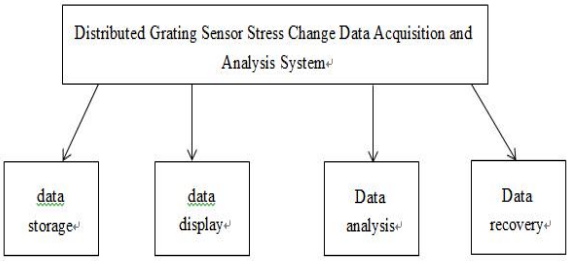

Figure 3 The overall function module design of the system

B. Design of System Function Module Structure

1）Design of system login module

Any system must have a login module. After the success of login system, it can enter the interface of data analysis mode selection, either choose the next page it wants or exit the system. When the user chooses one of the functions, the background will transfer the functional relationship between the data to the background of data control.

2）Design of Data Acquisition and Storage Module

After login, that is, the relationship between login and data selection mode has been accepted. When the data collected from the database has been acquired, the data that you want to store should be stored first. Then you can select the data fragments that you want to store according to the situation of data graphics presentation.

3）Design of Data Acquisition and Display Module

After using the relationship between the data and connecting the database to acquire the collected data stored in the database, the data will be presented in the form of a broken line graph or a curve graph, and there is a display of comparative analysis of the data, which is the data display.

4）Design of Data Acquisition and Playback and Analysis Module

After data display, data playback can be selected according to the need, provided that the relationship between the data has been received, and the data collected from the database has been acquired, then the data segment that you want to play back can be selected according to the situation of graphics presentation. When data playback, it is also presented in the form of polygons or curves; then, when the function of data playback has been completed, the data can be analyzed, so data playback and data analysis are closely linked.

SYSTEM FUNCTION REALIZATION

A. Data acquisition and display module

After the successful login of the system, you will see a graph on the left first, and the three items of the wavelength difference in the lower right corner, the load meter reading and the stress sensor wavelength are all empty. But when you click the button of data display, you can see that the data are displayed, and the collected data will be presented in the form of graphics, and in the lower right corner, the wavelength difference, the load meter reading and the stress transmission. Sensor wavelength will display the corresponding data.

B. Data Acquisition and Storage Module

After the data display is completed, the data storage interface will appear when the data storage button is clicked. Users can select the data fragments they want to store according to their preferences and input time range. Of course, the data fragments are based on the data table and the recording time of the collected data. That is to say, the data fragments to be stored can not exceed the recording time of the original collected data. Scope. After the input is completed, click the storage button, and the data record will be inserted into the storage table.

C. Data Acquisition and Response Module

After the data is displayed, you can choose to click on the data playback control and then reach the expected interface. In the data playback interface, users can choose the data fragments they want to play back according to their preferences. Of course, the data fragments are based on the data table and the recording time of the collected data. That is to say, the data fragments they want to play back can not exceed the recording time of the original collected data. When the time input is completed, click the playback button, and the graphics based on the playback data will be displayed on the data playback interface.

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