IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 5, May 2016.
www.ijiset.com
ISSN 2348 – 7968

Early Warning and Anti-theft System for Expressway along the Highway based on Optical Fiber Micro-vibration

Yanjie Hu and Min Deng

CCCC Second Highway Consultant Co. Ltd

Wuhan430056, China

Abstract

Aiming at the shortage of the existing security methods of Expressway cable, this paper puts forward a new warning system for the prevention and control of the expressway along the optical fiber micro vibration. The utility model with the advantages can realize long-distance distributed monitoring, fast test speed, high positioning accuracy, the cable safety warning, nip in the bud, the greatest degree of protection of the highway of normal operation and safety that avoid the indirect economic loss of a large number of direct economic losses and immeasurable. The technology will reach the leading level of domestic cable security, and can be popularized in the whole country and even worldwide, and it has a wide prospect of application.

Keywords:*Optical Fiber,Micro-vibration,Anti-theft System,Early Warning,Expressway.*

1. Introduction

The Traffic engineering is an important part of highway, including monitoring and control system, toll collection system and communication system, is important technical means for highway traffic information collection, information transmission, control and management, is composed of a large number of field electromechanical equipment and laboratory computer network system. Among them, the mechanical and electrical equipment in the field of the main layout in the scope of the toll plaza 5-10km unattended, including traffic flow detector, variable information board, camera, variable speed signs, weather detector, such as traffic lights, laying a considerable distance of power cable to ensure the normal work. However, driven by economic interests, highway high and low voltage cables, power equipment, electrical and mechanical equipment and other fields to become the object of the crime of theft. Since the incidence rate is increasing, highway management department from a management point of view, strengthen the cables and power equipment inspections, monitoring and maintenance; public security department has also increased efforts to crack down on such cases, but to no avail, the economic losses caused by as little as a few million yuan, more than million yuan. The theft of the expressway cable, power equipment and the field equipment has seriously affected the normal operation and management of the highway. While causing heavy losses to the state property, but also on the highway running on the vehicle to form a huge security risks, resulting in difficult to estimate the direct or indirect economic losses. Through technical and market research found that domestic and international cable anti-theft technology research is a hotspot and difficulty in the current number of industries. However, the existing anti-theft alarm occurred in the cable is destroyed. Although able to recoup some of the losses, but the cable damage caused by the loss of no can be avoided. Therefore, how to effectively monitor the safety of the cable, the cable is damaged in advance warning, is the current urgent need to solve the problem.

2.System Design of Distributed Optical Fiber Sensor based on Alarm

From Dongguan Expressway supporting cable anti-theft security program is designed with optical fiber perimeter security system, front sensor system part of the optical fiber sensing technology, sensing cable attachment lashing fixed on the protected cable, constitute a "detection sensor tape", outdoor completely passive, installation without geographical constraints, and the reliability is high, hidden well, is the leading technology of a new generation of intelligent security products.Optical fiber perimeter security system can filter vehicle, wind and rain on environmental interference, of illegal mining, drag and drop, hitting the cable damage action issued a warning signal, thus of high speed matching of power cable to good protective effect.The need to deploy from Guan highway 40 kilometers, on both sides of the road supporting cables about 80 kilometers in length, taking into account the feasibility of system, maintenance, price and cost of the project. The site formatted with two sets of system, a total of 256 standoff, on each side of the road for 128 sector, average each defense area is about 300 meters long.

ISSN 2348 – 7968

3.Comprehensive Protection Alarm Monitoring System for Optical Fiber Grating Cable

Optical fiber grating cable comprehensive protection alarm monitoring system is based on Fiber Bragg grating sensing technology took the lead in the domestic developed model has cable anti-theft alarm function of the integrated system is set computer, optical fiber sensing, optical fiber transmission, photoelectric control, intelligent analysis, pattern recognition is not high technology in the integration of systems engineering. This system is able to provide the owner with a set of intelligent analysis, accurate addressing, intrinsically safe, non electric detection of cable comprehensive protection excellent solution.Fiber Bragg grating (FBG) cable protection alarm monitoring system is using fiber Bragg grating as the signals of the sensing element, using fiber Bragg grating strain (vibration) sensitivity and light reflection principle, through the reflected light wavelength demodulate information to determine the digital measurement technology for measurement of strain (vibration). System can realize the cable on the highway and key position, different forms of installation of the door alarm monitoring, monitoring content includes: cable tube box cover opening and closing of the cable vibration and other events; the place of the precise location of the accident; have a self-test function; can display and alarm and and other security equipment linkage. The product output signal into a digital signal, the precision high; easy to network, to achieve a wide range of deployment; no power detection system, intrinsically safe explosion-proof, anti electromagnetic interference, anti lightning.

4. System Modeling and Simulation

System modeling according to the system detection signal transmission and transformation process step by step. At present, the commonly used modeling methods are theoretical modeling, experimental modeling and finite element modeling. According to their respective characteristics, the mathematical model of distributed optical fiber vibration sensing system is established by the method of theoretical modeling. Process modeling is divided the following steps: for external impact force caused by the foundation soil vibration, the elastic half space theory to establish the mathematical model, computation of various relevant parameters and by means of the theory of wave in half space is analyzed. For the cable vibration, the use of single degree of freedom linear vibration system model to establish the mathematical model; the computational model of fiber of the forced bending, the establishment of two closely spaced optical fiber by the same forces of axial deformation; optical fiber interference light intensity and the photoelectric conversion is using Mach Zehnder interference principle of instrument and photoelectric conversion formula were calculated.

After the system model is established, it is necessary to carry out simulation research to determine whether the model can accurately reflect the working characteristics of the real system, which is realized by computer simulation technology. Matlab/Simulink is used to simulate the system mathematical model, and its programming interface is friendly and easy to use, which is beneficial to improve the efficiency of modeling. In the process of simulation, the parameters of the model are determined. Because of the large number of model parameters, the complexity of system modeling is greatly increased. These parameters part of the query of dynamics of rock and soil statistics or experience formula to obtain, another part must be obtained through statistical experiments, such as artificial mining, mining machinery under the condition of soil vibration frequency.

In the simulation model, for different modes of vibration input different impact force and soil vibration frequency values, and corresponding adjusting part with the impact force of the soil parameters, under the different conditions of the obtained simulation waveform and amplitude frequency characteristic curve and the experimental sampling waveform like, preliminary implementation of vibration signal pattern recognition.

5. Conclusions

This paper studies the distributed optical fiber vibration sensing system from the angle of system model. Firstly, the principle of the optical fiber vibration sensing system, interference measurement, phase modulation, sensitive threshold and positioning technology are analyzed, which is conducive to the follow-up study. Because the system of the measurement object for various forms of vibration signals, so also on vibration test and mechanical basic principle are introduced, focusing on the vibration mathematical modeling to solve the problem by the research methods. Research for specific engineering vibration problems, often is to solve the problem of the characteristics and requirements, seize the main influencing factors, the reasonable mechanical model is summarized, and application of mechanics and mathematics knowledge established the mechanical model of the corresponding mathematical model, and then the mathematical model is established for the analysis calculation, the computational results are compared with the results of experiment, the income theory study results

ISSN 2348 – 7968

can correctly to solve the practical engineering vibration problems, if not resolved, you need to modify the mechanical model. And then check again

References

[1]Yang Zhao,Yanguang Cai,Defu Cheng.A Novel Local Exploiation Scheme for Conditionally Breeding Real-coded Genetic Algorithm.Multimedia Tools and Applications, 2016.
[2]Liya Wang,Yang Zhao,Yaoming Zhou,Jingbin Hao.Calculation of flexible printed circuit boards (FPC) global and local defect detection based on computer vision.Circuit World,42(2),pp49-54,2016.
[3]Jianting Li,Xiao Ma,Yang Zhao.On Anti-Periodic Solutions for High-Order Cohen-Grossberg Neural Networks with Bounded Delays.Journal of Computational and Theoretical Nanoscience,12(11),pp4593-4600,2015.
[4]Shuo Xiao,Yang Zhao,Jiayu Zhuang,Wei Chen.Stability Result of Time-Dependent Variational Inequality.Journal of Computational and Theoretical Nanoscience,12(11),pp4549-4552 ,2015.
[5]X. Fan, C. Yuan, and B. Malone, "Tightening bounds for Bayesian network structure learning," in Proceedings of the 28th AAAI Conference on Artificial Intelligence (AAAI-2014), pp. 2439-2445, 2014.
[6]X. Fan, K. Tang, and T. Weise, "Margin-based over-sampling method for learning from imbalanced datasets," in Proceedings of the 15th Pacific-Asia Conference on Knowledge Discovery and Data Mining (PAKDD-2011), 2011, pp. 309-320.
[7]X. Fan, B. Malone, and C. Yuan, "Finding Optimal Bayesian Network Structures with Constraints Learned from Data," in Proceed. of the 30th Conf. on Uncertainty in Artificial Intelligence (UAI-2014), pp. 200-209, 2014.
[8]X. Fan and C. Yuan, "An Improved Lower Bound for Bayesian Network Structure Learning," in Proceedings of the 29th AAAI Conference on Artificial Intelligence (AAAI-2015), pp. 2439-2445, 2015.
[9]X. Fan and K. Tang, "Enhanced Maximum AUC Linear Classifier," in Fuzzy Systems and Knowledge Discovery (FSKD), 2010 Seventh International Conference on, 2010, pp. 1540-1544.
[10]Yandong Zhang,Yang Zhao.Design & implementation of an Air Quality Monitoring System for Indoor Environment based on Microcontroller,International Journal of Smart Home,9(11),pp301-312,2015.
[11]Yan Wang,Wengang Zhou,Yang Zhao.Study on the load forecasting of power system based on gray forecasting model,Metallurgical and Mining Industry,7(10),pp89-95,2015
[12]Xinwei Yu,Yanling Guo,Yang Zhao,Zhiping Li.Dynamics analysis and simulation of steering screw on automobile recirculating ball type steering gear,Metallurgical and Mining Industry,7(10),pp82-88,2015
[13]Haijing Lv,Zhenkun Han,Yang Zhao.Research on eco-city planning based on comprehensive evaluation model,Metallurgical and Mining Industry,7(10),pp62-68,2015.
[14]Bing Liu,Yang Zhao,Yuanyuan Dang.Data flow network security strategies based on data mining,Metallurgical and Mining Industry,7(10),pp46-53,2015.
[15]Lei Zheng,Renjie Hu,Yang Zhao,Jinming Bao.Design and implementation of material position detection system based on FPGA,Metallurgical and Mining Industry,7(10),pp75-81,2015.
[16]Hanqing Tao,Yang Zhao.Intelligent fault prediction of railway switch based on improved least squares support vector machine,Metallurgical and Mining Industry,7(10),pp69-75,2015.
[17]Liya Wang,Jiankun Shang,Yang Zhao.Information Prediction of the trend of network attacks based on mechanism analysis method,Metallurgical and Mining Industry, 7(8),pp328-334,2015.
[18]Huiling Guo,Wengang Zhou,Yang Zhao.A license plate recognition algorithm based on image processing technology,Metallurgical and Mining Industry ,7(8),pp322-328,2015.
[19]Huabei Nie,Bin Yang,Yang Zhao.Construction and realization of the algorithm bootstrap on synchronization database, Metallurgical and Mining Industry, 7(4),pp256-261,2015.
[20]Wenbo Geng,Honghui Zhang,Quan Cheng,Yang Zhao.Distributed embedded system for communication based on ant colony optimization algorithm, Metallurgical and Mining Industry, 7(4),pp262-267,2015.
[21]Wenbo Geng,Yang Zhao ,Quan Cheng.A method for designing the brushless direct current system using FPGA based on fuzzy set similarity algorithm,Metallurgical and Mining Industry, 7(4),pp56-63,2015.
[22]Feng Liu,Wengang Zhou,Yang Zhao.A weighted value scheduling algorithm based on Hadoop computer platform,Metallurgical and Mining Industry, 7(4),pp268-273,2015.
[23]Zhenghong Guo,Xinhua Ma,Yang Zhao.Dynamics Analysis for a Fractional-Order HIV Infection Model with Delay,Journal of Computational and Theoretical Nanoscience,12(12),pp5103-5108,2015.
[24]Pengwei Li,Yang Zhao,HongliZhao,Haitao Yang.Composite Metric and Application in Performance Evaluation of Transport Protocols,Journal of Computational and Theoretical Nanoscience,12(12),pp5530-5534,2015.
[25]Shenghai Hu, Manhui Zhang, Xiulian Liu,Yang Zhao.The Configuration-Complete Quaternion Model of Kinematics and Kinematic Error of Metamorphic Mechanism,Journal of Computational and Theoretical Nanoscience,12(12),pp5566-5576,2015.
[26]Jingyu Wang,Zaizai Yan,Yang Zhao,Zhihan Lv.Maximum Principle for the Time-Space Fractional Diffusion Equations,Journal of Computational and Theoretical Nanoscience,12(12),pp5636-5640,2015.
[27]Jun Li, HanPing Hu, Junshan Pan,Yang Zhao.A Research on the Competitive Inhibitory Model of Network Defense Based on Resource Competition,Journal of Computational and Theoretical Nanoscience,12(12),pp5641-5653,2015.
[28]Wei Zhang, Yanchun Zhu, Yang Zhao, and Lihua Wu.Research on Evolution of Asia-Pacific Stock Markets Network Structure Based on Complex Network Theory,Journal of Computational and Theoretical Nanoscience,12(12),pp5859-5869,2015.
[29]Zongyi Xing,Xinrong Liu,Yang Zhao,Yong Qin,Limin Jia.Optimization of Vibration Damping for the Power Assembly Suspension System Based on Ant Colony Algorithm,Mari Papel y Corrugado,pp281-289,2016.
[30]Huiling Guo,Yan Hou,Yang Zhao.RESEARCH ON IMAGE MATCHING ALGORITHM BASED ON TPS TRANSFORMATION MODEL,International Journal of Simulation,Systems, Science & Technology,17(8),2016.

ISSN 2348 – 7968

[31]Wengang Zhou,Huiling Guo,Yang Zhao.A NOVEL METHOD FOR DETECTING SIMILAR MICROBLOG PAGES BASED ON LONGEST COMMON SUBSEQUENCE,International Journal of Simulation,Systems, Science & Technology,17(8),2016.
[32]Xiaopeng Chi,Yang Zhao,Yue Yu.RESEARCH ON THE STATUS OF SPORTS ECONOMY IN THE NATIONAL ECONOMY DEVELOPMENT IN MULTI-OBJECTIVE FUZZY DECISION MODEL,International Journal of Simulation,Systems, Science & Technology,16(1),2016.