Design 3D Visualization Digital Road System of Pavement Distress

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Abstract. The traditional detection methods at present cannot meet the real needs of the road maintenance organization. Manual measurement takes long time and low efficiency, costs labor intensity, affect the normal traffic and has a security risk. Multifunctional detection vehicle unable to accurately detect three-dimensional pavement distress. The type of disease detection is not complete, leading to inaccurate evaluation results, thereby affecting the accurate decision of maintenance organization. This research design 3D visualization digital road system of pavement distress, Road disease integrity detection based on three-dimensional visualization reconstruction have been realized, compared with traditional road detection technology, three-dimensional visual road reconstruction system which designed in this paper could realize full coverage of road damage data, evaluate road conditions rapidly and accurately, and provide reliable and scientific technology support for road maintenance decision.

Introduction

In recent years, the rapid development of highway construction, with highway mileage, especially highway mileage increases, the road maintenance and management after completion of the workload have also increased rapidly, which made the highway detection level need the higher requirements.

At present, the traditional manual measurement (Fig. 1) and multifunctional detection vehicle (Fig. 2) rapid continuous detection are mainly detection methods used for asphalt pavement surface distress survey. Table 1 Comparison of the two methods.

The traditional detection methods at present cannot meet the real needs of the road maintenance organization. The manual measurement can comprehensively and accurately detect and evaluate the road, but it must rely on the investigators do investigation of the scene to get enough accurate data. It is high cost and low efficiency, affect the normal traffic, It is a security risk. It does not meet the social requirements of information technology and automation technology. Multifunctional detection vehicle contains information and automation technology, to achieve rapid detection. But the main object is two-dimensional disease, such as crack fracture, net-shaped cracking etc, unable to accurately detect three-dimensional disease,
such as pot hole, swelling, rut, subsidence etc. The type of disease detection is not complete, leading to inaccurate evaluation results, thereby affecting the accurate decision of maintenance organization. The road needs heavy maintenance will be mistakenly judged to intermediate maintenance, and needs intermediate maintenance will be mistakenly judged to ordinary maintenance. It to a certain extent reduces the maintenance decision-making reliance on automatic detection of data reliability. Therefore, the research and development of a 3D digital road system becomes an urgent task.

Table 1. A comparison of Advantages and Disadvantages of Manual Measurement and Multifunctional Detection Vehicle.

| Instrument                        | advantages                              | disadvantages                                                                 |
|-----------------------------------|-----------------------------------------|-------------------------------------------------------------------------------|
| manual measurement                | A ruler, measuring tape and three meter ruler, etc | The comprehensive investigation, relatively high accuracy | long time, cost labor intensity, and speed is low, the impact of traffic, investigators have security risks |
| multifunctional detection vehicle | Hardware: high resolution Linescan CCD Camera software; pavement crack automatic recognition system | High speed, high efficiency, high safety, does not affect the traffic | It cannot detect recognition the deformation of 3D failure information, incomplete and inaccurate test results |

**3D Visualization Digital Road System of Pavement Distress**

According to the information collection function of pavement distress and show the 3D visual simulation of pavement, this paper designed 3D visualization digital road system of pavement distress includes the main function module as shown in Fig. 3.
Establish a 3D Visualization model of Pavement

In the digital road hierarchy model, GPS layer includes GPS latitude and GPS elevation information. Cross-section reconstructs information of road shape and grade of slope, including cross-section road furrow and road profile smoothness. The texture layer reconstructs road surface information, including micro road information, such as crack fracture, texture etc. We put each level of information together, to reconstruct 3D visualization model of pavement. This article reconstructs 3D surface of pavement, X axis for the vertical profile mileage, Y axis for cross-section, Z axis for altitude. The reconstruction process needs to combine coordinate information, section information and texture information in unified coordinates of the road.

Display of 3D Visualization Digital Road System

In construction of 3D mesh surface, the method is the approximation of the latitude and longitude grid lines. The method comprises the following steps, first is to calculate surface mesh, second is mesh smoothing, last one is according to the grid vertex drawing polygons.

The principle of making colored road is based on the terrain, making the corresponding color table. Firstly, according to the difference of elevation, established corresponding color table, then according to elevation of each vertex in the mesh model to find the corresponding color index value.

View Three-dimensional Scene

It contains three modules, one is road information module to calculate pavement distress information, Second is 3D visualization module to show 3D reconstruction effect of the road, last one is operation panel module to load the elevation data, choose display mode of three-dimensional road and 3D scene browsing mode.
Operation steps: You can click on the operation panel to load files, choose elevation data files you want, and then click load, as shown in Fig. 5, the other two video file and 2D images file loading similar.

The road display mode, you can choose to display the three-dimensional reconstruction model in a grid form or colored form of road.
In the direction of 3D reconstruction, you can control the road moving forward and back, left and right, as shown in Fig.6.

As shown in Fig.7, you can enter to view mileage in the edit box (in meters), click on the jump, you can see the corresponding sections. In the moving, you can choose automatic moving forward or backward, can also adjust the speed of moving.

As shown in Fig.8, you can choose the path you want to export the data. This system can output length, width, area and other information of pavement distress (pot hole, swelling, rut, subsidence) in TXT text format or EXCEL format.

**View Road Environment**

It consists two modules, one is video display module to detect road environment, other is the two-dimensional picture playback module to display two-dimensional overlooking picture of the road.

**Calculation and Evaluation of Pavement Distress**

The last step is to export the pavement distress information into the "urban road evaluation and decision system", to evaluate the detection road. The system realizes the evaluation of road information data integrity, and data dual storage about files and database. Based on analysis of the data, you can get Influencing factors of the evaluation results. Report output format evaluation of road evaluation results can be selected according to the unit, or on the road down the overall output. It realizes pavement evaluation of the road.

**Summary**

Through the research on calculation method of three-dimensional pavement damage, road disease integrity detection based on three-dimensional visualization reconstruction have been realized, compared with traditional road detection technology, three-dimensional visual road reconstruction system which designed in this paper could realize full coverage of road damage data, evaluate road conditions rapidly and accurately, and provide reliable and scientific technology support for road maintenance decision.

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