Project Summary

Texas Department of Transportation

0-5708: Improving Capabilities of Automated Distress Rating

Background

This project is a follow-up on two previously funded projects for automated pavement distress inspection. The goal is to further improve the capabilities of the automated pavement distress rating system (VCrack). The tasks are to extend the capacity of the distress detection algorithms for concrete pavement inspections and to improve the optics of the light bar and the camera's setup to enable the system to scan a 12 ft lane width.

What the Researchers Did

During the two-year period, we have accomplished the following main tasks:

Designed the system with new hardware

We designed a system, called Crackscope, using a new camera, lense, and a new lighting device that permit the system to cover a 12 ft lane width. The Crackscope uses one StockerYale Magnum II line projector (referred to as Laser), which has an 810nm 7w laser diode to illuminate the pavement for image acquisition. It is mounted side by side with a linescan camera in a custom design enclosure. The front plate of the enclosure has an 8 in. long and 0.5 in. wide open slot aligned with the central line of the optics of the Laser and the camera. The enclosure is installed vertically downward at a height of 7.5 ft above the ground, and the laser line covers approximately a 12 ft wide pavement surface (see 0-5708-1).

Established the communication protocol

We developed the communication protocol for the Crackscope computer to communicate with other modules of the Vnet so that the Crackscope can instantly get vehicle speed, DMI, timestamp, and other information from the Application Manager, as well as output the cracking data to the Application Manager. The output protocol is included in the Crackscope Operation manual.

Implemented laser safety measures and developed an operation manual

The laser safety measures take two different approaches to prevent people in close vicinity from being exposed to the laser. One approach uses the proximity sensor to detect objects in the area and to shut off the laser if the detected object is within a 2-4 ft range. The second approach is the laser modulation by the speed control. When the vehicle speed is below a preset speed (e.g., 5 mph), the laser outputs a minimal power, which is eye-safe. The system also has an interlock switch that is near the operator who can switch off the laser at any point of time. The operation manual specifically states when the laser should be turned off.

Research Performed by:

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Conducted field tests

Field tests were done on TxDOT testing site, which were visually rated and ten compared to results collected by pavement rating experts. Although the Crackscope ratings for longitudinal, transverse and alligator cracking are generally consistent with the manual ratings, Crackscope tends to underestimate pavement cracking because most "white" cracks and low contrast cracks are hardly detected.

The repeatability test was performed on the same site by inspecting the pavements with multiple runs on the same day, and by repeating the test in different days. The results show that the coefficient of variance (CV) of the longitudinal and transverse data varies from 5% to 13% on different days. If all the data are combined together, the CV of both cracks is still in the range of 4% to 14%.

What They Found

IIn summary, the CrackScope system is a field prototype of automated pavement crack rating system consisting of a digital line scan camera, laser-line illuminator, and proprietary crack detection and classification software. CrackScope is able to perform real-time pavement inspection with 100% distance coverage at travel velocities from 5 to 30 mph. It covers up to 12-ft wide lanes depending upon mounting height with a resolution of 1.5 mm to 1.75mm/pixel. The system consumes approximately 150w electrical power, and can perform both daytime and nighttime surveys.

What This Means

This prototype has substantial improvement in optics over the previous system. The shadow effect when capturing images on sunny days is diminished with the new system. This enables us to concentrate on the higher level objectives of the project, such as improve the performance of image processing algorithm and the flexibility of the software.

The real-time image capturing software has been developed to collect pavement surface data. The test results quantitatively verified that the principle of our detection system is technically sound and indicated that the algorithm implemented in the software works in most cases. However, when compared with manual crack rating, the image processing algorithm tends to underestimate the cracks. This is partly because some of the cracks are not discernable in the picture due to the limited pixel resolution and contrast. Also, the generalization of the algorithm is another problem. For example, the algorithm may work well on pictures with normal contrast, but may not work well on pictures with very low contrast.

For More Information:

0-5708-1 Design of CrackScope (VCrack)
0-5708-2 Improved Pavement Distress Rating System

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