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RESEARCH ARTICLE

AUTOMATIC ASSESSMENT OF PAVEMENT DISTRESSES-A PAST EXPERIENCE

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ABSTRACT

The Pavement Distress Assessment (PDA) is an essential phenomenon in Pavement Management System (PMS) which is used to provide the sufficient information for making consistent and more cost-beneficial decisions for safe and comfortable road management. The collection of distress-data is a great challenge to the pavement engineers. The distress data can be collected using either ground-manual surveys or automatic assessing techniques. The present article focused on automatic assessment of pavement distresses using Digital Image Processing. Initially, the different image-acquisition systems are presented and discussed. Later, the image processing techniques for classifying and quantifying the different pavement distresses such as alligator cracking, potholes, raveling, bleeding and rutting etcetera. Finally, the choice and status of available techniques are summarized.

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INTRODUCTION

Many researchers have been focused on wide variety of technical solutions to overcome the hurdles in detecting, classifying and quantifying the pavement defects. The manual-inspection methods are labor-intensive and time-consuming procedures which result in queueing of the vehicles along the ground surveying pavement-sections. With these drawbacks, the automatic assessing techniques are evolved for safe and quick evaluation of pavement condition. As the pavement condition monitoring is an important criterion in Pavement Management System (PMS) for making the cost-reducing and timely decisions regarding the maintenance choices for distressed pavements. In the early times, the implementation of these automated methods was limited due to the inaccurate prediction of types and intensity of pavement defects. To take this into consideration, the commercial agencies and researchers started the research in enhancing the accuracy for detecting the pavement distresses. With this background, the present article made an effort to review the previous studies for implementing the automated pavement distress assessment techniques. The architecture of the present article is shown in Figure 1.

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IMAGE ACQUISITION SYSTEM

Komastu System: This system was developed in late 1980s by Japanese association Komastu. (Wang et al. 2000). This survey vehicle was developed to measure the rutting, cracking and longitudinal profile simultaneously. This survey vehicle was attached with image-capturing and data-processing systems. This system was attached with cameras having a resolution of 2048 x 2048 pixels. These cameras could capture in the night time only and at a speed of 10kmph. Argon laser light illumination and Photo Multiplier Tubes (PMT) were attached for collecting the road profile along the lateral direction (figure 2)

Digital Highway Data Vehicle (DHDV): Generally, DHDV combines the different technologies like GPS mapping, inertial profiling and laser illumination imaging techniques. The high-resolution line-cameras are used to capture the pavement images mounted on back of the DHDV. In the DHDV system, the Laser Road Imaging System (LRIS), Right of Way (RoW) imaging system are included for collecting the images of pavement surface, profile images and RoW. LRIS used to collect the images with the help of 2 line-scan cameras and laser illuminators at speed of 100KMPH. RoW imaging system used for collecting the geo-referenced pavement images within built Differential Global Positiong System. The data flow DHDV system. (Figure 3).

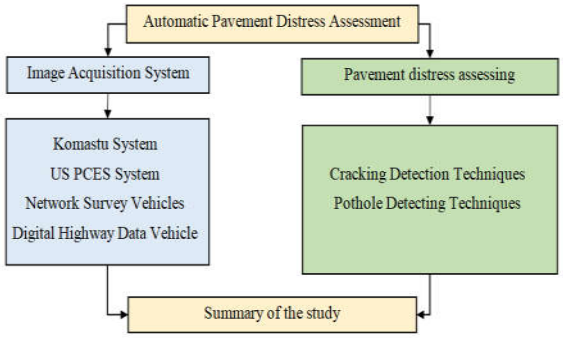

Figure 1. The architecture of the current article

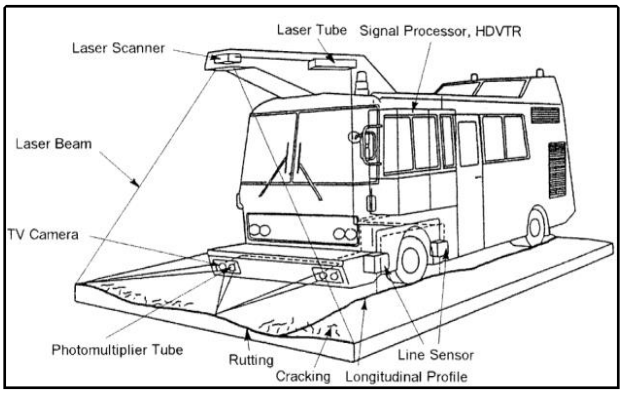

Figure 2. The Komastu Survey Vehicle

Figure 3. Digital Highway Data Vehicle

US-PCES System

This system was developed by United States of America during 1980s. It was launched by Earth Technology Corporation and named it as Pavement Condition Evaluation System (PCES). This system adopted a vehicle with two line-scan cameras and these cameras could cover a pavement width of 8ft.

Multi-Purpose Survey Vehicle (MPSV)

Multi-Purpose Survey Vehicle (MPSV) is another type of vehicle used for taking the pavement images with the help of Florida-DOT. The line-scan camera and artificial lighting system were provided in MPSV (Figure 4).

Figure 3. Multi-Purpose Survey Vehicle

High Speed Laser Detection Vehicle

The present High-Speed Laser Detection Vehicle (HSLDV) was developed by Chang'an University. Wei et al. (2009) *discussed a mathematical morphology method for automatic-detection of pavement crackings in which HSLDV was used for capturing the pavement surface.*

Figure 3. High Speed Laser Detection Vehicle

Pavement distress assessment techniques

Cracking Detection: The various techniques like thresholding, decomposition, wavelet transforms, beamlet transforms, curvelet transforms, ridgelet transforms were developed for pavement crack detections. In addition to these technqiues, the morphological operators were used in enhancing the accuracy of pavement crack detection. The crack-strength and region-based approaches were adopted for quantifying the cracked areas on pavement surfaces. To date, the linear classifiers, Back-Propagation Neural Network, Deep Convolution Neural Networks have been used for classifying the pavement cracks in to longitudinal, transverse, alligator and block crackings. In addition to them, the Canny edge detection become popular in detecting the cracks with more accuracy. The sub-mm laser techniques were also developed to quantify the micro-cracks.

Pot-hole detection: Generally, potholes are formed due to extensive alligator cracking. 3-D laser techniques, Stereo-vision techniques, line-scanning cameras were used in assessing the potholes. The morphological operators like erosion and dilation are become popular in improving the accuracy of pothole-detection. The pothole detection can be illustrated in terms of defected pavement area and non-defected pavement area. The visual appearance such as the texture parameters can be identified by using different algorithms such as Difference of Gaussian Filtering, Canny detection algorithms. The transfer learning, Deep Learning techniques are also playing a vital role in pot-hole detection.

Summary

The Pavement Distress Assessment is a crucial stage in Pavement Management System. The process of quantifying the pavement distresses has been changed from manual to automatic assessing techniques. Initially, the distresses were identified at low-speeds only, but, then the researchers focused on accurate and quick estimation of distresses even at high-speeds. The modern computer technologies made more comfort in detecting and quantifying the pavement distresses.

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