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Subgrade Cumulative Plastic Deformation under the Bridge in the Transitional Period of Orbit Dynamics Analysis

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In this paper, the author researches on the dynamic characteristics analysis of bridge transition track under cumulative plastic deformation of subgrade. This paper considered interaction between structural layers and, by in combination with the dynamic model of slab track and by use of finite element software, established the spatial dynamic numerical model of vehicle-track-subgrade coupling system and then analyzed the dynamic response in the bridge-subgrade transition section in the form of regular and inverted trapezoid. The results show that: Under the action of train load, the dynamic responses in the two kinds of transition section are basically consistent; The settlement of the section in inverted trapezoid is slightly larger than that of the section in regular trapezoid, while the section in regular trapezoid is more favorable to maintenance of the track regularity, in contrast to the section in inverted trapezoid; The junction between bridge and subgrade(in the range of 5 m behind the abutment) is the weak portion in the whole transition section, and should be designed and constructed separately. By considering the dynamics indices of locomotive, the track deflection angle of the transition section should set the limit value of 0.05%, K 30≥210 MPa in the range of 0~5 m behind the abutment and K 30≥150 MPa out of the range of 5 m.

1. Introduction

The rapid development of computer science and space science and technology, leap in sensor technology, aviation and aerospace technology and other platforms provide a solid technical foundation for the remote sensing technology and data acquisition platform, and promote the modernization of remote sensing technology to become a very active field of information science. Features of remote sensing technology is (Rother et al., 2004; Lomenie et al., 2003; Mohamad Akhir and Kanniah, 2017): Under the the premise that no direct contact with the relevant objectives, can dynamically, fast, accurate access to a large number of earth observation data, and to judge them, classification and identification. These features make remote sensing technology plays a very important role whether in the military or in the civilian aspects (Sithole and Vosselman, 2006).

In the civil context, applications of remote sensing technology covers the identification and localization of geographic information systems (GIS) updating and maintenance, precise mapping of two-dimensional and three-dimensional map of the city, an important goal of the data, land use planning, weather forecasting, disaster prevention, resources investigation, f or the development of national economy has made a significant contribution; On the military side, the applications include a strategic and tactical reconnaissance (Yu et al., 2007), many aspects of accurate identification and location mapping and military topographic map updates, important military targets, the military command automation important military targets, the military command automation system, Gao precision-guided weapons, military surveillance, early warning military. In the military, automatic target identification and location can be used to firepower, Evaluation of Attacked Effectiveness, military command automation systems, automatic guided weapon systems. In addition to military uses, it also plays an important role in the geographic information system for data update and maintenance, urban planning analysis and guidance (Fu et al., 2009).

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2. Current lack of detection algorithms bridge

In all potentially important civilian and military targets, bridges over water automatic detection and localization have a very important of the relevance and scientific value. First of all, the bridge is an important goal of artificial construction, is also a key transportation hub and an important military force often deployed around the war. So the bridge and its surrounding facilities are important military targets, has an extremely important strategic and tactical significance. Secondly, since the remote sensing images, Bridges various features associated with water and harbor goal now has a very high degree of similarity (Chen and Dong, 2010). Therefore, it is important for other studies with the goal of identifying the type of problem and has important theoretical significance. More importantly, with the rapid development of national economies, the accelerated pace of urbanization, bridges and other large buildings is one of the fastest growing in the ground object facilities, geographical databases most likely to change the section and also demand the greatest part of the update, and the updating workload is often enormous. Thus, recognition and detection of remote sensing images of Bridges became one of the important topics addressed urgently needed.

The main work of this paper is to identify research and implementation for remote sensing images Water Bridge objectives, namely computer as a means to detect the complex remote sensing images and precise positioning of bridge over water. General description of the problem as follows: Given a region of remote sensing images, be pre-treated to meet the requirements needed for the identification, then use bridges features detected whether there is a bridge, and do accurate recognition, information extraction and positioning.

Throughout the existing bridge recognition algorithm, the main deficiencies in the following areas (Wang et al., 2009):

(1) Part of the algorithm think the main feature of the bridge is the existence of two parallel lines (Sun and Mao, 2011).

(2) In the process of land and water segmentation, considered to be low grey river (Chung and Lin, 2011), and bridges and land has high gradation, histogram distinctive characteristics. Therefore, only for image segmentation using the general threshold segmentation method to extract water. But the practical application of a lot more obvious peak or valley image exists.

(3) Image Experimental data are used in most studies included a small piece of bridges, which is the premise of the research carried out already exists in the target, missing search and find potential targets on the big picture capabilities. But in practice most remote sensing images are not included rivers, even if not necessarily river bridge.This paper has comprehensively analysed the effect patterns of the factors such as the bending deformation of the rail top, the rigidity changes of the rail foundation, the train running speeds, the train running direction and other factors on the dynamic performance of the bridge/approach embankment of high-speed railway for the first time in China. The calculation results have demonstrated that the rail top bending deformation resulted by the settlement difference of the embankment and bridge is the main factor that effects the safe and comfortable running of high speed trains, the handling of which should be emphasized; the rigidity changes of the track foundations resulting from the rigidity differences between the embankment and bridge should not become the control conditions. The changes in the indexes of dynamics performance are not big when trains pass through the bridge/approach embankment of high-speed railway and the running direction of trains will not play a restricting role.

3 Bridge deformation detection principle and binary image processing

3.1 Bridge Deformation Detection Principle

Bridges need to be considered in the design of the external force has a certain ability to resist, such as wind, traffic, temperature, tides and some unpredictable loads, such as earthquakes, floods and typhoons.

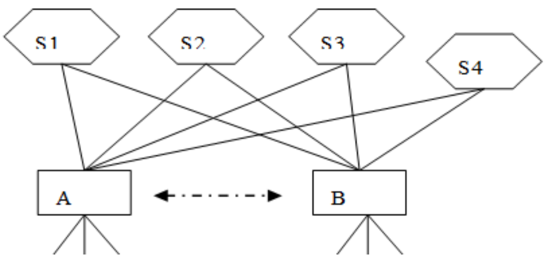

Figure 1: Deformation Detection Schematic

Typical large flexible dynamic deformation of the bridge is lateral vibration caused by the wind and the vertical direction due to traffic due to changes in ambient temperature.
As shown in Figure 1, if A and B are two points at the same time observing the same set of satellites (at least four). And A is a known point, through some sort of data link; the correct information is send to the original B point, the location of point B can be determined.
Formula is as follows:

$$S_A = ((x_A - x_A^{'})^2 - (y_A - y_A^{'})^2)^{\frac{1}{2}} \tag{1}$$

$$S_B = ((x_B - x_B^{'})^2 - (y_B - y_B^{'})^2)^{\frac{1}{2}} \tag{2}$$

After obtaining the positions of A and B, the degree of deformation of two points can be calculated: $|S = S_A - S_B|$
GPS receiver receives at least four GPS satellite positioning signal (electromagnetic wave) on the ground. According to the positioning signal arrival time difference between the GPS receiver, using the equation (3), calculates the position (latitude and longitude, altitude, etc.) on the ground as well as the degree of deformation GPS receiver.

3.2 Binary Image Processing

After bridge binary image processing, bridge image can be captured into a black and white image, thereby compressing the bridge image, reducing the amount of data bridge deformation detection system, thereby reducing the complexity of operations. Normally, during the process of the bridge image data compression, the data loss situation will exist. Many of the details bridge-related will be lost. So, in this process we need to minimize the loss of valuable detail. Bridge deformation detection process, binary image processing is an effective means to bridge initialized image acquisition, is data base of bridge strain detected.
Bridge deformation detection process requires the use of a threshold value of the image pixel classification of bridges binary image processing. This binary calculation method is simple, convenient, and high efficiency of binaries. Using this method of linearization processing, need to calculate the threshold of image pixel classification, and in the bridge, all the image pixel grey value with the threshold value are compared, and the bridge all the image pixel grey value with the threshold value are compared, At this stage, the bridge binary image processing main methods are threshold calculation method. The steps are as follows: Use the following formula calculates the ratio of bridge suspected deformation region pixel in the whole bridge image: $\mathrm{P} = \frac{P_P}{P_j}$
Of which, Pp is number of pixels of deformation region suspected in bridges image, P_j is number of total pixels in bridges image.
Using the following formula to calculate bridge image intensity distribution coefficient: $\mathrm{P}_i = \frac{P_i}{N_j}$
Pi is number of pixels where value is I in bridges image.

Using the following formula to calculate bridge image grey cumulative distribution coefficient:

$$P_l = \sum_{j=0}^{l} P_j \tag{3}$$

Using the following formula to calculate bridge image pixel classification threshold:

$$U = \{1 \mid \min_l |P - P_l|\} \tag{4}$$

According to the method described above, it is possible to do bridge binaries image processing, in order to achieve data compression and to preserve valuable bridge image information.
Using the maximum entropy method can detect a bridge image deformation. Setting the probability of a set of events can be described by the set of data P={P_1, $P_{2, \ldots,}$ P_N}. So the amount of information of this group is events entropy, can be calculated using the following formula: $F_i = P_i \square ln P_i$
Because of P_1+$P_{2+ \ldots,+}$$P_{N=1,}$ under the condition of P_1=$P_{2= \ldots,=}$$P_N$=1/N
Entropy can reach a maximum value. Using the maximum entropy method to calculate bridge image deformation degree, need to use the maximum entropy method to calculate bridge image distortion threshold, in order to gain the degree of deformation of the bridge. The steps are as follows:
Bridge image grey value range is [0,255], then use the following formula to calculate the probability distribution of all pixels in the bridge image:

$$P_i = \frac{p_i}{P_j} \text{ (i=1, 2, . . . , 255)} \quad (5)$$

Setting the initial threshold bridge image deformation degree classification is $U=U_0$
Using this initial threshold value the image can be divided into two bridge portions D_1 and D_2. Bridges can be calculated using the following formula slight deformation threshold:

$$F_1 = \sum_{i=0}^{N} \frac{P_i}{P_U} \bullet \ln \frac{P_i}{P_U} \quad (6)$$

Of which $P_U = \sum_{i=1}^{U} P_i$.
Use the following formula to calculate the deformation degree can be the bridge:
If $P_1 < F_1$, there is no deformed bridge; If $F_1 \le P_1$, there is slight deformed bridge; If $P_1 \ge F_1$, there is serious deformed bridge;

4. Experimental content

There are four aspects of specific studies of this article, including Multi-feature extraction and integration of remote sensing image, under complex background SVM-based remote sensing image river target detection, geodesic active contour model (GAC) based the river precise correction and based on information measure and prior knowledge of bridges detection. Figure 2 shows the basic flow diagrams bridge detection algorithm.
(1) Multi-feature extraction and integration of remote sensing images. The premise of rivers is to find image features which can effectively distinguish rivers and other geographic regions. Therefore, this paper analyses the difference between the river and the remote sensing images in other geographic areas in the apparent. On the basis of existing various features analysis, through a large number of experiments and observations for the river and the city, fields, forests, ponds and other geographic target of remote sensing images, we chose the corner information feature, local pick features and texture features based on wavelet extraction.

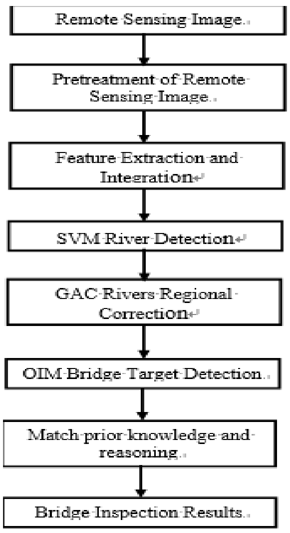

Figure 2: The Flow Chart of Bridge Detection Algorithm

(2) Under complex background SVM-based remote sensing image river target detection. After feature extraction after preliminary treatment, the original image of each pixel has a corresponding three-dimensional feature vector. But if you want to complete the image of the river area, only owning these features is not enough, it needs to be some process. Target detection based on remote sensing images often used as a binary classification problem. Rivers objective is to detect as two types of images: River area and the background area. Currently it has a variety of machine learning methods for solving the two-class problem. In these methods, SVM has many advantages. Therefore, we choose SVM to detect river objective: first river samples and background samples are input to the SVM in training. Then the decision function training was to classify the test image, to get the final test results.
(3) Geodesic active contour model (GAC) based the river precise correction. After SVM classification, it will be roughly the target area of the image in the river. However, due to various factors, the river area often had a

certain noise, and the ratio of the actual area of the river is narrower, and the entire river region is often divided into a number of small isolated areas.

(4) Based on information measure and prior knowledge of bridges detection. After obtaining accurate river region, we need to search the area along the river where all the region of interest based on the information measure and fuzzy C-means clustering to extract river region stronger all directional goals. After completion of the search, in the river area of the bridge will be a lot of suspected target, we need to find out the false target. Therefore, this article established a priori knowledge base of bridges, and as a basis for all suspected target do further high-level matching and verification work, remove the false bridge, to obtain the test results finally.

5. Simulation results

During bridge deformation detection process, need to use a pressure sensor to collect pressure signal of different spatial positions on the bridge, calculating the extent of the bridge shape change according to pressure signal. Suppose bridge deformation uniformity is poor, resulting in the distortion characteristic of the defect, lowering the accuracy of detecting the deformation of the bridge. Therefore, we proposed bridge deformation detection method based on maximum entropy algorithm. Set the selected bridge actual deformation coefficient is 0.3. In the process of using different algorithms in the detection of bridge deformation, the sample data acquisition is shown in Table 1. We used four algorithms, including pressure sensor algorithm, infrared image algorithm, ray reflection algorithm and maximum Entropy algorithm we proposed in this paper.

Table 1: Experimental Sample Data

Algorithm	The number of sensors
Pressure sensor algorithm	48
Infrared image algorithm	53
Ray reflection algorithm	50
Maximum Entropy algorithm	51

Using infrared image algorithm to detect bridge deformation, the test results obtained are shown in Figure 3. Using pressure sensor algorithm to detect bridge deformation, the test results obtained are shown in Figure 4.

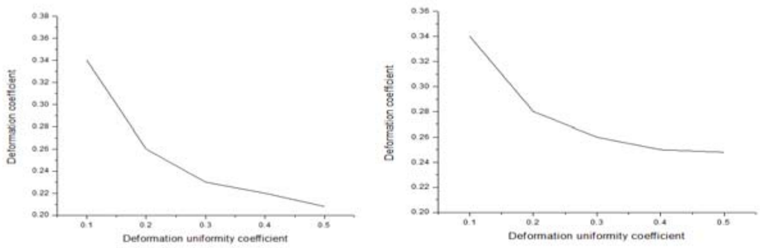

Figure 3: Test Result of Infrared Image Algorithm

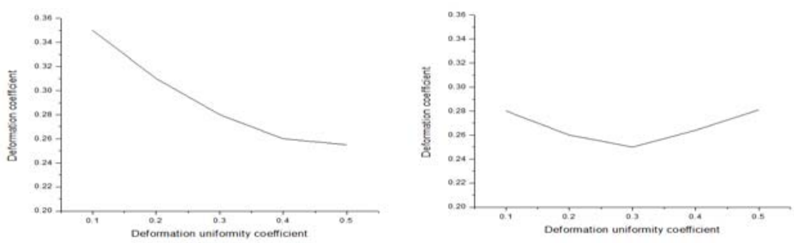

Figure 4: Test Result of Pressure Sensor Algorithm

Through the above four images we can know, using the maximum entropy method to detect deformation, can avoid the defects of characteristic distortion caused by the poor uniformity of deformation of bridge defects. So it can overcome the drawbacks of traditional methods to improve the accuracy of detect deformation bridge.

The experimental data were analyzed and Table 2 can be obtained. According to Table 2we can know, with the image of maximum entropy method proposed to detect the bridge deformation, the results obtained with the actual situation most closely.

Table 2: Bridge Deformation Sensing Data

Algorithm	Deformation uniformity coefficient	Deformation coefficient
Pressure sensor algorithm	0.40	0.21
Infrared image algorithm	0.36	0.23
Ray reflection algorithm	0.42	0.18
Maximum Entropy algorithm	0.41	0.26

6. Conclusions

Taking the control values of dynamics performance assessment indexes preliminarily established by this paper as the target function, the unevenness control standards (rail top bending angle) of the bridge/approach embankment under different speed grades are: V=160km/h, θ≤0.55%, V=250km/h, θ≤3‰, V=350km/h which are very good because they tally with the relative Japanese research results. This paper has put forth the structure designs and technical standards for the bridge/approach embankment under different speeds in light of the analysis results of the dynamic performances of the bridge/approach embankment by the relative domestic and overseas materials about the treatment measures for the bridge/approach embankment and the practical experience and research results of the existing projects; part of the contents of which have been put into the "Temporary Requirements for Design of Railways, Bridges, Tunnels and Stations of Newly Built Express Railways -with 200km/h Trains" and the" Temporary Requirements for Design of Railways, Bridges, Tunnels and Stations of the Beijing-Shanghai High-Speed Railway", which has been applied in the construction of the Qinhuangdao-Shenyang dedicated passenger line and the engineering effects of which are being tested by its operation.

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