Automated Cracking Survey and Protocol Development

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

SURF 2008
Portoroz, Slovenia

October 21 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
Available Technologies

- Roughness: Mature but Different
  - TTI Profiler Certification: Highest Standard in the US
- Rutting: 1200 Points on 4-Meter Width
  - Widely Deployed
- Right-of-Way Imaging
  - Support Multiple HD 1080P Cameras
  - Ready for Automated Asset Management
- Laser based Pavement Surface Imaging
  - 1-mm Resolution, Complete Coverage, High Quality at Any Time
- Automated Cracking Software: the New Frontier
Line Scanning Method

External Sync Source

Line-scan Camera

Speed Encoder

Longitudinal

Transverse
Digital Highway Data Vehicle (DHDV, Last Generation)
The Parallel Computing Approach

Dual-CPU Acquisition

Single Computer

Multi-CPU, Distress Analyzer

Expanded View of the Distress Analyzer

CPU Core 1

CPU Core N

Project Manager for Parallel Processing

GPS  DMI  Camera
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
Incident angle of the illumination system allows increased visibility of small cracks by the use of the projection of shadows.
System configuration on an inspection vehicle

Small tilt angle to help contrast transverse cracks
DHDV with LRIS (# 1, Early 2006)
Part Two

- Technology Solutions
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
  - Post-process
- MHIS Deluxe, MHIS Web
  - Viewing and Post-Process (Editing)
  - Crack Map, SCANNER et al
- ReportWriter
  - Reports Statistics
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
Basic Data Format

- Crackmap
- Image ID
- DMI Pulse
- Bounding Box Location
- Crack Length
- Crack Average Width
- Crack Types
MHIS Deluxe

- Manually Marking/Editing Distress Area
- Google Map
- Multiple Databases Management
- PCI Survey
- UK SCANNER Survey
- AASHTO Protocol
Part Three

- Cracking Survey
  Comparisons and Variations with Protocols
BatonRouge, LA, 74 wb, 2006-06-28 (Wheel Path)

AASHTO Index

Section (in 100m)

- S1 Manual
- S1 Auto
- S2 Manual
- S2 Auto
- S3 Manual
- S3 Auto
Los Angeles, CA, 1st Street, 2007-12-19

Section (in 50m)

UK Index

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

Section (in 100m)

AASHTO Index

- S1 Manual
- S1 Auto
- S2 Manual
- S2 Auto
- S3 Manual
- S3 Auto
Repeatability (SCANNER)
Repeatability (AASSHTO)
Variations Between 2 Raters (SCANNER)

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

UK Index

Section No. (in 50 m)

Rater A
Rater B
Variations Between 2 Raters (AASHTO)

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

AASHTO WheelPath S2

Rater A
Rater B

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

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

AASHTO WheelPath S1

Section (in 100m)

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

AASHTO WheelPath S1

1 Ft Left

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

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

AASHTO WheelPath S2

1 Ft Left
Center

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

Fayetteville, AR, 15th Street, 2008-2-4
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)
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Fayetteville, AR, 15th Street, 2008-2-4
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)

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

0 0.1 0.2 0.3 0.4 0.5

1 Ft Left
Center
Part Four

- Keys to Protocol Application
Ideal Capabilities in Distress Automation

- 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 Particular Protocol?
  - NO, (SCANNER?)
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
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
  - National Standard in UK for Several Years
  - Being Adopted in Some European Countries and Former UK Colonies
  - Simple, Relatively Powerful, Consistent and Objective
  - Expandable to Include (1) Load and non-Load Cracking Information by Locating Data on Selected Grids, (2) Severities
Grid based SCANNER Method
Thank You!