I. RESEARCH PROJECT TITLE

Analysis of Road Condition Data Employing Sensor Fusion and High Level Classifications.

II. PROJECT STATEMENT

KSU-EECE has worked the last two years develoing a collection of image processing algorithms for detecting and classifying cracks in the roadway using image analysis techniques. Currently the algorithms have been shown to be effective at detecting and classifying sealed and unsealed cracks. Initial efforts have been made at integrating other sensor data. It is believed that by including data from an integrated surface profiling system, highly accurate and informative classifications can be made. It should also be possible to employ higher level reasoning and thereby classify the causes of the surface cracking, such as fatigue and block cracking. The intent of the research is to provide KDOT personnel, concerned with overall health of the roadway, the ability to automatically analyze pavement condition data in a timely and consistent fashion.

III. RESEARCH PROPOSED OR RESEARCH OBJECTIVES

The overall objective of this research is to develop methods for searching through extensive data collected from KDOT's imaging system and classifying roadway health. The data recovered from the system is intended to facilitate the surveys of the state wide roadway health.

IV. ESTIMATE OF FUNDING AND RESEARCH PERIOD

Investigator and Graduate Student Time: $50,000
Proposed time frame: 12 months beginning in June 2008

V. PAYOFF POTENTIAL TO KDOT

The KDOT Pavement Management System provides decision support for both Capitol Improvement Project selection and Substantial Maintenance project selection and scope. The KDOT has invested heavily in systems to monitor the health of the roadway infrastructure. The current procedures to collect this data require two passes. One pass is with a profilometer generates measures of roughness, rutting, and faulting. The second pass involves a manual survey for cracking and joint distress. While this manual survey has been effective, it does entail some subjectivity in the ratings and requires slow passes on the shoulder or travel way introducing safety concerns. KDOT now owns a data collection vehicle with a profiler and a line-scan imaging camera. The line-scan camera provides images of the road surface. Current software has not proved to detect or characterize these images sufficiently to replace the existing manual process. This effort is to develop algorithms and software to evaluate this data, thereby making use of it to monitor the health of the road ways in a timely and consistent manner. Additionally, the

image-based pavement analysis system will improve safety by removing the need for pavement surveyors to get off their vehicles to take measurements in highways.

VI. IMPLEMENTATION STRATEGY

The image processing developed thus far has been similar to most recognition processes. Currently we have effectively implemented each of basic processes of 1) Preprocessing, 2) Feature Extraction, 3) Classification. Measures of performance have been computed, to verify the effectiveness of the various stages. Having reached this stage, we need to move to higher levels of processing to effectively classify the roadway. Amongst the classification processes to be explored are sensor fusion and higher level reasoning.

The use of multiple sensors has been the subject of extensive research and in each case one of the main problems that had to be addressed is that of registration. Registration is the process of matching the data from each sensor with an exact phenomenon. In our system, it is important to understand the relationship between the data from the camera and the height profiling sensor. Effective methods for analyzing profile data and aligning it with the results from the camera are to be explored. A first attempt at this is depicted in Figure 1.

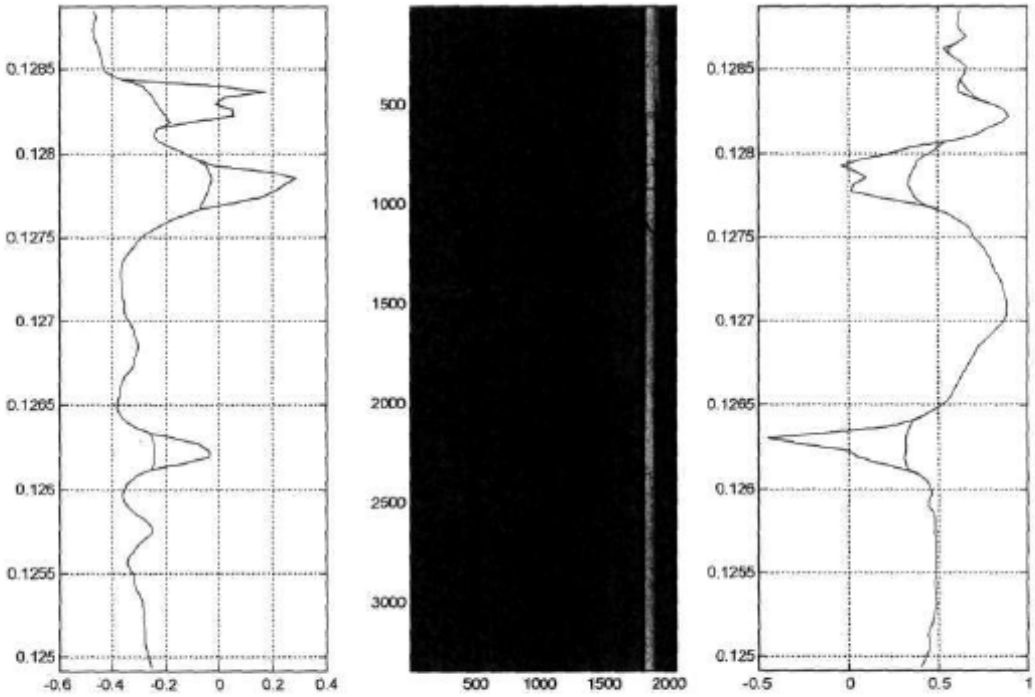

Figure 1. Profile Data and Image Data Displayed Together

Once the system is capable of making valid transverse cracks classifications of class 0, 1, 2 and 3 cracks, expanding to other classifications will be required. Amongst the cracking phenomenon to be explored, are block and fatigue cracking. An initial test of fatigue

cracking has been performed, and it is believed that with minor modifications to the current image processing, fatigue cracking can be detected successfully. Additionally, dimensions of the crack along with its relative position with respect to the wheel path can give further insights into classifying fatigue cracks. Similarly, higher level analysis of the cracks detected by the current processing should be able to detect block cracking. For example, a search for long straight cracks connected at right angles might work to classify block cracking. A variety of artificial intelligence techniques, such as fuzzy logic, are available to try and piece together such information.

VII. PROJECT PERSONNEL

Kansas State University
- Dwight D. Day, Associate Professor, PhD Electrical Engineering, Co-Principle Investigator
- Bala Natarajan, Assistant Professor, PhD Electrical Engineering, Co-Principle Investigator
- Graduate Student Support

VIII. SUBMISSION INFORMATION

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