

Automated Pavement Distress: Proven Technology and Procedure

Paul Harbin P.Eng.
Vice President, Engineering
Fugro-Roadware

Automated Pavement Distress

- Why?
 - Safe
 - Objective
 - Repeatable



History

- Data Acquisition
 - Lasers
 - Areas scan cameras
 - Line scan
 - 3D imaging?

... History

- Processing
 - RISC processors
 - Standard workstation using NT & XP
 - FPGA
 - Standard workstation using XP & Vista
 - More sophisticated algorithms & increased image size & resolution

... History

- Testing and Evaluation
 - Limitations vs. Capabilities
 - Emphasis on what CAN'T be done instead of what CAN be done
 - Delayed acceptance and implementation
 - Good or bad?

Now ...

- Proven
 - Used world wide (public and private agencies)
 - Many 100's of thousands miles processed

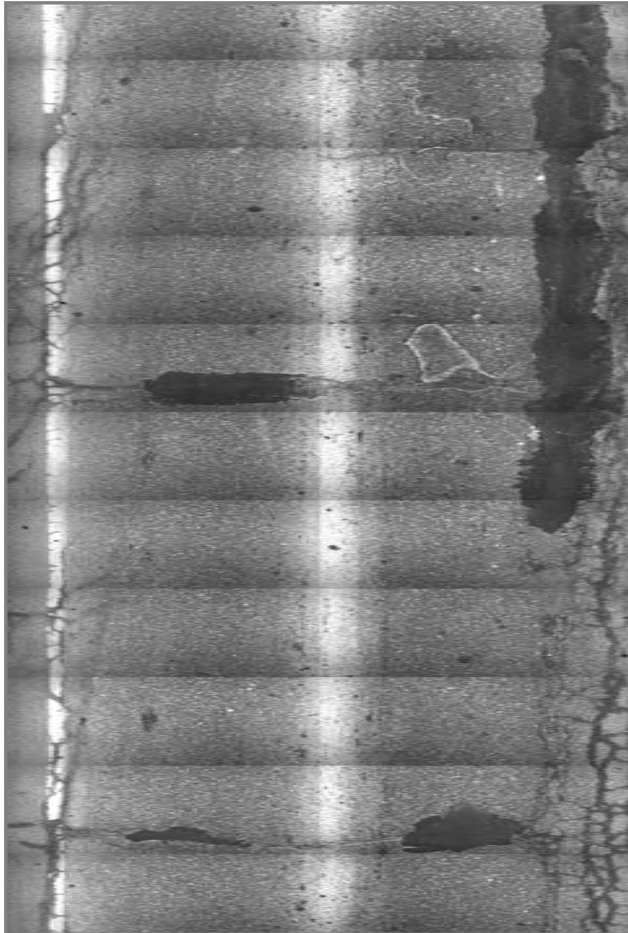
Key Components

- Image Acquisition
- Image Processing
- Quality Assurance & Quality Control
 - About procedures and processes as much as it is about the product

Image Coverage

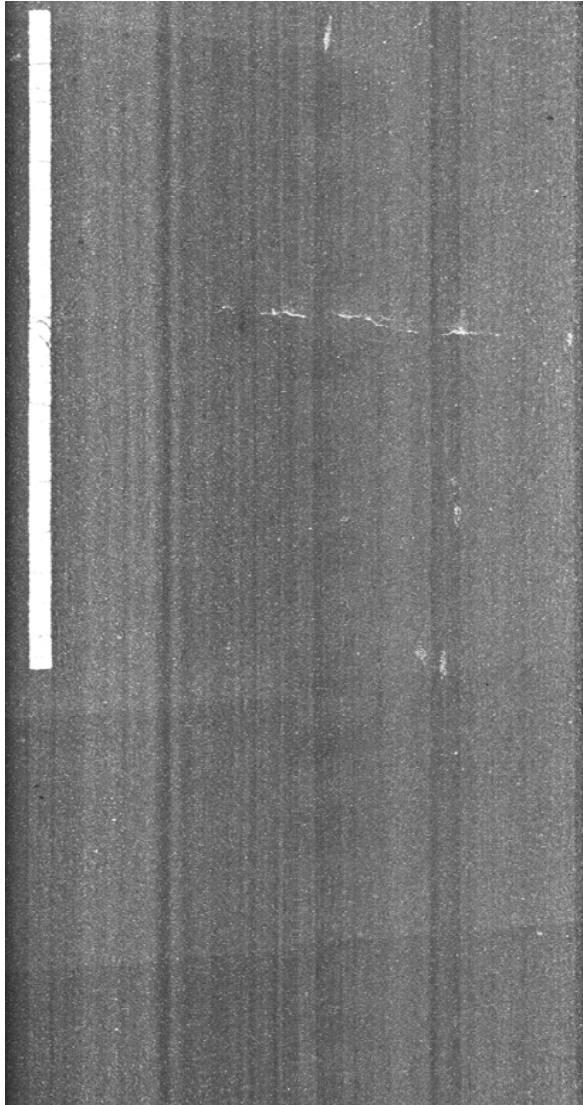
- 4 m (13 ft) lane width
- 100% continuous imaging at 62 mph
- Analog → Digital → Line scan cameras
- 3 → 2 → 1 mm pixel resolution
- 0.16 → 0.48 → 1.6 GB per mile

Image Capture



- Real-time stitching
 - Longitudinally
 - Transversely
- Continuous coverage saved in 52.8 ft intervals

Image Capture



- Real-time stitching
 - Longitudinally
 - Transversely
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Lighting

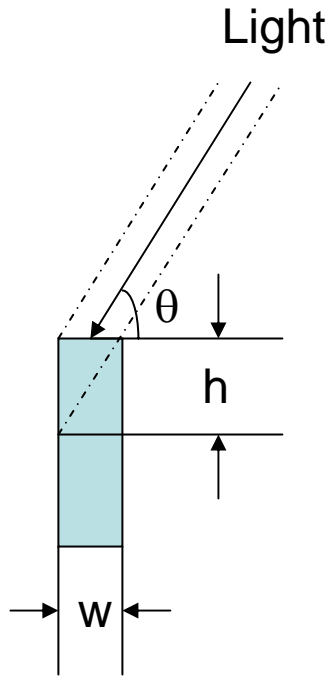
- Eliminate shadows
 - Trees
 - Building
 - Signs
- Cast shadows
 - In the cracks
 - Provide contrast



Assumption: For Crack Detection

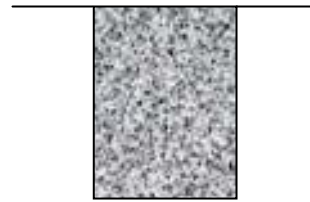
- Crack – continuous black line(s)
- Is this assumption true?
 - Yes for most cases
 - No for some cases

Illumination Angle

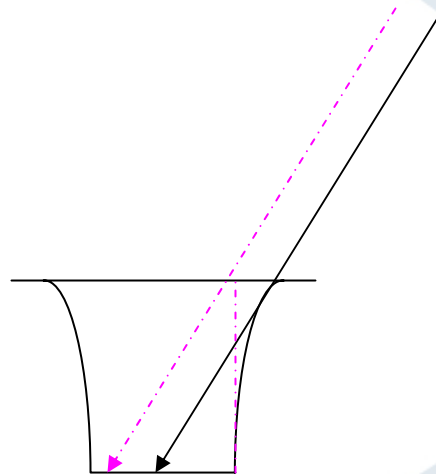

$$h = w * tg(\theta)$$

| $w \backslash \theta$ | 1 (mm) | 2 (mm) | 3 (mm) |
|-----------------------|--------|--------|--------|
| 30° | 0.58 | 1.16 | 1.74 |
| 45° | 1 | 2 | 3 |
| 64° | 2.05 | 4.10 | 6.15 |

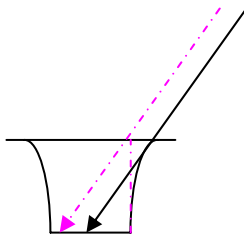
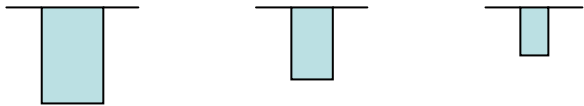
Crack is filled with dirt / dust.



Crack edges are worn or missing.



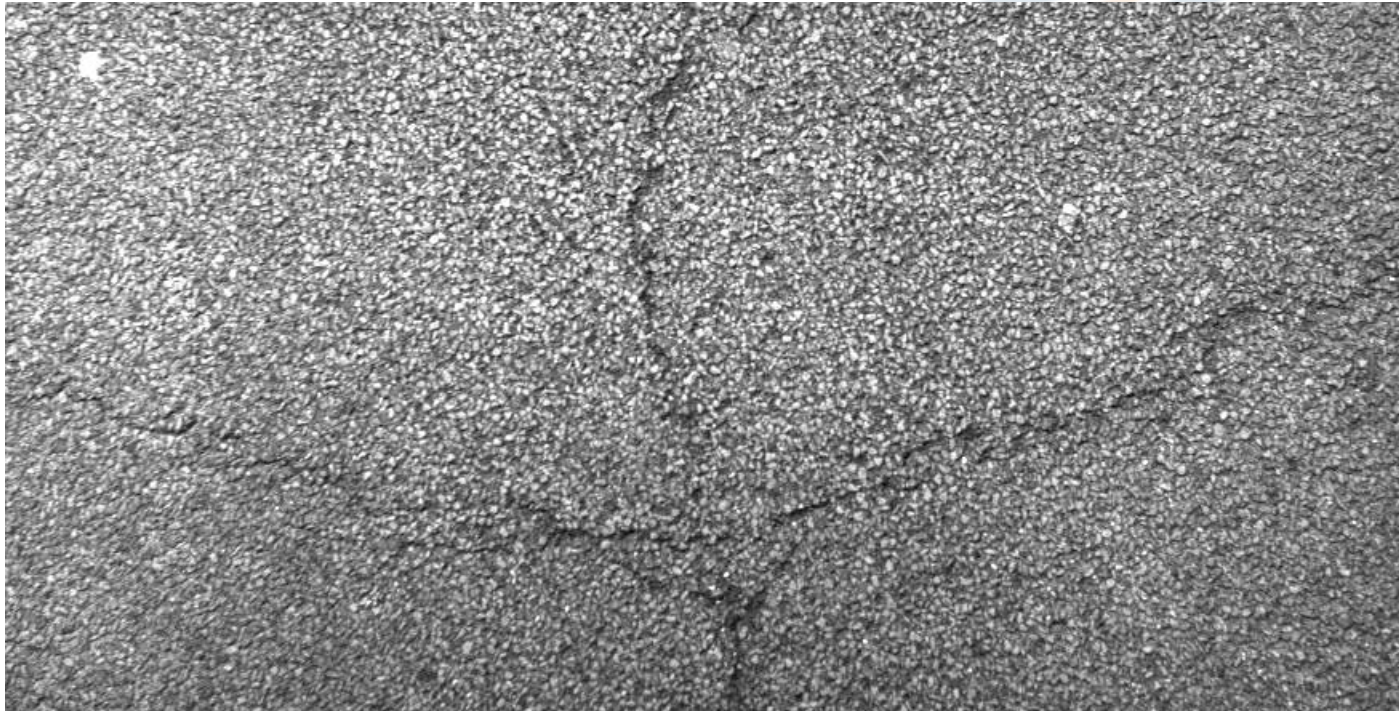
In images we get ...



Less than actual crack size
(smaller in width, if it is
smaller than pixel size, it
tends to be broken)

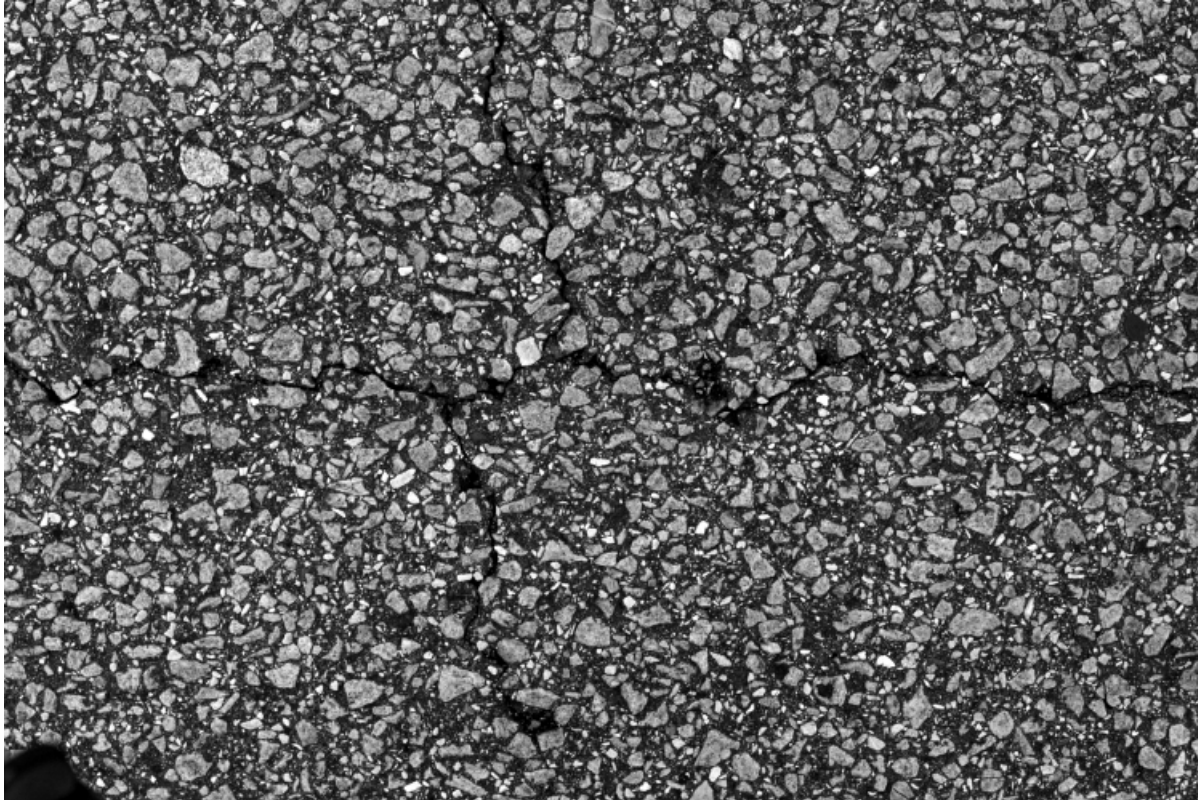
Less contrast (blurry, hard to
detected)

Surface cracking



- Mostly found on rough texture surface (heavily broken in the figure).
- Sometimes, the crack can be seen in ROW, but not in pavement video.

Other difficulties



- Rough texture surface

Visibility and detection is difficult & variable

- Random direction of cracks vs. directional lighting.
- Random depth of cracks vs. random shadows representing crack width.
- Random missing crack edge vs. random shadows representing crack width.

What does this mean?

- Difficult to detect wide cracks
- Difficult to detect narrow cracks
- Difficult to detect cracks without depth
- Crack detection is a DIFFICULT task

Image Processing

- Automated crack detection
- Classification
- Rating
- QA / QC

WiseCrax

- Detailed crack attributes
 - Location
 - Type
 - Severity
 - Extent
 - Density
- 100% Coverage
- Flexible classification scheme

Project Set-up

Road Section

Collection Info

Project No. Section No. 107001

Highway VT Truck 1729

File 29H0WH00 Run #:

Date 091702

Lane 49 Direction 54 Chainage in Millimiles

Section Dimensions

Section Width (m) 4 Lane Width (m) 3.2

Axle Width (m) 1.5 Lane Center (m) 1.8

Wheel Path Width (m) 0.75 Edge Width (m) 0.75

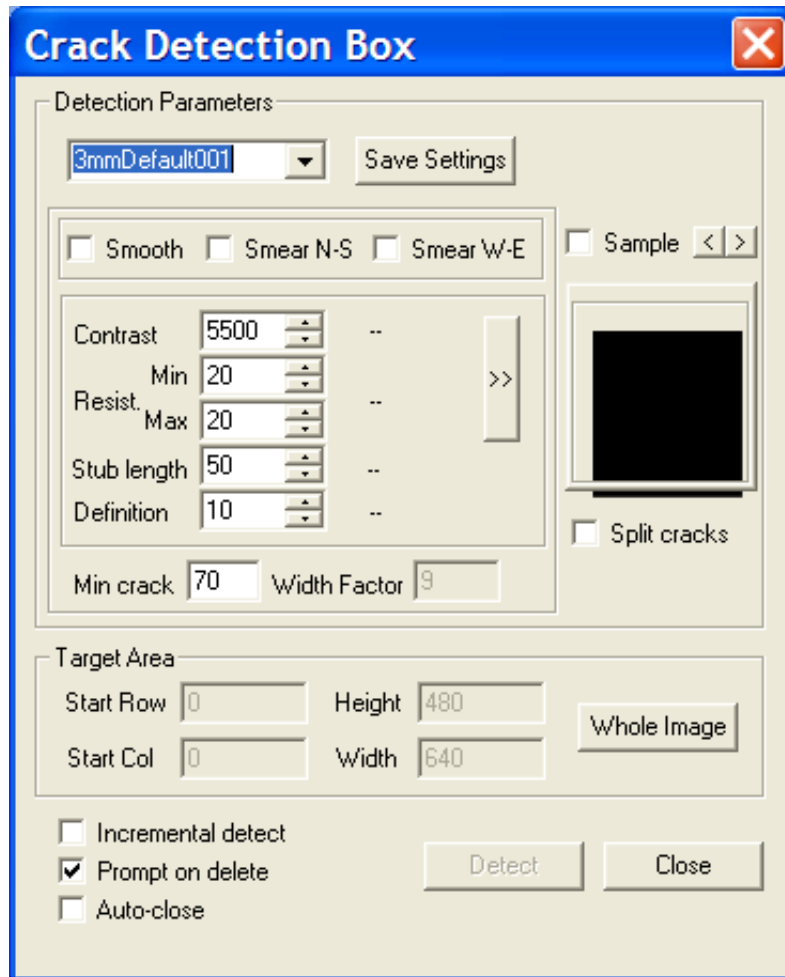
Image Directory C:\wx\images Select...

Rating Scheme FHWA03 Edit Schemes...

Save Settings as default Cancel OK

- Road zones
 - Lane width (automatic)
 - WP widths
 - Edge width
 - Etc.
- Rating scheme
 - Select
 - Edit


Crack Detection



- Parameter setting
 - Signal to noise ratio
 - Crack grouping
 - Noise limits
 - Crack length

ngs

Sample < >

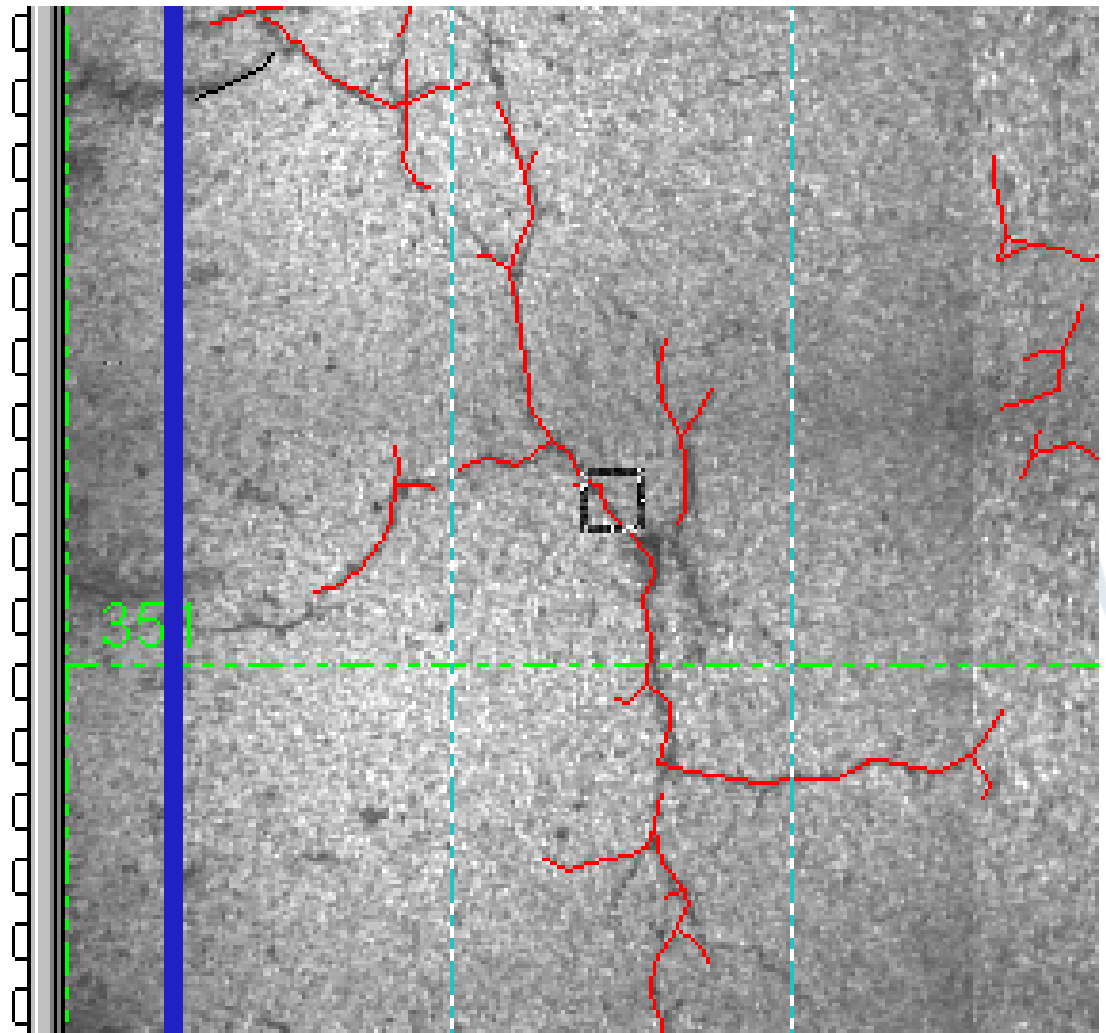


>>

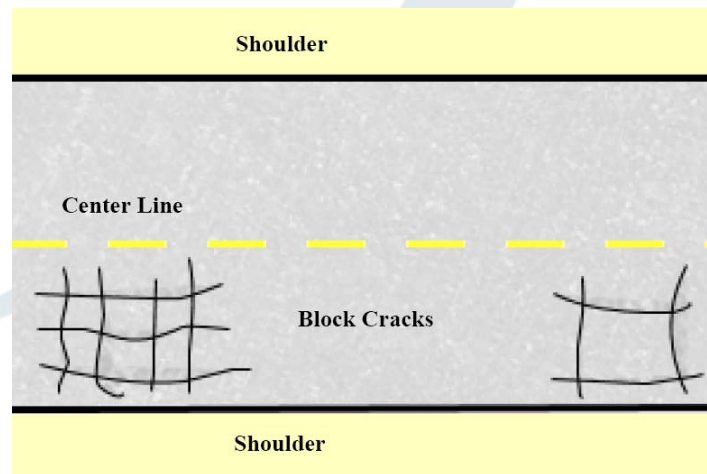
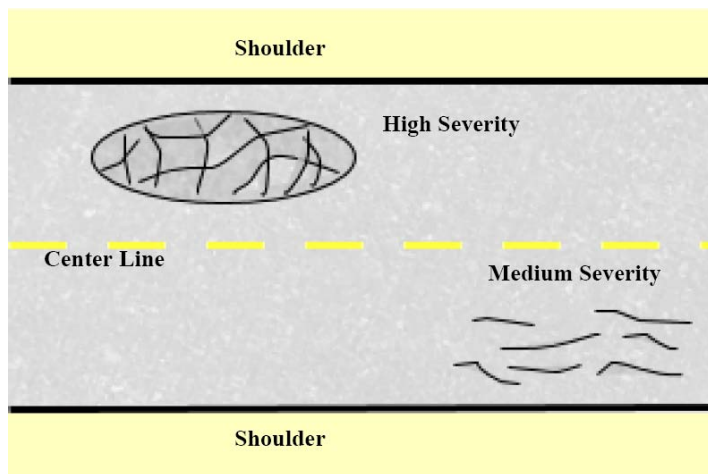
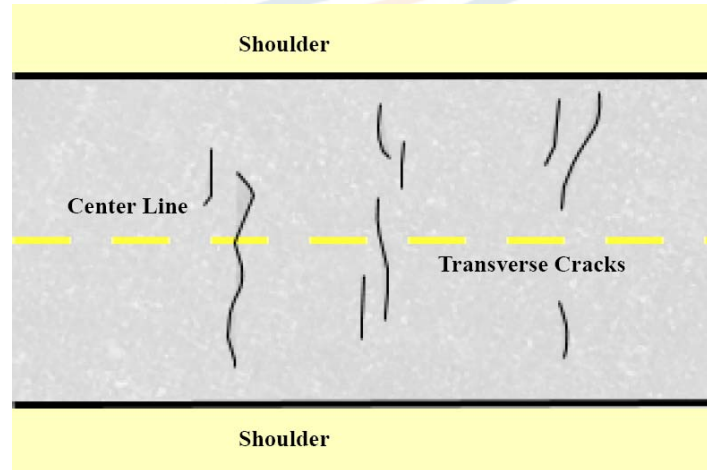
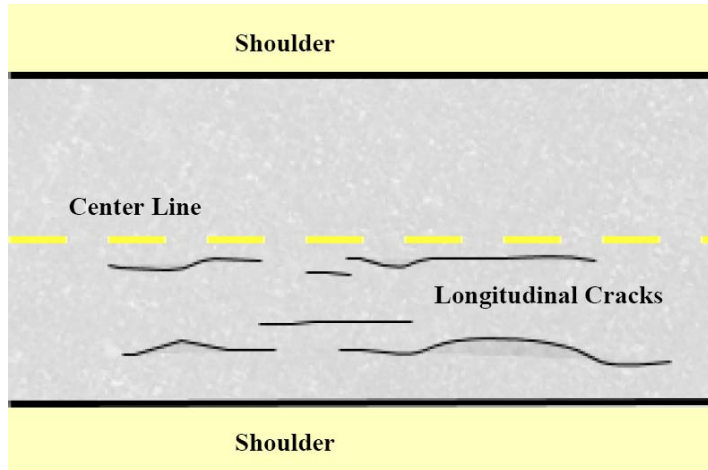
Specify

Whole Image

The left panel is a software control interface. It features a 'Sample' checkbox with a checkmark and navigation arrows. Below this is a thumbnail window displaying a grayscale image with a red outline. Further down are two horizontal sliders with tick marks. At the bottom, there is a 'Specify' button and another checked checkbox labeled 'Whole Image'.



Classification



Parameter Setting

Classify Options

Classification Parameters

Iowa Block Save Settings

Classify

Longitudinal 10

Transverse 10

Block 90

Alligator 10

Radius of Influence 4000

Joints

Classify Joints

Sensitivity 500

MinLength(m) 1

Target Area

Start Row 0 Height 480

Start Col 0 Width 640 Whole Image

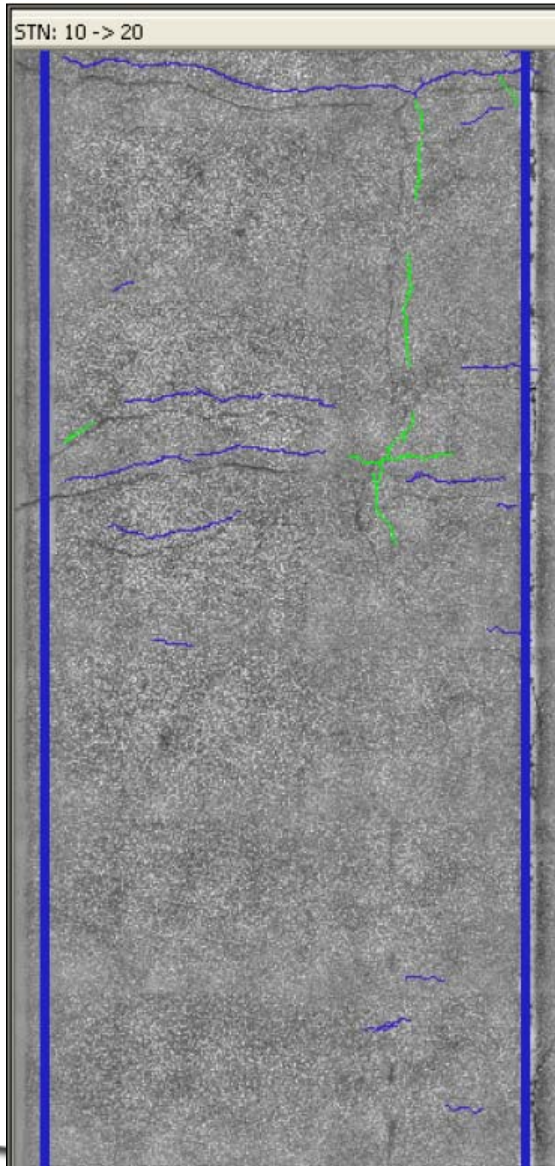
Incremental classification

Auto Close

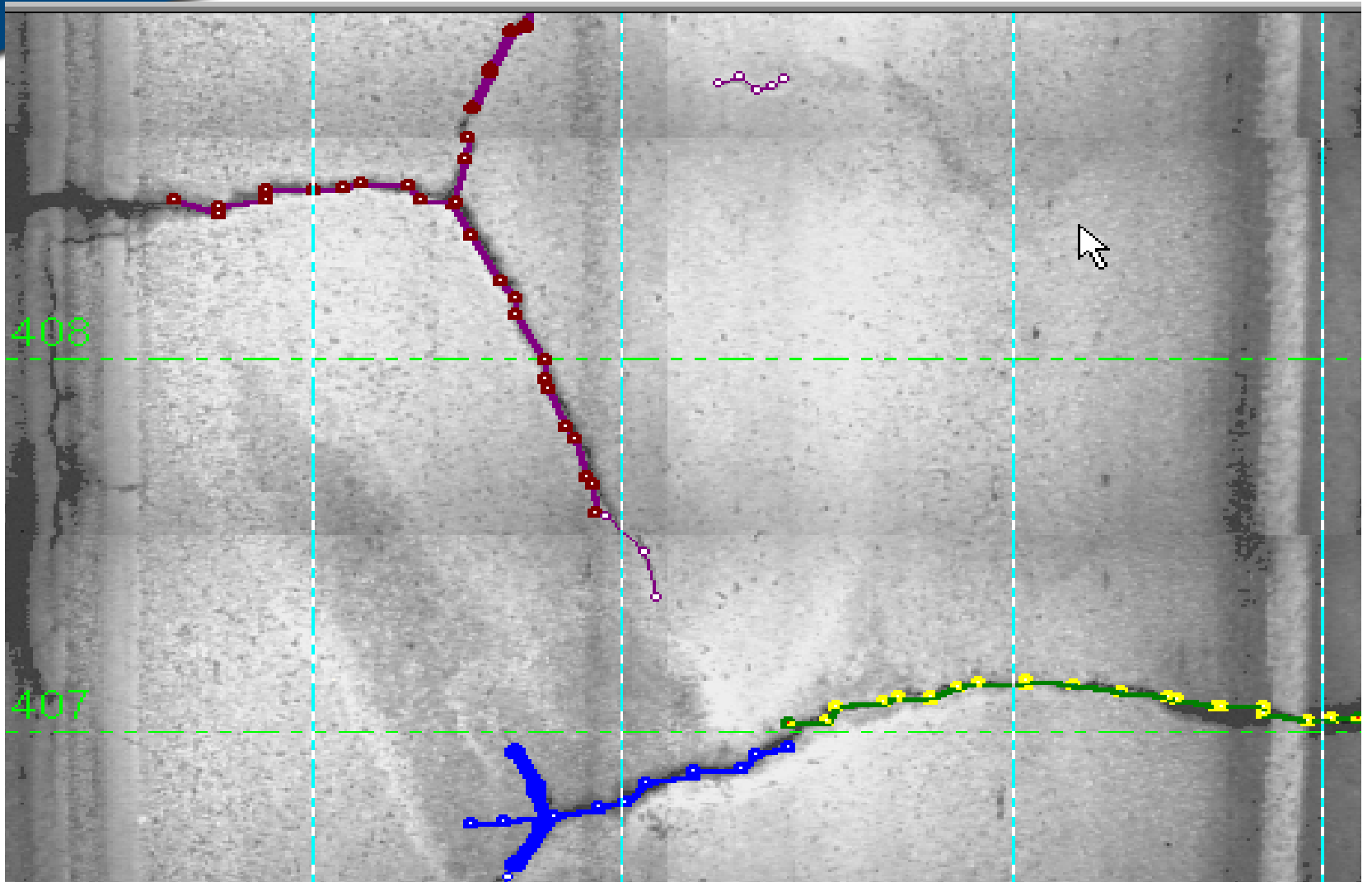
Close Classify

- Classification schemes
- Crack type
 - Longitudinal
 - Transverse
 - Block
 - Alligator

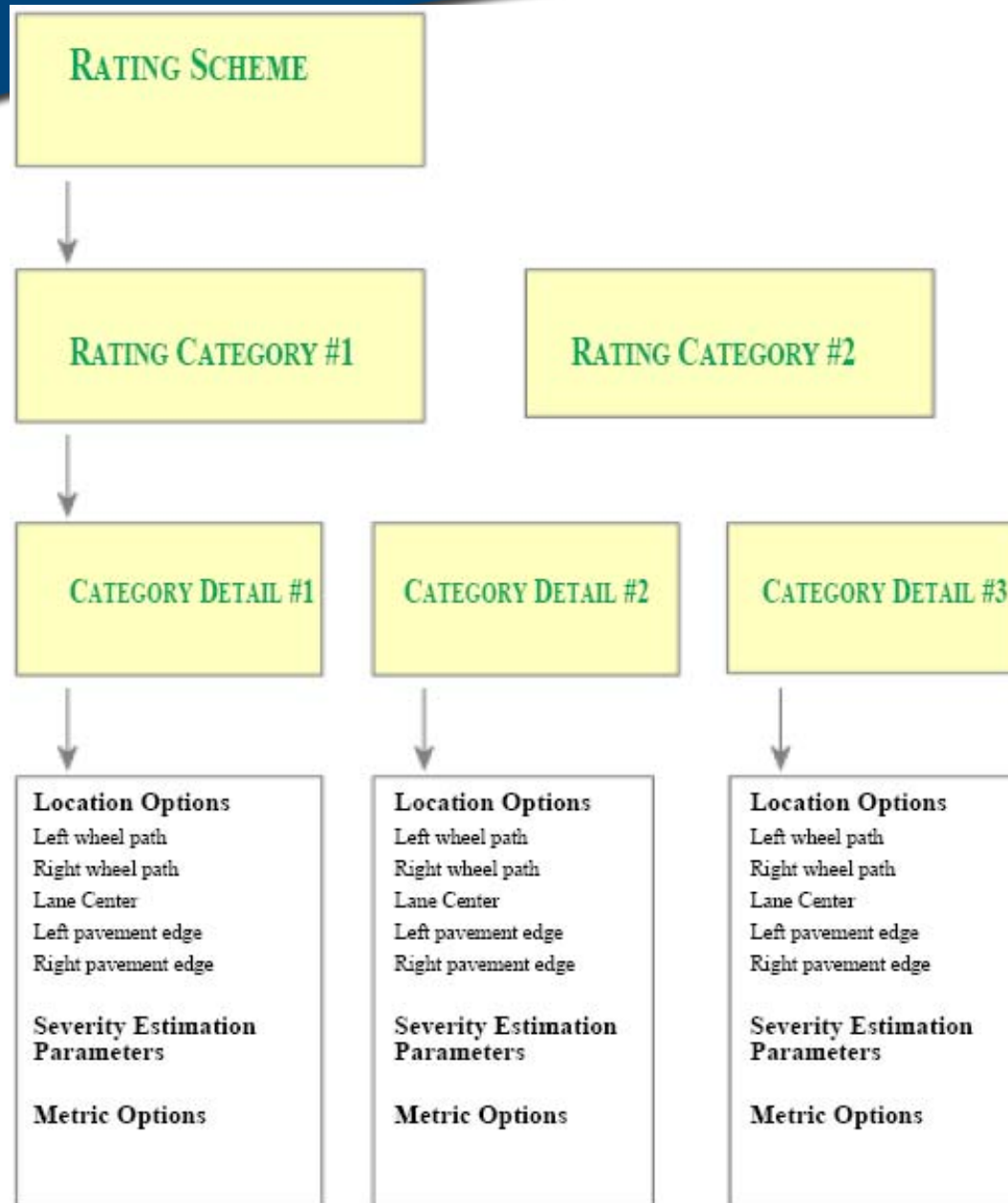
Classification Result



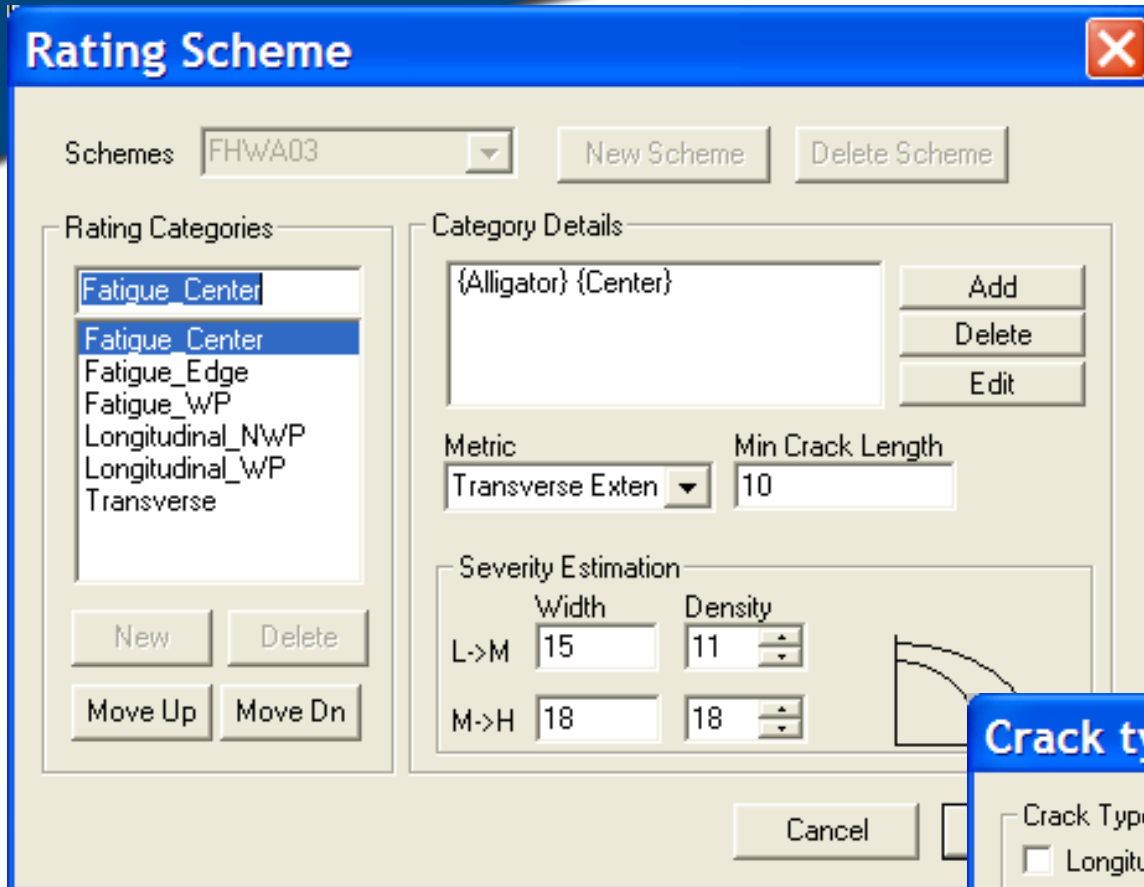
- Green – longitudinal
- Blue – transverse
- Blue Edges – auto detected lane width



Rating



Rating

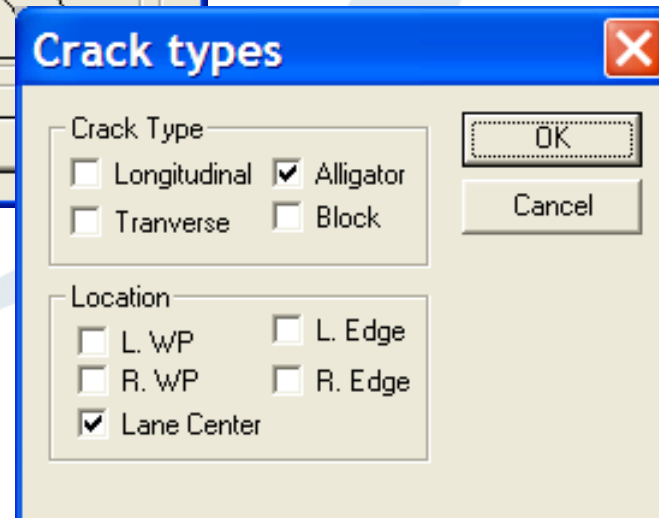


The 'Rating Scheme' dialog box is used for configuring rating schemes. It features a 'Schemes' dropdown menu currently set to 'FHWA03', with 'New Scheme' and 'Delete Scheme' buttons. The 'Rating Categories' list on the left includes 'Fatigue_Center', 'Fatigue_Edge', 'Fatigue_WP', 'Longitudinal_NWP', 'Longitudinal_WP', and 'Transverse'. The 'Category Details' section shows '{Alligator} {Center}' with 'Add', 'Delete', and 'Edit' buttons. Below this, the 'Metric' is set to 'Transverse Exten' and 'Min Crack Length' is 10. The 'Severity Estimation' table is as follows:

| | Width | Density |
|------|-------|---------|
| L->M | 15 | 11 |
| M->H | 18 | 18 |

Buttons for 'New', 'Delete', 'Move Up', 'Move Dn', and 'Cancel' are also present.

- Schemes
- Categories
- Details
- Metrics



The 'Crack types' dialog box allows for selecting crack types and locations. Under 'Crack Type', 'Alligator' is checked, while 'Longitudinal', 'Transverse', and 'Block' are unchecked. Under 'Location', 'Lane Center' is checked, while 'L. WP', 'R. WP', 'L. Edge', and 'R. Edge' are unchecked. 'OK' and 'Cancel' buttons are at the bottom right.

- Provides flexibility

Batch Processing

- Parameters for a given pavement;
 - Type
 - Condition
 - Level of distress
- Assign parameter set for given sections
- Process
- Review

Usage

- 100% Automated
 - SCANNER Surveys (U.K.)
 - Various State DOTs (MD)
 - Network operation (typical)
- Manual intervention
 - To see 100% of cracks
 - Remove false positives
 - Project level (typical)

QA / QC

- Detection is not perfect
- Series of steps and procedures for validation
 - Collection
 - Processing
 - Indices

Future

- Always getting better ...
 - Algorithm improvements
 - Increase in detection rate
 - Reduction in false positives
 - Faster processing
 - 3D data augmentation

Thank you

... Questions?