Automated Survey of Pavement
Surface Distresses

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New Frontier

- **Automated Distress Data Collection & Analysis**
  - MBTC and AHTD Support
  - UA System: the Only Such System at the Achieved Performance Levels
  - A Number of Test Sections
System Design

Camera Head
1300 x 1024, or 2048 x 1024
Gray-Scale

GPS Receiver

Roughness & Rutting Bar

Traveling Direction

1300 x 1024 Color Video Camera

Computers, RAID Storage, Image Compression & Processing Systems

DMI
Telescoped Camera and Four Strobe Lights
Pavement Surface Imaging

- **Digital Frame Camera, Two Options**
  - 2/3-in Charged Couple Device (CCD), 12 F/S, 1300 x 1024, 8-bit
  - 1-in CCD, 8-15 F/S, 2k x 1k, 8-bit
- **Coverage:** 100% Pavement Surface
- **Lane-Width:** 14-ft, or adjustable
- **Strobe Lights:** Synchronized Illumination
- **Streaming & Compressing**
  - 12 frames/second into Computer Storage & Database at Real-Time
- **Data Collection Speed:** at any highway speed, up to 80 MPH
• **Width:** 14-ft, **Speed:** 60 MPH  
• **Resolution Per Frame:** 1300x1028, 8-bit  
• **For 1,000-mile Pavement Images**  
  - 250 KB per Image after compression  
  - $0.25 \times 1000 \times 5280 / 10 = 132 \text{ GB}$  
• **Considering Redundant Storage for Images**  
  - Maximum 264 GB for 1000-mile Pavement  
  - Maximum $3,000 \text{ Cost of Disk Drives}$  
  - Options for 6000 lane miles of data
Automated Survey of Pavement Distresses

• Issues
  - High quality & high resolution digital images
  - Algorithms for auto processing: accuracy & speed
  - Establish distress protocols to be consistent with TN DOT requirements

• Our Approach
  - Based on the digital data vehicle for collection
    - Speed
    - Accuracy
    - Real-time processing
The Parallel Computing Approach

GPS  DMI  Camera

Dual-CPU Acquisition

Expanded View of the Distress Analyzer

CPU 1

CPU N

Project Manager for Parallel Processing

Multi-CPU, Distress Analyzer

Project Manager for Parallel Processing
Sample Interface of the Distress Analyzer
Parallel Distress Analyzer
Wheel-Path Designations
Data with Texas Method, 2.8-Mile

Crack Statistics in Texas Indices

- Red: Block Crack
- Green: Alligator Crack
- Blue: Transverse Crack
- Yellow: Longitudinal Crack (scaled to 0.1)
Data with AASHTO Interim Protocol, 2.8-Mile
Four-Pass Test with Universal Crack Indicator (CI), 2.8-Mile

Repeatability Test

Universal Cracking Indicator

Sub-section

1st Run
2nd Run
3rd Run
4th Run

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Importance of Image Quality

- Automated Processing Algorithms must minimize shadows

- Limitation of Digital Cameras CCD Sensors
  - Blooming of Bright Objects under Sunlight, such as striping, marking, and others

- Solution
  - Using Artificial Strobe Lights at Night or under Cloudy Weather
Data Compression & Reduction

- **JPEG Compressed image:**
  - Quality comparable to raw image’s

- **Automated image processing**
  - Relying on the compressed images only

- **Traveling speed**
  - Dynamically adjust frame-rate in data collection
  - Stitch images into contiguous pavement surface
Performance of the Current Automated System

- **Accuracy**
  - Produce crack map and geometrics of nearly all cracks shown in images
  - Correctly classify vast majority of longitudinal, transverse, block, & alligator cracks

- **Speed**
  - Over 60 MPH with Two Hi-End Processors
  - Ready-to-Use Tabulated Distress Results upon the Completion of Data Collection (Real-Time Processing)
Future Work

• The NCHRP IDEA Project
  - Using Stereovision to model pavement surface in 3-D at 1 to 2-millimeter resolution
  - Potential to automatically provide ride (roughness), rutting, pothole, cracking, and other distress data.
Demonstrations
Conclusion

- Leader in Automated Survey of Pavement Distress in terms of Accuracy & Speed
- 3D Vision at 1 to 2-Millimeter Resolution for Comprehensive Pavement Survey