CENTER FOR TRANSPORTATION RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

Project Summary Report 0-4958-S
Project 0-4958: Development of an Artificial Lighting System to Enhance the Automated Pavement Distress Measurement System
Authors: Bugao Xu, Ph.D.
September 2005

PROJECT SUMMARY REPORT

Artificial Lighting for the Automated Pavement Distress Rating System

Purpose and Scope of the Project

An automated pavement distress rating system was developed under Texas Department of Transportation (TxDOT) Research Project 7-4975 in the past several years. The system now can scan 100 percent of pavement surfaces at any vehicle speed between 5 and 70 miles per hour, detect cracks in real time, and transmit the rating results to the central computer at a specified distance interval (per station or per 0.1 mile). Currently, the system uses natural light for simplicity and energy conservation. Although the system can capture analyzable images under a wide range of lighting conditions (cloudy or sunny), natural light causes two problems for the system. One is that cracks detected under different lighting conditions are less consistent than those in similar conditions. The other problem is that the system has difficulty differentiating shadows of external objects (e.g., passing vehicles, trees, and wires) from sealed cracks or patches. Artificial lighting is the ultimate solution for eliminating all shadows in the image and for improving the data uniformity across different weather conditions.

The objective of this research is to develop a low-power, linear light source that matches the need of the line scan camera used in the

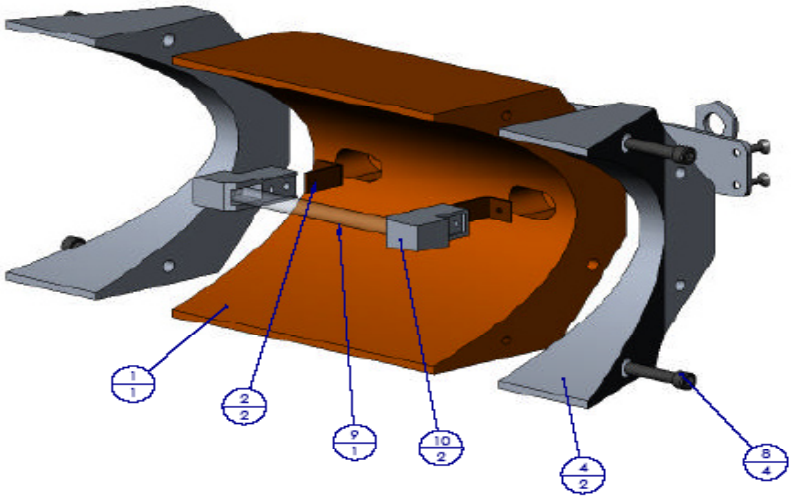

Figure 1 Halogen Light Device

Figure 2 Laser Line Projector

system. The light source should form a 0.25- to 1-inch-wide stripe covering the pavement width up to 12 feet at a height of 6 feet or less. The lighting intensity should give sufficient illumination for night scanning, and the energy consumption should not require a designated power supply. The system should be able to automatically turn the light source on or off based on the conditions of the natural light and shadows. The light source should be compact, light, and safe for operations.

What We Did ...

Three different approaches of generating a linear light source were implemented using halogen lamps, laser line projectors, and LED arrays. As a result, three prototypes of lighting devices were developed for performance tests.

1. Halogen Light with Specially Designed Reflector

The researchers chose a 300-watt halogen lamp as a light source and designed an ellipsoidal, cylindrical reflector to focus the lights to form a 1.5-inch-wide beam at a working distance of 20 inches (Figure 1). Three units of such a device are needed to cover a 12-foot-wide pavement.

2. High-Power Laser Line Projector

The researchers chose a 2-watt laser line generator that can form a 0.2-inch-wide beam and cover a 6-foot-wide pavement at a working distance of 6 feet (Figure 2). For full lane pavement inspection, two units were required.

3. High-Intensity LED Array

An array of LED diodes was mounted behind a cylindrical lens to form a 0.5-inch-wide beam (Figure 3). One unit consists of 40 LED diodes, which can cover 1.5 feet in distance at a working distance of 2 feet.

What We Found ...

Both the halogen lighting device and the laser projector are compact in size and can project a long beam on the pavement. Two units of these devices can cover the scanned width of the pavement, but the halogen light consumes high energy (300 watts per unit), and the laser projector is not eye-safe. Additionally, it is difficult to maintain the alignment of the laser line with the line scan camera. The LED device consumes 30 watts per unit. The total energy consumption for a pavement survey vehicle is less than 300 watts. The

narrow bandwidth of the laser light also permits blockage of most visible light. The field test data also support the following findings:

- LED lighting effectively eliminates shadows and "white" cracks.
- R^2s of multiple runs when the LED light is on are above 0.9.
- R^2s of the runs with nonshadow natural light and LED light > 0.9.
- R^2s of multiple runs with LED light in daytime and at night > 0.9.
- LED lighting significantly improves quality of alligator cracking data.

The Researchers Recommend ...

We recommend changing the wing units on both ends of the light bar from the flat set-up to an angle set-up, and changing the voltage regulator to the current regulator.

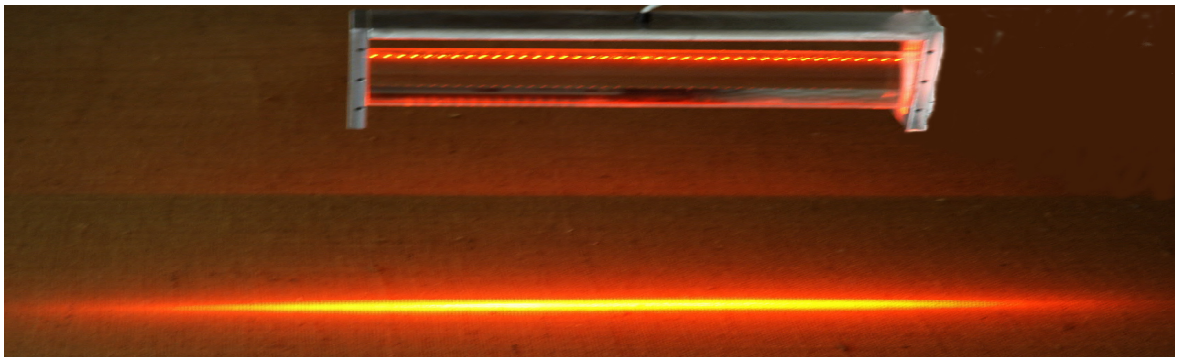

Figure 3 LED Linear Lighting Unit

For More Details...

Research Supervisor: Bugao Xu, Ph.D., (512) 471-7226
email: bxu@mail.utexas.edu

TxDOT Project Director: Carl Bertrand, Construction Division, Retired

Todd Copenhaver, Construction Division, (512) 465-3065
email: tcopenh@dot.state.tx.us

TxDOT Research Engineer: German Claros, Ph.D., P.E., Research and Technology Implementation Office, (512) 465-7403
email: gclaros@dot.state.tx.us

The research is documented in the following report:

0-4958-1 *Linear Lighting System for Automated Pavement Distress Measurement*

To obtain copies of a report: CTR Library, Center for Transportation Research, (512) 232-3126, email: ctrlib@uts.cc.utexas.edu

Your Involvement Is Welcome!

Disclaimer

The University of Texas at Austin
Center for Transportation Research Library
3208 Red River #115
Austin, TX 78705-2650