Automated Cracking Survey and Multi-Function Vehicle

Kelvin CP Wang
University of Arkansas & WayLink
kcw@uark.edu

RPUG 2008
Austin, Texas

October 28 2008
Four Parts of Presentation

- Part One: History
- Part Two: Technology Solutions
  - Automation: Data collection and Processing
- Part Three: Cracking Survey
  - Comparisons and Variations with Protocols
- Part Four: Keys to Protocol Application
Part One

- History
UK HARRIS (Highways Agency Road Research Info System)

- Multi-Function
- Automation of Cracking Survey
  - Primarily Image Collection
  - Automated Detection and Classification of Cracks: Not in Production
Australian RoadCrack, RTA & CSIRO
Pavement Evaluation (Non-Structural)

- Roughness: Mature but Different
- Rutting: Point Lasers or 1200 Points on 4-Meter Width
- Right-of-Way Imaging
  - Support Multiple HD 1080P Cameras
  - Ready for Automated Asset Management
- Laser based Pavement Surface Imaging
  - 1-mm Resolution (X & Y), Complete Coverage, High Quality at Any Time
- Automated Cracking Software: the New Frontier
Digital Highway Data Vehicle (DHDV, Last Generation)
The Parallel Computing Approach

GPS  DMI  Camera

Dual-CPU Acquisition

Expanded View of the Distress Analyzer

CPU Core 1

Multi-CPU, Distress Analyzer

Project Manager for Parallel Processing

High bandwidth Data Link
New Laser based Illumination

- Same 1-mm Resolution
- Complete Pavement Coverage, 4-meter Wide
- Any Weather Condition as long as Dry Pavement
- No Bad Shadow under Any Lighting Condition
- Uniform Image Quality
Part Two

- Technology Solutions
DHDV with LRIS (# 8, June 2008)
Recent Delivery, Ohio US
Recent Delivery, Ohio US, **800Watts**
Recent Delivery, Ohio US
During Data Collection
Workstation for Post-Processing
Grid based SCANNER Method
Software Solution

- Automated Distress Analyzer
  - Real-time or Post-process
- MHIS Deluxe, MHIS Web
ADA-Automated Distress Analyzer
ADA (Automated Distress Analyzer)

- RAW image: 2048 by 4096 pixels (~1mm/pixel)
- Processing speed: Real-time (60MPH or higher)
- Platform: DHDV & Workstation
- Pavement type: Supports both Asphalt and Concrete
- Result: Crackmap, Crack geometries
- Applicability: User Decision
Performance Measures of Network Level Pavement Surveys

- Roughness, Rutting, and Cracking
- Performance Requirements
  - Fully Automated
  - Highway Speed
Simple, Realistic, and without Baggage

- UK SCANNER
  - UK National Standard
  - Roughness, Rutting, & Cracking
  - Fully Automated
  - Fully Implemented, 2006-Now
  - A Model to Follow by Countries and Territories
Part Three

- Cracking Survey Comparisons and Variations with Protocols
Los Angeles, CA, 1st Street, 2007-12-19 (Wheel Path)

AASHTO Index

Section (in 100m)

1 2 3 4 5 6 7 8

S1 Manual
S1 Auto
S2 Manual
S2 Auto
S3 Manual
S3 Auto
Los Angeles, CA, 1st Street, 2007-12-19 (Non-Wheel Path)

AASHTO Index

Section (in 100m)
Repeatability (SCANNER)

Boscawen, NH, NH 132, 2008-5-2

Section (in 50m)

UK Index
Repeatability (AASHTO)

Boscawen, NH, NH 132, 2008-5-2

Section (in 100m)

AASHTO Whelpath S1

Run 1
Run 2
Run 3
Variations Between 2 Raters
(SCANNER)

Fayetteville, AR, 15th Street, 2008-2-4

UK Index

Section No. (in 50 m)
Variations Between 2 Raters (AASHTO)

Fayetteville, AR, 15th Street, 2008-2-4

- Section (in 100m)
  - AASHTO Wheel Path S2
  - Rater A
  - Rater B
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)

Fayetteville, AR, 15th Street, 2008-2-4

AASHTO Wheel Path S1

Section (in 100m)
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)

Fayetteville, AR, 15th Street, 2008-2-4

Section (in 100m)
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)

Fayetteville, AR, 15th Street, 2008-2-4

AASHTO Wheel Path S3

Section (in 100m)
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)

Fayetteville, AR, 15th Street, 2008-2-4

AASHTO Non-WheelPath S2

Section (in 100m)

1 2 3 4 5 6 7 8 9 10 11 12 13 14

1 Ft Left
Center
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)

Fayetteville, AR, 15th Street, 2008-2-4

AASHTO Non-WheelPath S3

Section (in 100m)
Part Four

- Keys to Protocol Application
Ideal Capabilities in Distress Automation (US Practices)

- PCI, cracking & many others
- LTPP, cracking & many others
- AASHTO Interim Protocol

- Cracking:
  - Linear Cracking, Block & Alligator Cracking
  - Wheel-Path Cracking (Load-Associated)
  - Non-Wheel-Path Cracking (Non-Load Associated)
Reality

- Poor Image Acquisition Technologies Until 2006

- Protocol Development for Automation
  - Which is First? Protocol or Technology Maturity?
  - Network Level or Project Level?
  - How to Use the Data for PMS?
  - Are All or Most Influencing Factors under Control for A Particular Protocol?
Reality

- Data Acquisition Technology Has Reached Stability in 2006: First Time Ever
- Network Level or Project Level?
  - Project Level Expectation in Many Cases, Why?
- Application of the Data for PMS?
  - Network Application: Priority
- Are All or Most Influencing Factors under Control for A US Particular Protocol?
  - NO
Influencing Factors

- Ground Truth of Crack Measurements
  - Comparability Among Manual Results?
- Accurate Positions of Cracks in Wheel-Path, Possible for Accuracy/Repeatability?
- Classification of Linked Cracks
  - Block or Alligator?
- Severity Levels
  - Width Measurement Accuracy?
- Benchmark for QC
  - Subjective
US Rodeo History from Early 1990’s for Automated Cracking Survey

- All Unsuccessful (No Exception)
- All with Complex Protocols
  - Longitudinal, Transverse, Block, & Alligator
  - Linear Cracks & Load Associated
  - Severity, Extent, et al
- No Questions Asked by Agencies
  - Do it again next time
  - Continue with current method
  - Some day the vendors will get it right (really?)
The Devil is the Protocol!!!
Need Simple and Controllable Protocol: Ultimate Importance

- Automation Target: Network Level Survey Only
  - Alert for Sections with Distress Problems for Additional Manual or Auto Analysis
- Eliminate or Reduce Influence of Un-Controllable Factors
- Automated Results: Easily Verifiable with Acceptable Variability
- Repeatable and Consistent
Available Protocol Outside US

- SCANNER in UK
  - Ratio: # of Grids with Cracks Over Total # of Grids
  - Simple, Relatively Powerful, Consistent and Objective
  - Easily Expandable to Include (1) Load and non-Load Cracking Information by Locating Data on Selected Grids, (2) Severities
Grid based SCANNER Method
Thank You!