Automated Survey of Pavement Surface Distresses

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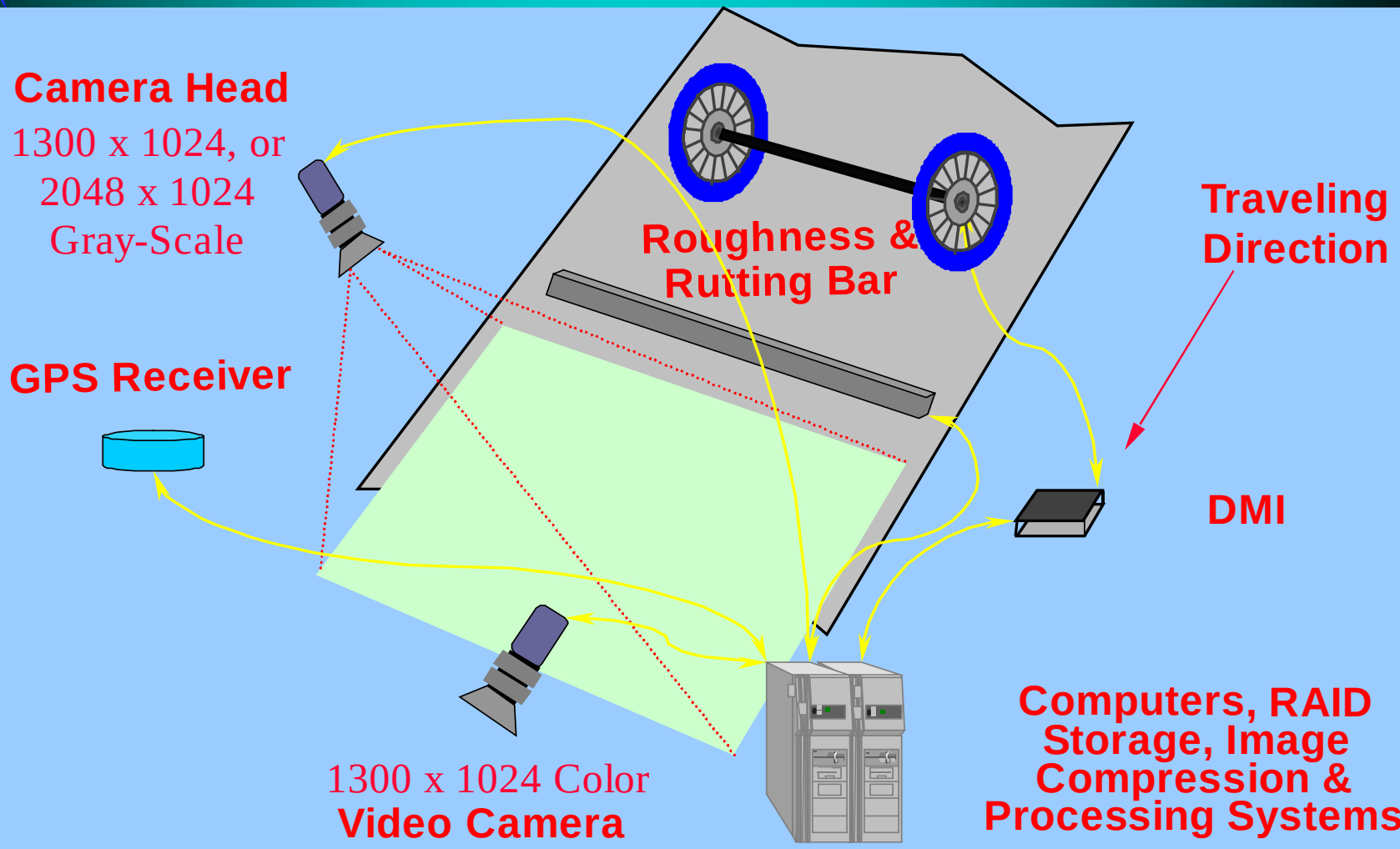
New Frontier

- 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



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

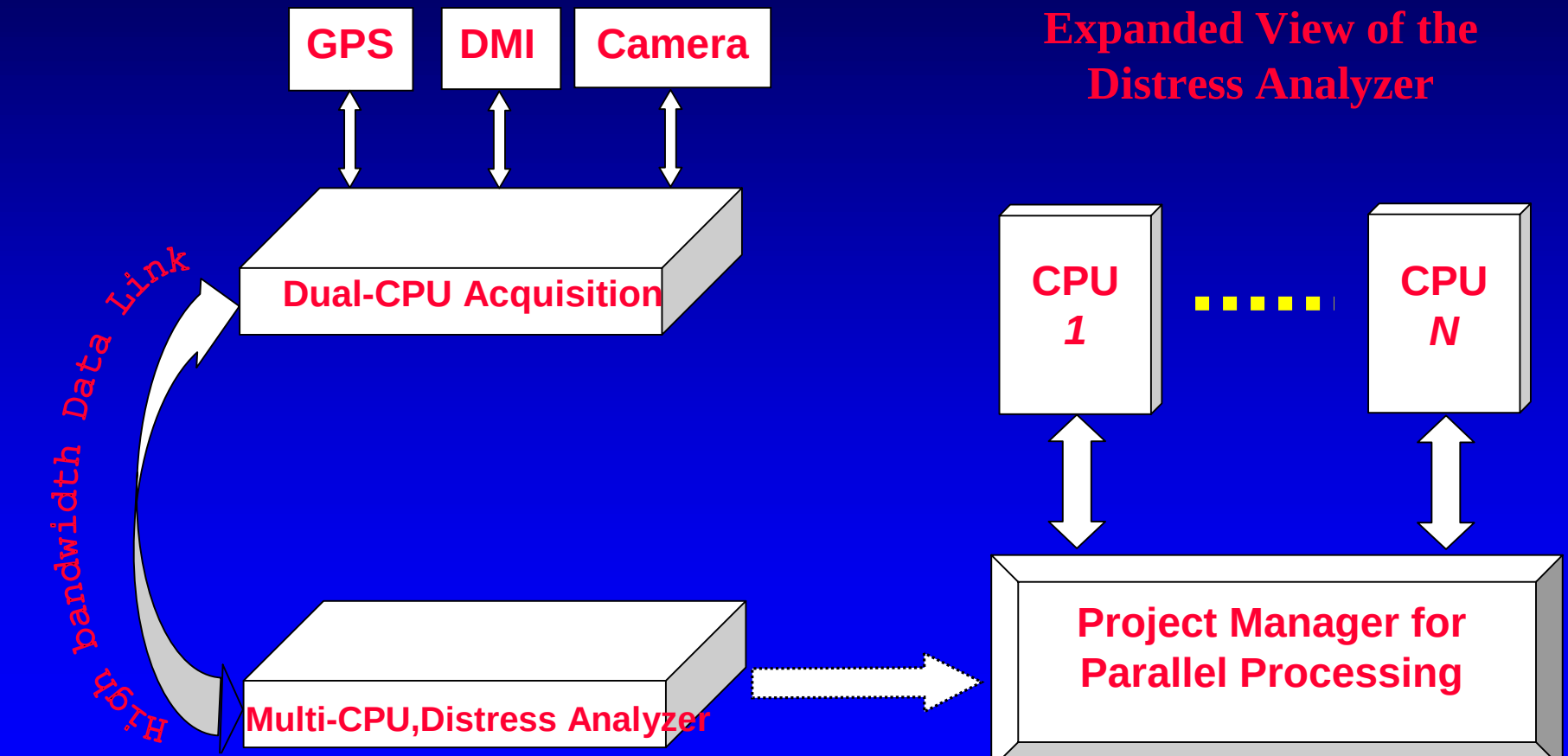
Data Collection Capability for Pavement Surface Images

- 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 x 1000 x 5280 / 10 = 132 GB
- Considering Redundant Storage for Images
  - Maximum 264 GB for 1000-mile Pavement
  - Maximum $3,000 Cost of Disk Drives
  - Options for 6000 lane miles of data

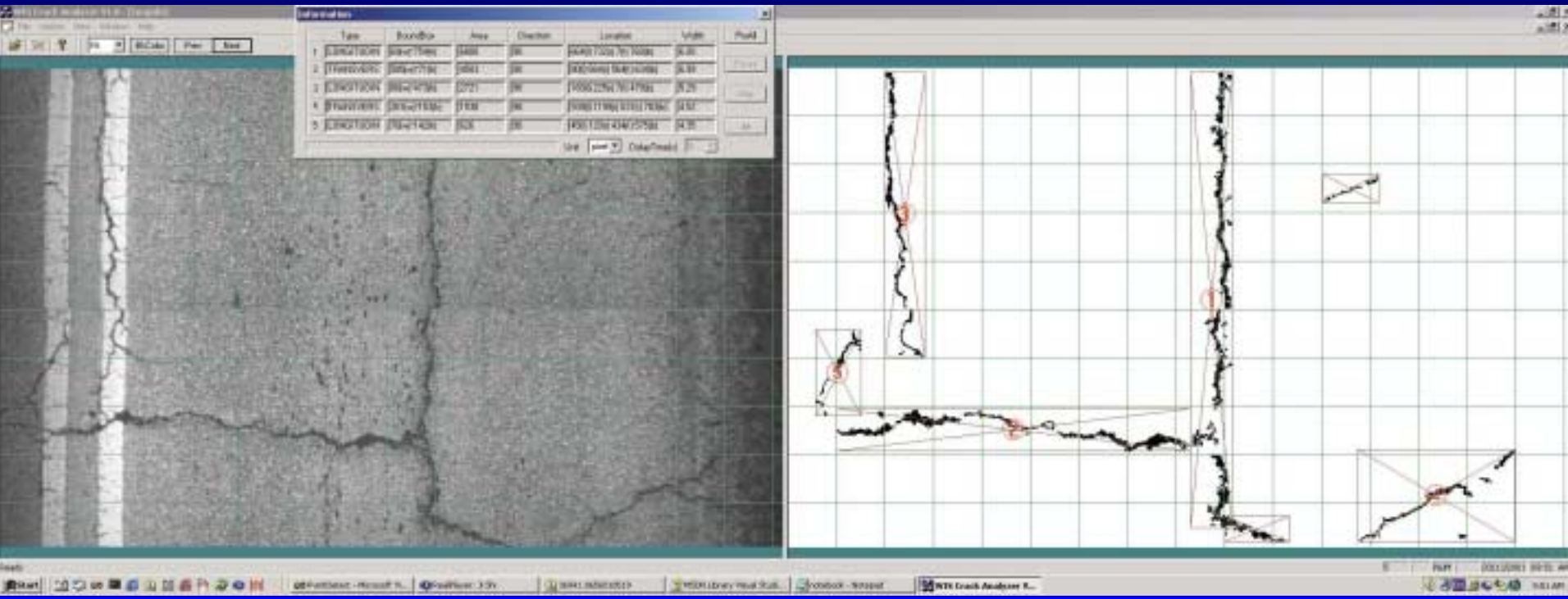
Automated Survey of Pavement Distresses

- 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

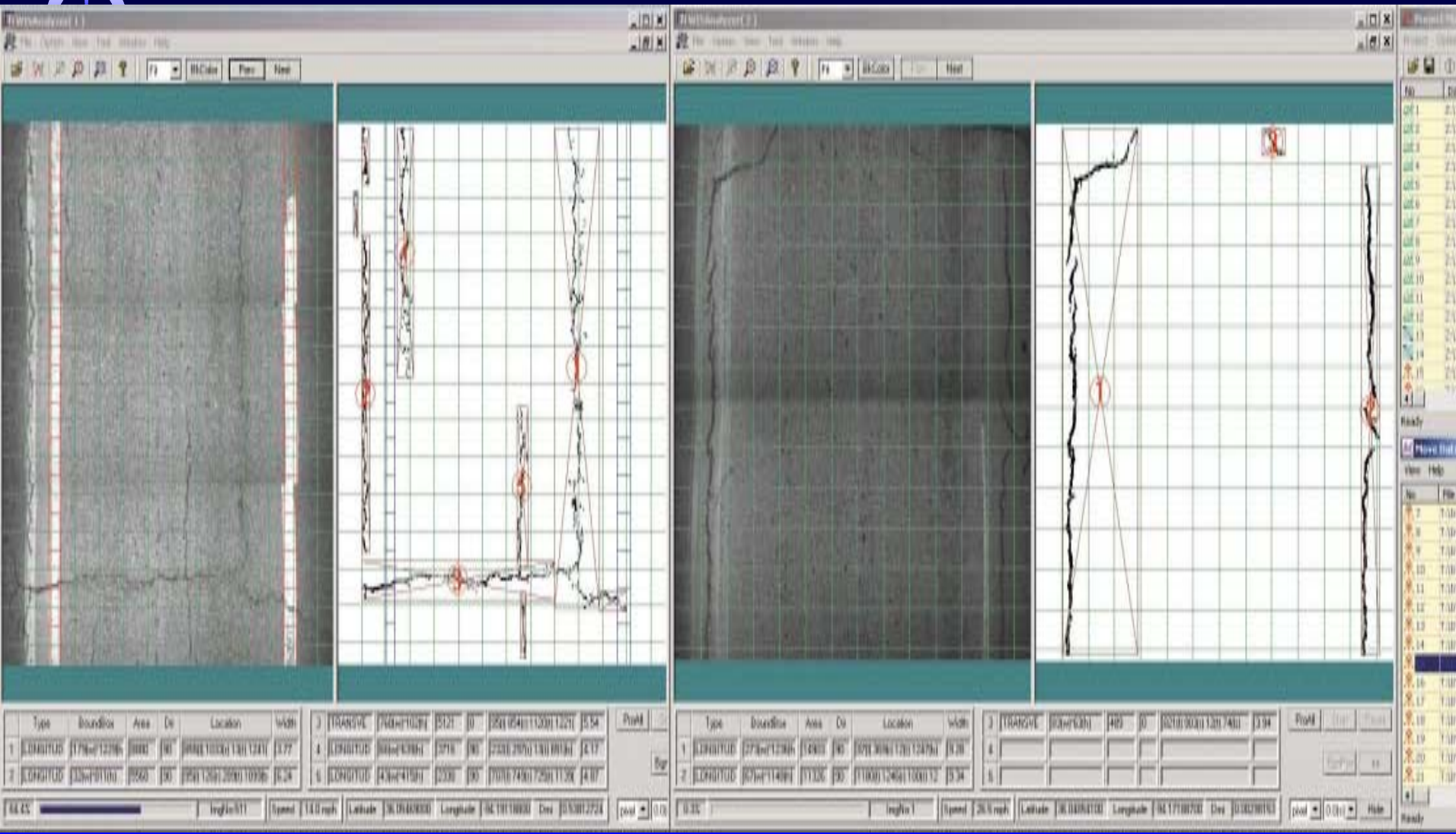
The Parallel Computing Approach



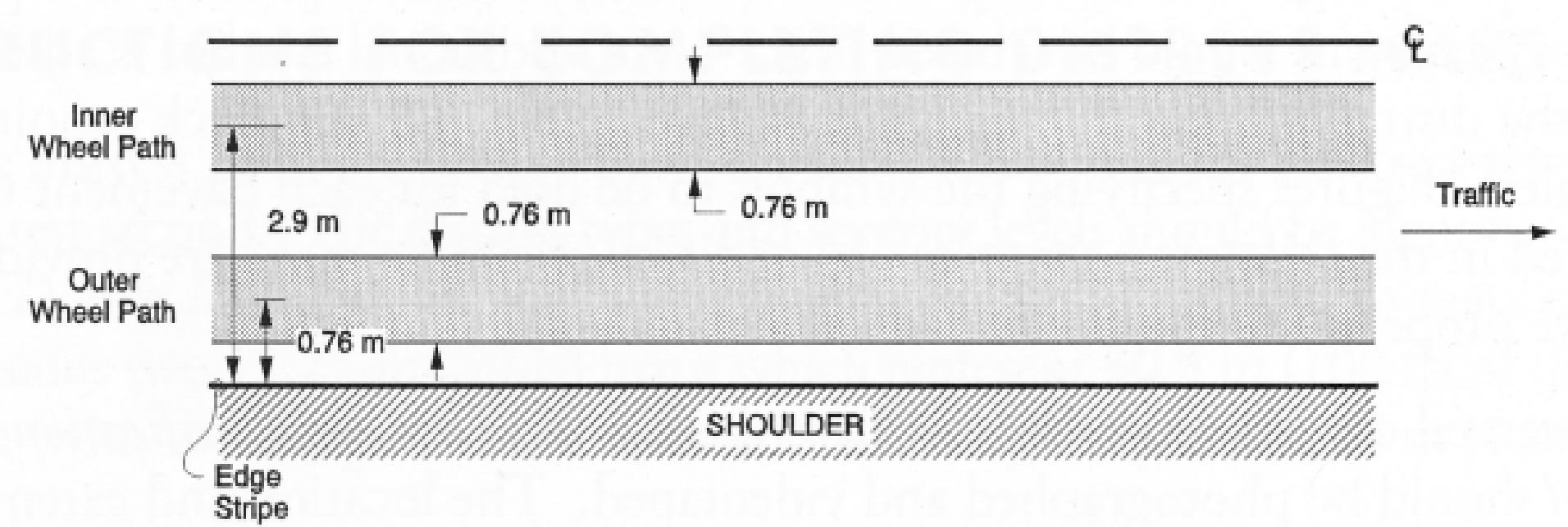
Sample Interface of the Distress Analyzer



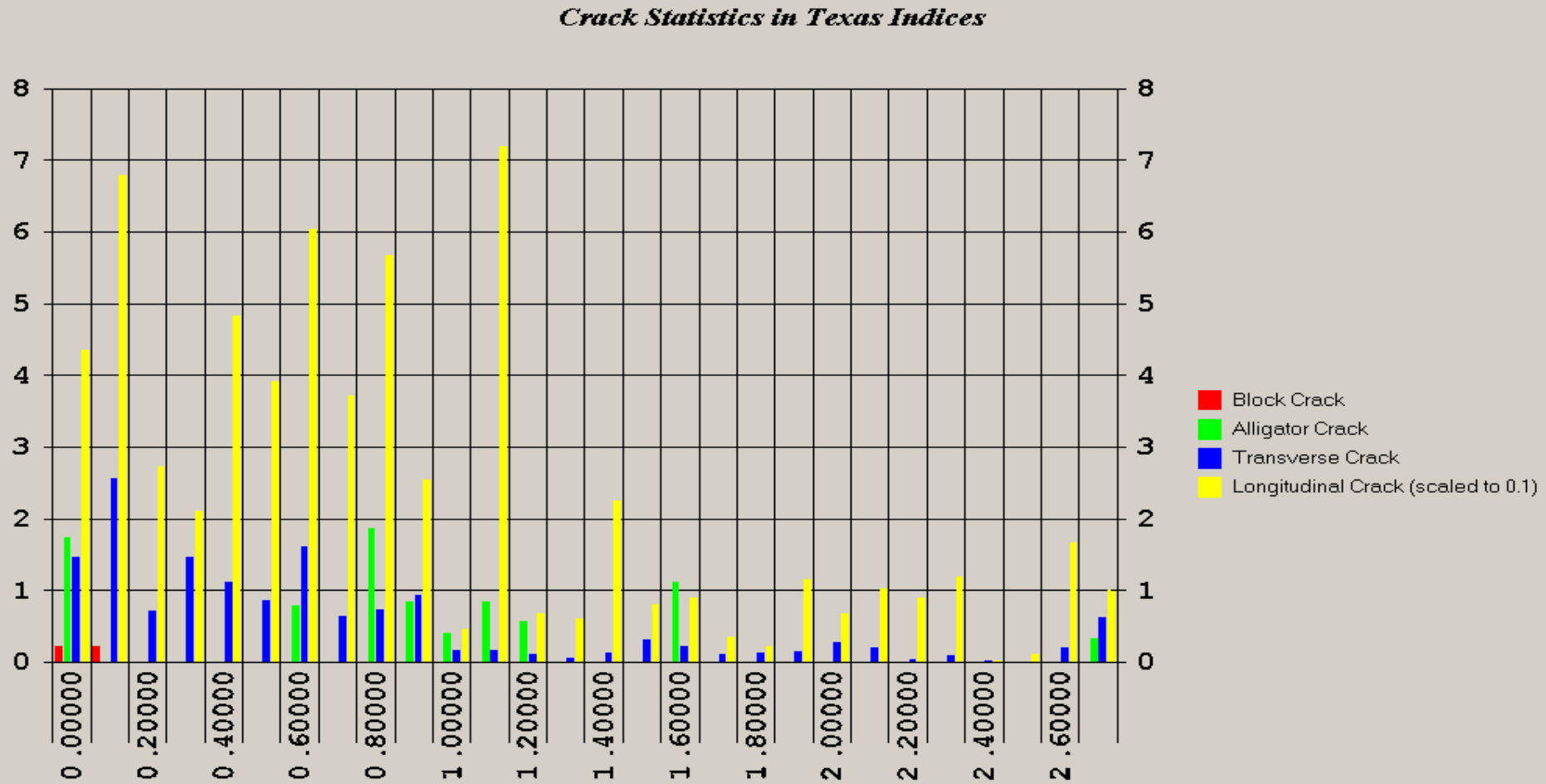
Parallel Distress Analyzer



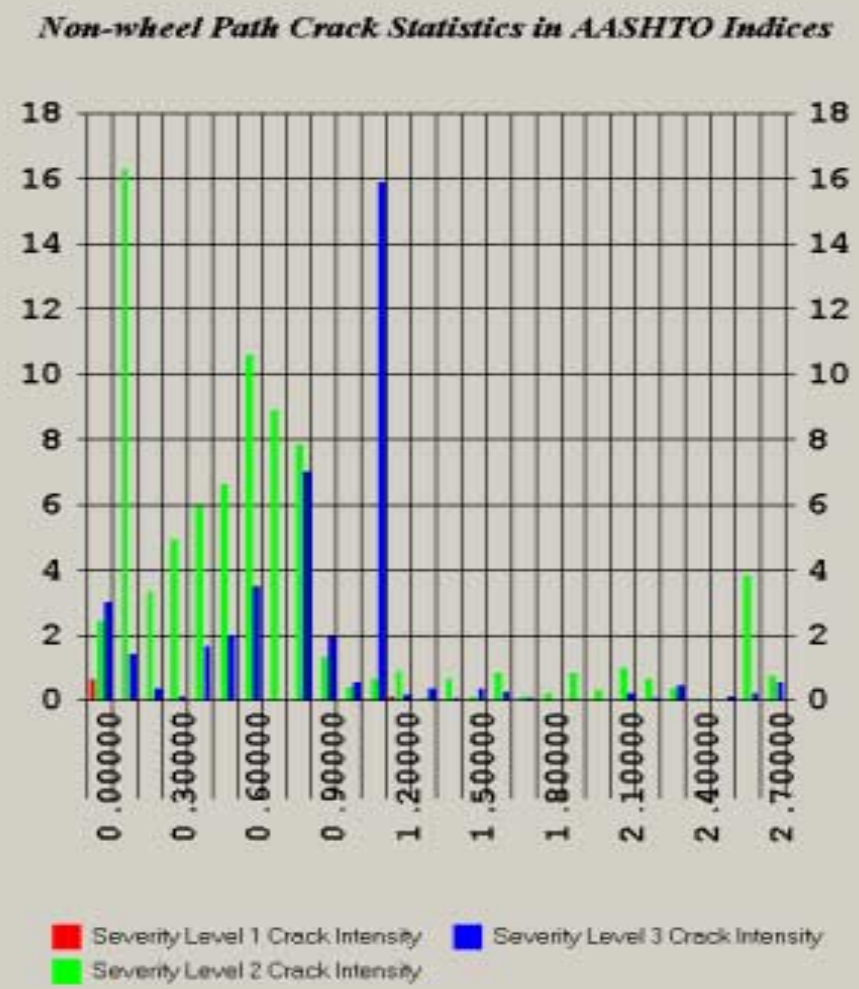
Wheel-Path Designations

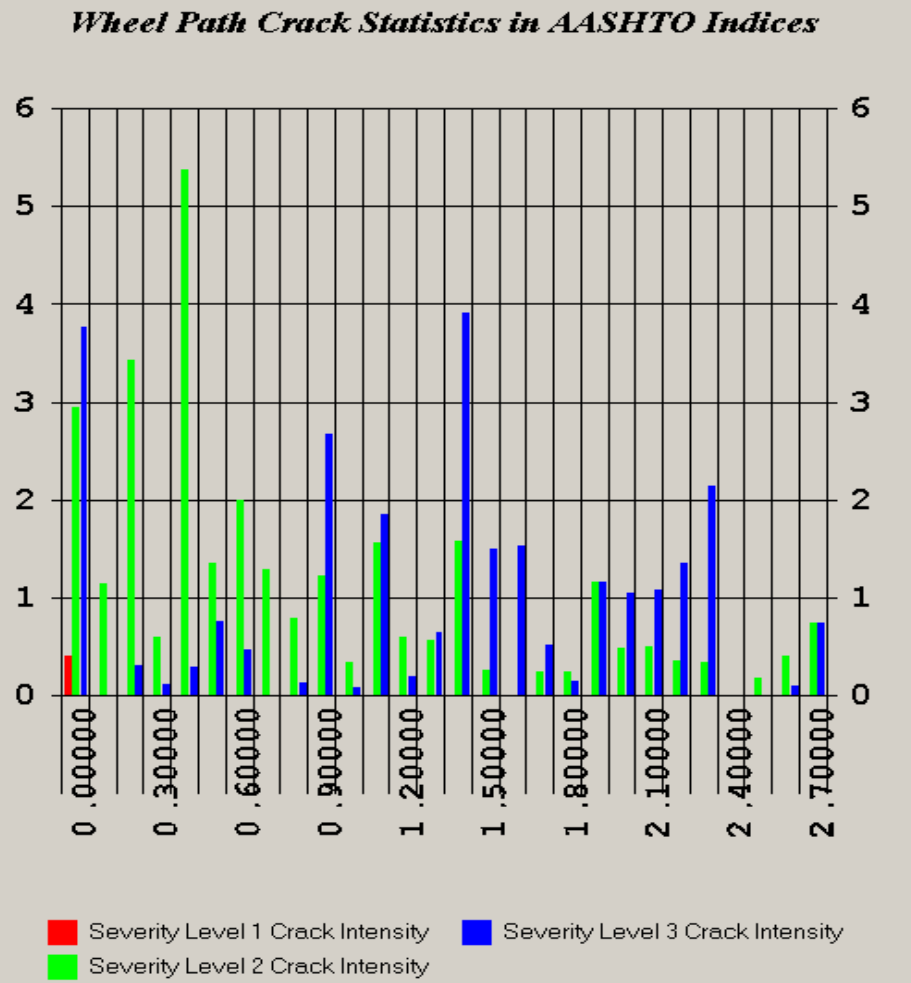


Data with Texas Method, 2.8-Mile

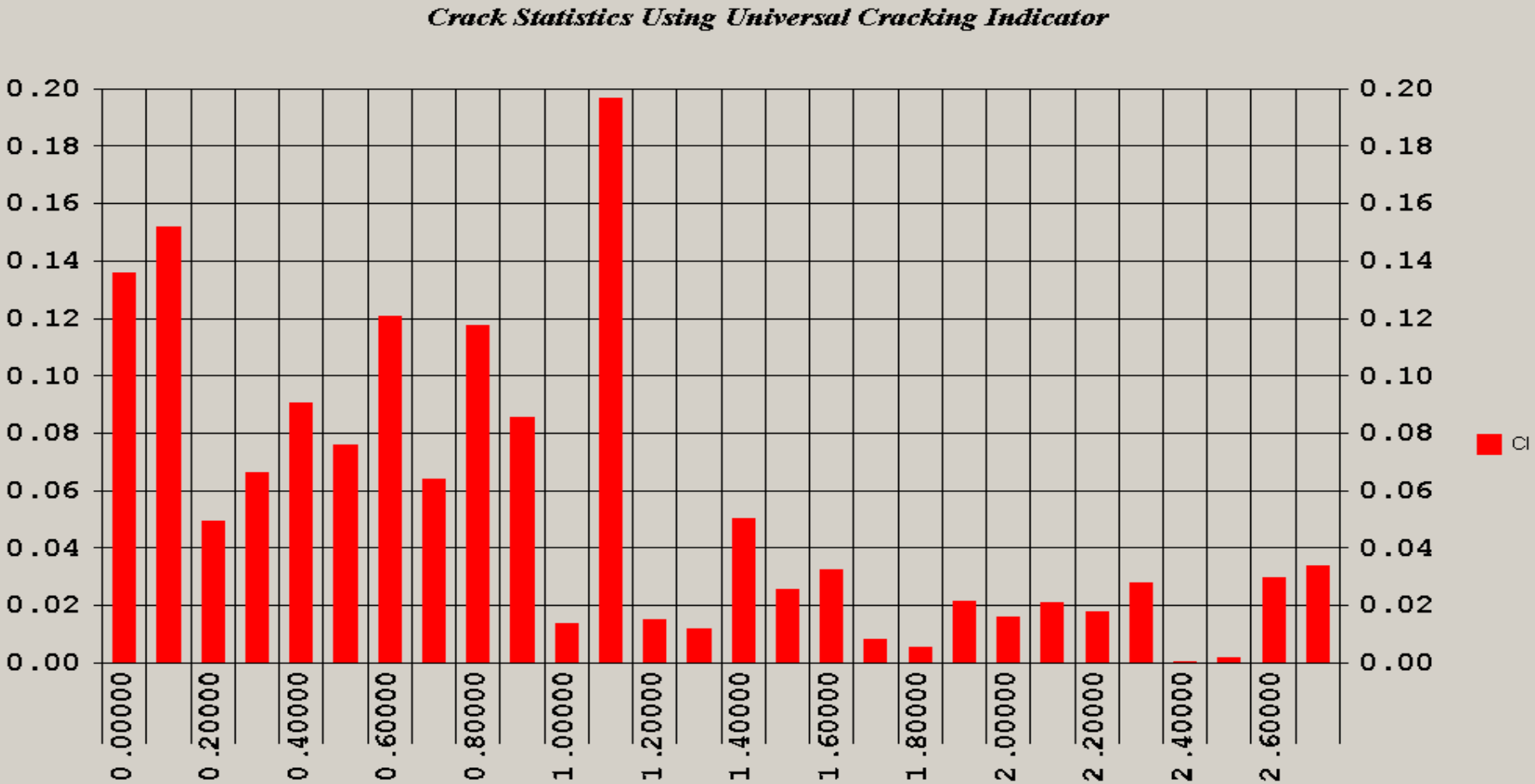


Data with AASHTO Interim Protocol, 2.8-Mile

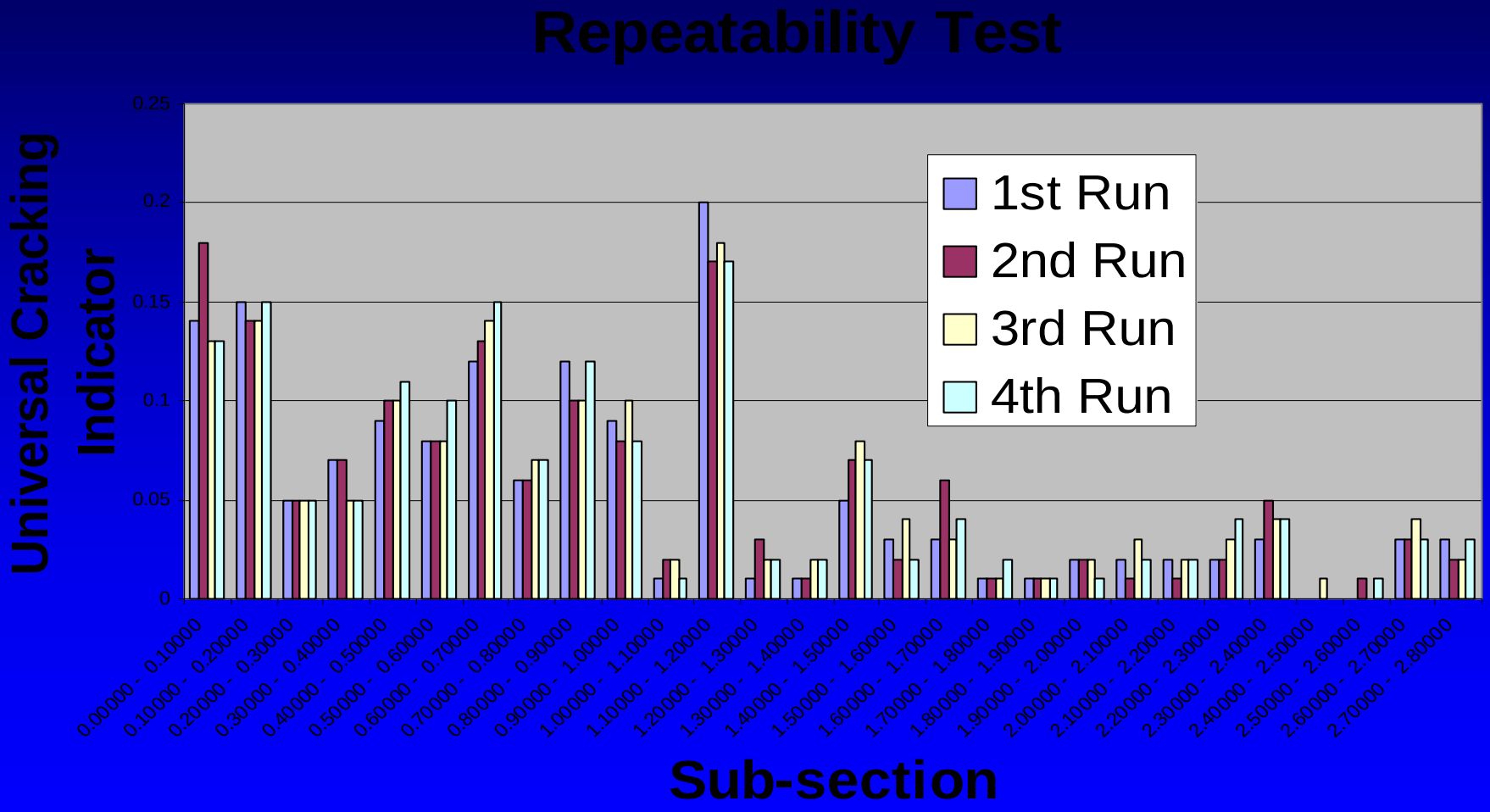




Data Using Universal Crack Indicator (CI), 2.8-Mile



Four-Pass Test with Universal Crack Indicator (CI), 2.8-Mile



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