Project Summary Report 5-1782-01-S
Project 5-1782-01: Implementation of the Real-Time Transverse Pavement Profile Measurement System

Author: Roger S. Walker, Ph.D., P.E.

PROJECT SUMMARY REPORT

Implementation of the Real-Time Transverse Pavement Profile Measurement System: Summary Report

What We Did…

This report discusses an implementation project between the Texas Department of Transportation and The University of Texas at Arlington. The Texas Department of Transportation (TxDOT) has been using a five-sensor rut bar system, implemented with ultrasonic sensor technology, to automatically collect estimates of pavement rutting for the Pavement Management Information System (PMIS) purposes. A number of problems occur when using the acoustic sensors for this purpose. TxDOT Project 0-1782 (see Report 0-1782-1) was initiated to investigate the possibility of using scanning laser technology for measurement of rutting that would alleviate some of the problems of the acoustic sensor. Following this project, TxDOT initiated an implementation project with The University of Texas at Arlington in December of 2002. This current report discusses the implementation effort.

Project 0-1782 Background: During Research Project 0-1782, a functional scanning laser process based around the Acuity AR4000 scanning laser was developed to scan the full width of the paving lane and to report and store the rut condition of each wheel path. The principal components of the measurement process are illustrated in Figure 1. The AccuRange laser is a laser-diode-based distance measuring system with 0.1-inch static resolution for distances to 50 feet. When used with the accompanying scanning mirror system, it provides a means for making multiple scans over a surface.

During the project it was found that significant noise problems occurred with the laser system during high speed measurements. This noise was found to be caused by the laser beam as it is swept across the pavement surface. Thus much of the effort during the project was focused on developing a means to distinguish the signal from the noise, and to address a means by which measurements could be made at highway speeds.

The raw laser data are first converted into distance readings and then put through a multi-step process to produce results that can then be used to compute rut and provide transverse surface scans. This process, which is discussed in detail in Report 0-1782-1, consists of the following steps for each scan: coordinate transformation, histogram clipping, spike suppression, scan comparison, and curve fitting. Rut detection was accomplished by using the European "string line" method. Figure 2 illustrates a processed scan after applying the string line rut procedure on a processed rut measurement taken from a section in Granger, Texas, during 2002.

During the last year of the project the multi-step process applied to each scan provided valid rut measurements that were verified from measurements at the Ride/Rut Calibration facility, and at sites in Austin and Granger, Texas. Thus it was decided to proceed to implementation of the system, acquiring 16 scanning laser systems for network and project level data collection.

What We Implemented…

The implementation project was initiated in December 2002. As specified in the implementation plan, during the

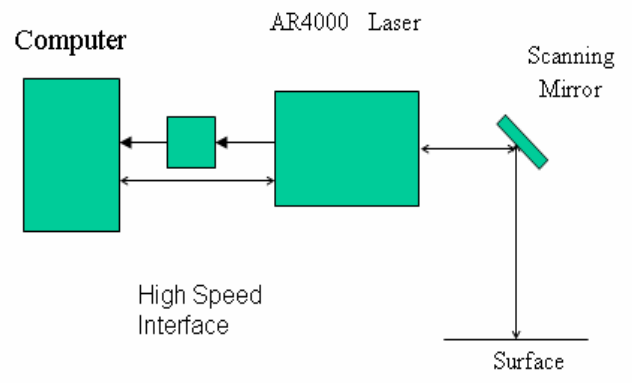

Figure 1. The Acuity Scanning Laser System

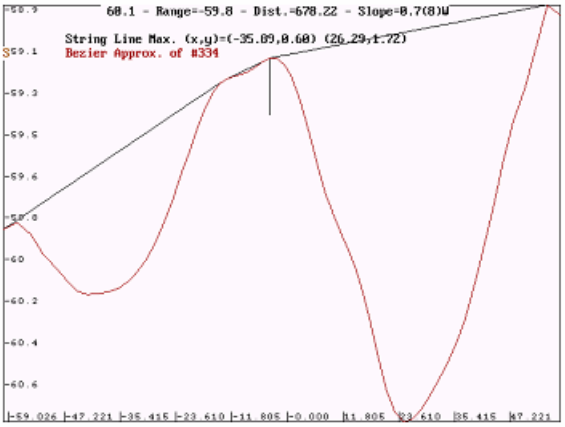

Figure 2. Processed Scan with String Line Rut Procedure

first year of the project, five Acuity systems were purchased. The remaining 11 systems were purchased during 2004. At the beginning of Research Project 0-1782 in 1999, the platform used for TxDOT data collection activities was based around a dedicated DOS system. By the time Research Project 0-1782 ended in August 2002, the platform used for data collection had changed to a Windows/Linux based network system.

TxDOT's Construction Division, Pavement Section, designed and developed a vehicle network system (VNET) for coordinating the data collection activities in the Texas Modular Vehicle (TMV). Since the system developed in Research Project 0-1782 was based around the DOS system, the implementation would require modifying the software so the system could integrate with the VNET concept. The original implementation plan called for the use of the real-time scanning and analysis programs developed during Research Project 0-1782 for collecting and processing the scanned data. A TxDOT 'wrapper' program would permit the use of the UTA developed multi-step data acquisition and processing software to integrate with VNET.

These plans were changed during the first project meeting in January 2003. At this meeting several key decisions were made by TxDOT project personnel that altered the original implementation plans. It was decided that TxDOT project personnel would rewrite the scanning laser data acquisition and processing software since they were developing the VNET concept and wanted the system to work directly with the network without the use of the 'wrapper.' During the implementation efforts, TxDOT also made a number of other changes in processing the raw laser readings and distance measurements. As a result, many of the processing and analysis methods developed in Research Project 0-1782 were not used. The new processing procedures are discussed in the TxDOT in-house operational manuals.

TxDOT project personnel designed and implemented a compact package and mounting system for the implementation. The TxDOT scanning laser package is illustrated in Figures 3 and 4. The packaging and mounting process also included external cooling for the scanning laser components. The TMV utilizes an Ethernet LAN to connect pavement management data collection subsystems such as profile, ride, rut, and texture. The TxDOT Scanning Laser System has been incorporated with the TMV.

Because scanning laser data was not available until the end of the implementation project, it was not possible to perform any of the originally planned resolution and accuracy tests by UTA project personnel. However, the data from the scanning system is planned for use in Research Project 0-4463 for 3-D surface measurements.

The system was recently taken to the Ride/Rut Calibration Section at College Station. The Rut Calibration Section includes four sets of three beams placed along the section as shown in Figure 5. The beam height differs for each set, beginning at 3.0 inches for the first set to 0.25 inches for the last set. Figure 6 provides a 3-D display of multiple scans over the first set of bars.

Implementation Conclusions…

During the project, 16 scanning laser systems have been purchased and installed on the TMV. They are currently being used during the 2004 PMIS data collection activities. TxDOT has a compact mounting system for the scanning laser which includes the acuity laser, rotating mirror, and power and embedded system components. Each package includes facilities for external cooling from the vehicle. The system includes laser mounting and installation procedures. The user operations were designed and implemented by TxDOT project personnel and are included in the TxDOT Data Collection Operations Manuals. The system is currently in use.

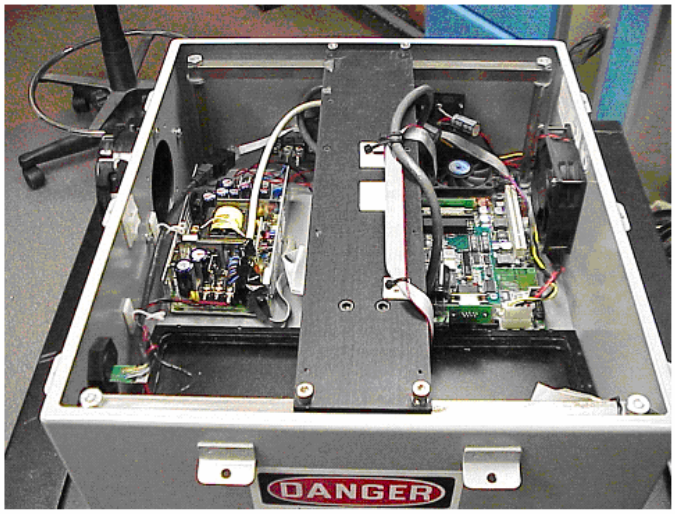

Figure 3. TxDOT Compact Packaging of Scanning Laser System

Figure 4. Scanning Laser System Mounted on TxDOT TMV

Figure 5. Rut Section at Ride/Rut Calibration Center

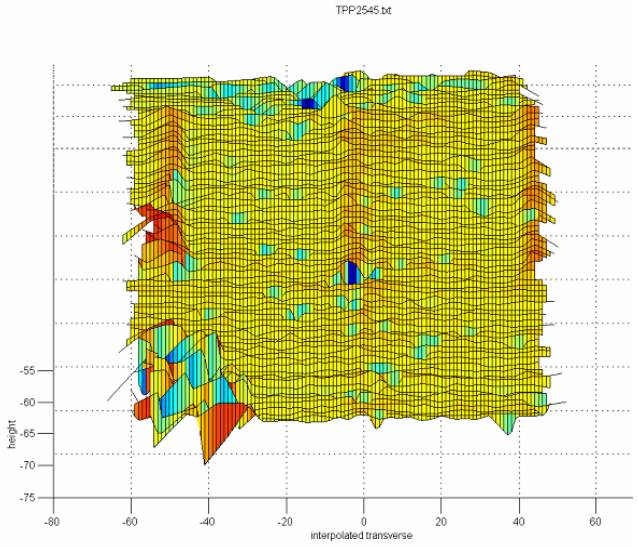

Figure 6. 3-D Plot at Beginning of Rut Section

For More Details…

The research is documented in Report 0-1782-1, *Development of a Real-Time Transverse Pavement Profile Measurement System.*

Implementation Supervisor: Roger S. Walker, (817) 272-3640, walker@cse.uta.edu

TxDOT Project Director: Carl Bertrand (retired)

TxDOT Contact: Brian Michalk, Construction Division, (512) 467-3935, bmichalk@dot.state.tx.us

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

To obtain copies of the report, contact:
Dr. Roger S. Walker,
Transportation Instrumentation Laboratory
The University of Texas at Arlington
P. O. Box 19015
Arlington, TX, 76019

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Texas Transportation Institute/TTI Communications
The Texas A&M University System
3135 TAMU
College Station, TX 77843-3135