Prestress Loss Analysis and Overload Early Warning Research of Simply Supported Girder Bridge Based on Embedded Computer and Fiber Grating Sensing Technology

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Abstract. Computer embedded operating system requires the joint development of computer technology, digital technology and communication technology in order to make the embedded operating system more perfect. At the same time, the embedded operating system plays an important role in the development of computer technology. Therefore, we should improve the hardware and software of the embedded operating system to adapt the system to the development needs of the new era. Through the analysis of fiber grating sensing technology, on this basis, the analysis of the prestress loss of the simply supported beam bridge and the research of overload warning are carried out to make it more reasonable.

Keywords: Embedded, Computer, Optical Fiber Technology

1. Introduction

The increase in traffic volume in our country makes the load on the road more and more heavier. At the same time, a large number of roads and bridges have been constructed, making their safe operation highly valued by the whole society. During the course of service, road bridges repeatedly bear loads such as vehicles, external environmental erosion and damage caused by human factors, etc. and certain structural damage will inevitably occur. In addition, the over-limit transportation of roads and bridges in China actually makes their durability and bearing capacity The performance gradually decreases until it threatens the safety of the bridge. It can be seen that, in the current actual situation of over-limit and overload transportation, the operation monitoring, maintenance and reinforcement of bridges, especially large bridges, are very necessary.

2. Embedded technology analysis
2.1. Embedded algorithm stage

Computer embedded operating system is the embedded algorithm in the first stage of computer information application. The embedded algorithm is a computing system in the form of a programmable controller based on a single-core control assembly. It has a lot of excellent functions, capable of detecting and indicating the function of mutual cooperation. However, the shortcomings of this stage are also more obvious. There are shortcomings such as not having the function of processing things or performing advanced algorithms, the calculation time is relatively long and the memory it has is relatively small and it cannot be connected with the user.

2.2. With CPU as the core

The embedded operating system with CPU as the core is the second stage in the development and application of computer information. This kind of embedded CPU processing system has the advantages of various types. The disadvantage is that the versatility and usage are relatively poor and the operating state of the processor is also different. It fluctuates back and forth between overload and light load conditions. Therefore, it is necessary to perform two operations. To improve the overall performance of the system, this process is more complicated and needs to be improved from time to time.

2.3. Universal embedding

The general embedded operating system is the third stage of development and the main body is the embedded operating system[1]. The performance of the operating system at this stage is already very good, you can make appropriate adjustments according to the specific situation, through static and dynamic evaluation criteria, to achieve the load balance between the various processors of course, not only the system is relatively stable, but also expensive Time is also reduced a lot.

2.4. Internet embedded system

What we commonly use now is the embedded system with the Internet as the core, which has developed to a very mature stage and will develop faster due to the laying of 5G. The current embedded operating system with the Internet as the system has perfect performance in all aspects and excellent performance. It can quickly process the execution instructions in the system, its response time is also very short and its operation is also very smooth. There are many mainstream operating systems, uXlinx, WinCE and Symbian are all representative. The structure of the embedded system is shown in Figure 1.

![Figure 1](image_url)  
**Figure 1.** Structure of the embedded system

3. Analysis of fiber grating sensing technology
Fiber gratings play an important role in the field of optical fiber sensing. Deformation caused by high temperature, light and heat, stress, Faraday effect and effective refractive index change caused by magnetic field are the sensing mechanism of fiber grating[2]. When the ambient temperature, magnetic field strength, solution concentration changes, or the stress of the fiber grating itself changes, the original parameters of the fiber grating will change. The resonant wavelength of the fiber grating or the transmission power at the resonant wavelength can be measured and finally Then you can get the required sensor information. Optical fiber temperature measurement technology can achieve multi-point online real-time monitoring of ambient temperature and equipment and realize the systematization and integration of temperature measurement equipment. The system compares real-time data and preset values on the measurement equipment to prevent temperature. The occurrence of accidents caused by excessively high levels realizes timely detection of downhole equipment failures, guarantees the life safety of workers and the production efficiency of the enterprise and prevents problems before they occur[3]. The great advantage of fiber Bragg grating temperature measurement technology is how to solve the problems of real-time monitoring, data processing and analysis, fault prediction and troubleshooting of the working status of mine equipment at the source, providing a powerful way for the smooth progress of underground work Guaranteed. Fiber grating temperature sensor is an important part of temperature measurement in this system. Depending on the temperature sensitive area inside the optical fiber, the temperature change at that point can be accurately monitored. When light passes through the fiber Bragg grating, the qualified light is reflected by the Bragg grating back to the receiving end and the receiving end receives the reflected light for data processing, while the light of the other wavelengths can pass through almost losslessly because it does not meet the conditions. The analysis architecture based on the embedded system is shown in Figure 2

![Figure 2. Analysis architecture](image)

4. Analysis of prestress loss of simple beam bridge and overload warning technology

4.1. Analysis principle of prestress loss of simply supported beam bridge

(1) Prepare construction work instructions before tensioning. Train the construction personnel to understand the knowledge of pre-stress construction and master the correct operation method[4]. (2) The tension force of the jack selected should be 1.5 times the required tension force and not less than 1.2 times and the maximum reading of the pressure gauge should be 1.5 to 2.0 times the tension force. The jack is used for more than 6 months before or during use; the number of tensioning exceeds 300
times; if there is an abnormality during the use period or the replacement of parts and accessories, it should be calibrated by the national legal metrology technical agency. The jack and the pressure gauge should be calibrated uniformly and used as a complete set. The operating direction of the jack piston should be consistent with the actual working state during tension. (3) The prestressed tendon tension generally adopts the stress control method and the actual elongation value should be checked at this time. If the ratio of the actual elongation value to the theoretical elongation value is designed to comply with the design regulations, if the design is not specified, the deviation should be controlled within ±6%. The theoretical elongation value ΔLL is calculated by the following formula: ΔLL=PPL/APEP, where: PP is the average tensile force of the prestressed tendon and the linear tendon is the tensile force at the tension end; L is the length of the prestressed tendon; AP is the length of the prestressed tendon Cross-sectional area; EP is the elastic modulus of the prestressed tendons. Before tensioning, it is inconvenient to measure the actual elongation value due to the inconsistency of the tension and bending degree of each prestressing tendon. At the same time, in order to ensure that the stress of each prestressing tendon is as consistent as possible, first use a small jack to remove each prestressing tendon of the steel strand during tensioning[5]. Tension to the initial stress σ0. The initial stress σ0 is 10% to 25% of the tensile control stress σcon and the longer the steel strand, the higher the value. The length of the steel strand is less than 30m and the initial stress σ0 is 10% to 15%; when the length is 30 to 60m, it is 15% to 20%. Measure the elongation value from the initial stress to the completion of the tension. The actual elongation value includes the measured elongation value and the estimated elongation value from 0 to the initial stress. The elongation value can be calculated using the elongation value corresponding to the second-level stress increment, but the second-level stress increment should be equal to the initial stress σ0. The actual elongation value ΔLs=ΔL1+ΔL2, where ΔL1 is the measured elongation value from the initial stress to the maximum tensile force and ΔL2 is the estimated elongation value from 0 to the initial stress.

4.2. Overload early warning technology

Relying on the Internet big data cloud platform technology, sensors are arranged on the main parts of the beams of the original bridge to monitor the response of the beams to vibration, deflection and strain during operation of the bridge under heavy loads and wind loads. Perform real-time monitoring, analysis and network sharing of data in the cloud era. Through detailed analysis of monitoring data samples, relying on the daily inspection and maintenance terminal of the mobile big data platform for bridges, the technical status and safety of the bridge's operational status, structural diseases, etc., are evaluated.

Based on the evaluation results of the sample data analysis of the bridge inspection system, timely repairs and reinforcements or load-limiting measures for bridges that have structural diseases or safety threats are carried out. According to the analysis of the damage morphology of over-limit and overloaded bridges, the reinforcement measures that can be taken are: (1) If there are evenly distributed small cracks in the over-run and overloaded bridge, we can evaluate the safety of the bridge by monitoring sample data. Take measures to repair cracks and paste carbon fiber membranes to reinforce the bridge structure and improve its rigidity[6]. (2) If the structural surface layer has longitudinal cracks along the main girder, the transverse connection structure is damaged and the road surface deflection is large (3) For bridges that have large cracks and cannot be closed under overload conditions circumstances, operational safety has been threatened at this time and we should promptly
take measures to replace new beams.

5. Conclusion

Because of the problem of over-limit and overloading of transportation, it will increase the probability and loss of traffic accidents, shorten the service life of road traffic projects and increase maintenance costs. For this reason, it is necessary to build a complete governance system through the application of advanced technologies and advanced governance models and the comprehensive and efficient use of various resources, to achieve the improvement of the quality and effect of comprehensive governance.

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