Advanced Automated Detection Analysis and Classification of Cracks in Pavement

SSI-D-Vision Technology Partnership

Objectives

•Develop a lower cost pavement management solution relying on camera imagery and computer vision analysis for automated distress characterization.

• Scalable solution with instrumentation tailored according to end user specified requirements

- Configurable for IRI, transverse profile, texture, geometry, distress
- Fully instrumented cost, including vehicle = ~$250,000
- Installable on end user's vehicle

•Offer a lower cost solution to support increased usage by city and county agencies without compromising quality

D-Visions' & SSI system

LMI Gocator lasers--full lane width transverse profile
-rutting, lane-edge drop off

IMU with GPS

Inertial profiler for IRI (wide-footprint Roline lasers)

Texture laser (MPD)

Downward looking very fast camera

This simple setup with Automatic Computer Vision Analysis
Is substantially more cost effective

Collection Vehicle

Collection Vehicle

Collection Vehicle

D-Visions' system and experience in Computer Vision

2D – 3D Transformation (Defense – demo)

Camera based Navigation (Defense)

Anti Missile Interception system (Defense)

Real Time processing of cracks in Pavement – Demo

The INRC (Israel National Roads Company) – Feasibility study of "Automated Detection Analysis and classification of Cracks.

Viewer - Demo

Background

Accurate and cost effective pavement condition analysis is essential for optimal usage of huge maintenance budgets

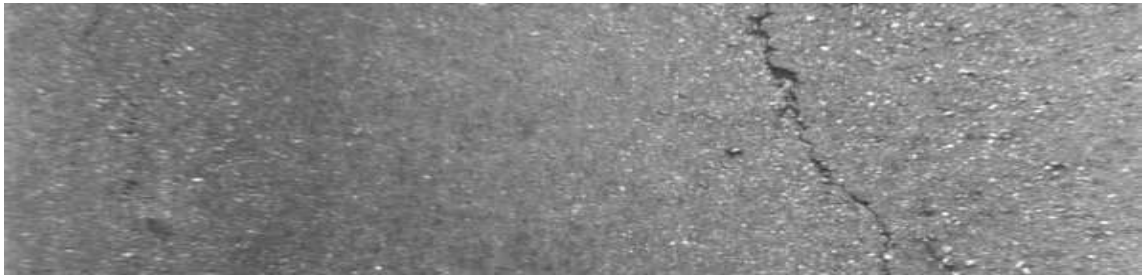
DOTs that do not use automatic analysis often encounter situations where:
- Roads got improved Pavement Condition Index (PCI) rating year-over-year even though rehabilitation was not performed
- Roads were rehabilitated but their PCI did not change, or the overall PCI expected improvement did not match reality and huge investment

In such cases it is impossible to manage the network maintenance or monitor the usage of enormous funds invested in preservation of roads.
In 2003 CalTrans spent $300 million on pavement rehabilitation[1].
The improvement of network fell bellow expected improvement.

1. http://www.fhwa.dot.gov/pavement/preservation/ppc0622.cfm

The problem

You start with a crack

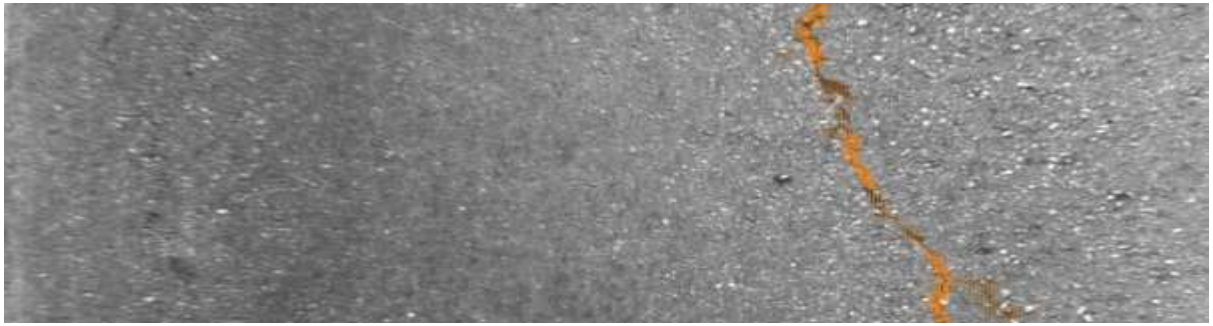


The eye has the expertise to analyze and define the crack
What do you do when you have thousands of miles to survey?

You want the computer to help, but , the variety of distress appearances is enormous, and computed results are not sufficient

You bring in Lasers. Costs are high, and you are left with huge amount of info, and Quality control will always go over imagery since this is what people understand instantly and intuitively

The solution?

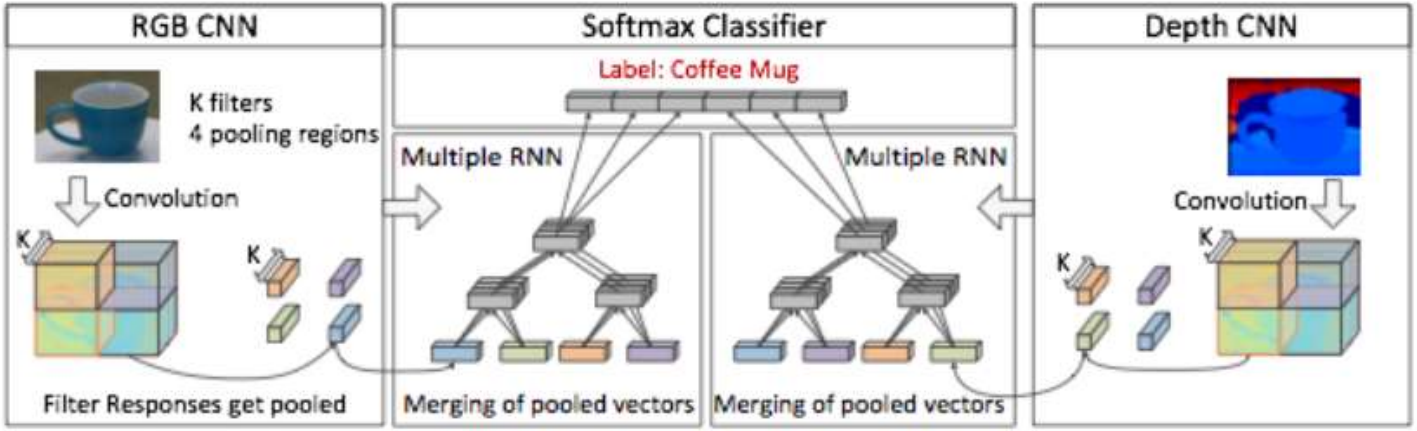


Now that Computer Vision can supply good results this is the way to go

Superiority of D-Vision solution

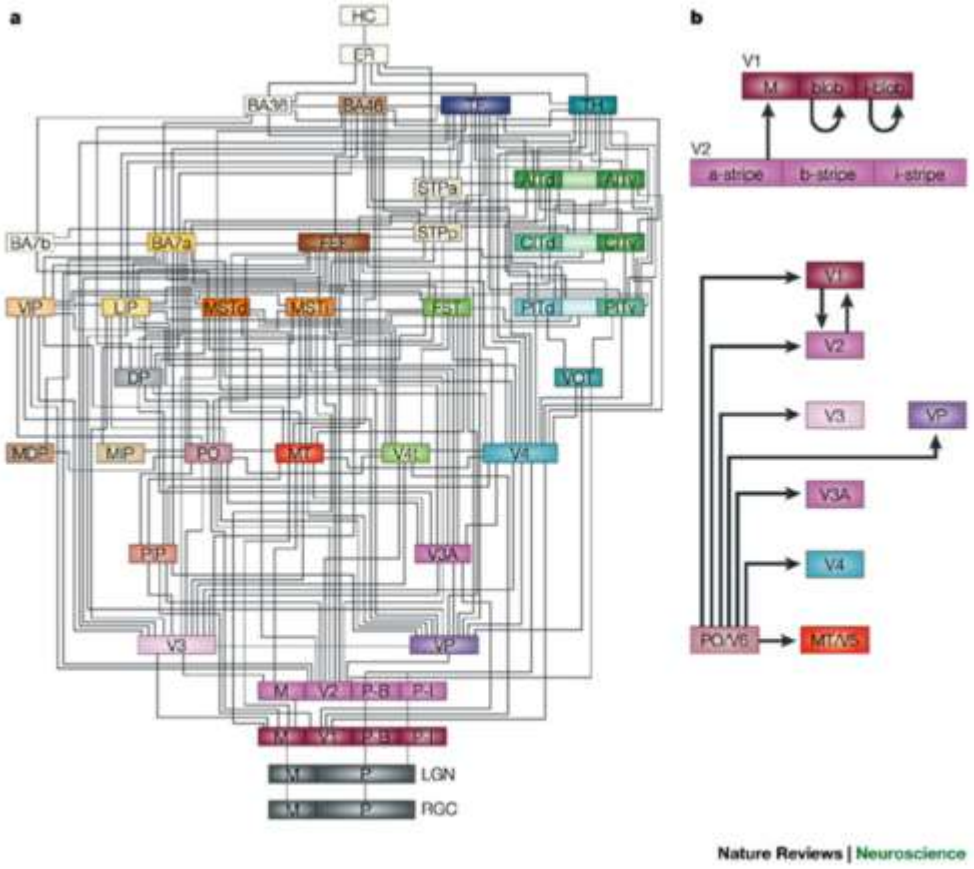
Humans rely mostly on their vision to perceive the world around them. That inspires efforts to create computer vision software that will do similar things.

The problem is that machine vision algorithms (example diagram:)



Look like a very simplified, partial versions of the inspiring visual cortex (example diagram:

Technology



Dvision's approach is derived from the brain's complexity - we use multiple feature detectors and classifiers with high degree of connectivity to obtain high classification probability.

Distress Characterization--Objective

Analysis must be automatic – **repeatable**, and comparable with previous surveys, transparent for quality checks and **accurate**, so that errors reduce to <5%

Generally, approaches for automatic crack detection include Laser data and images

Roughly:

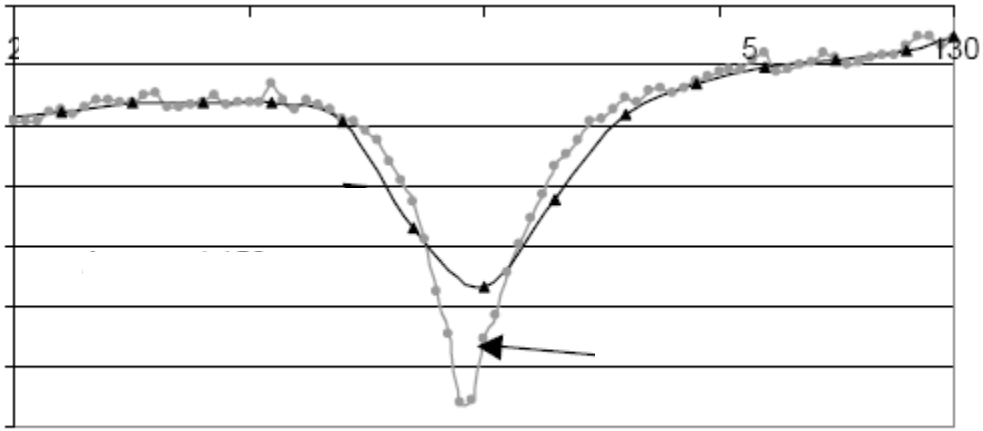
Sensor	Advantages	Cost
laser	Direct depth measurement	$500,000--??
camera	Low cost with much higher resolution (1,000 higher)	$5000

Background

Technically the base is to detect gradients with some thresholds.

Contrast in images

Depth in laser



- The problem with laser depth analysis (in addition to cost) is that it will not detect sealed cracks, patches and others.
- We claim that accurate Automated Computer Vision Detection Analysis and classification can yield a cost effective solution to the challenge.
- We rely mostly on vision and assist also with the lasers data

The challenge

Realistically a simple threshold analysis on gradients is not enough. The variety of distress appearances is enormous:

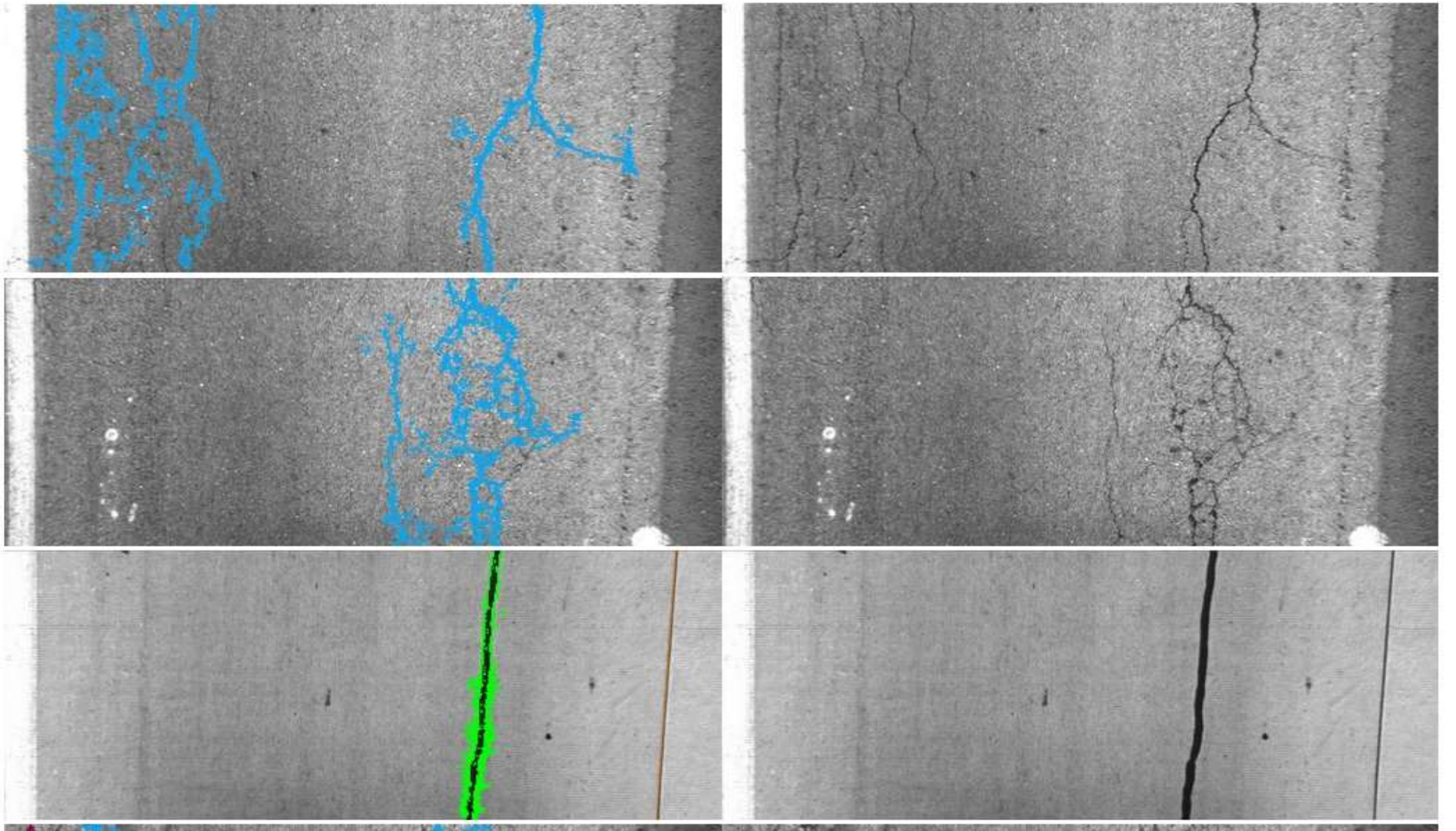
The Solution:

An Advanced computer Vision Automatic Solution

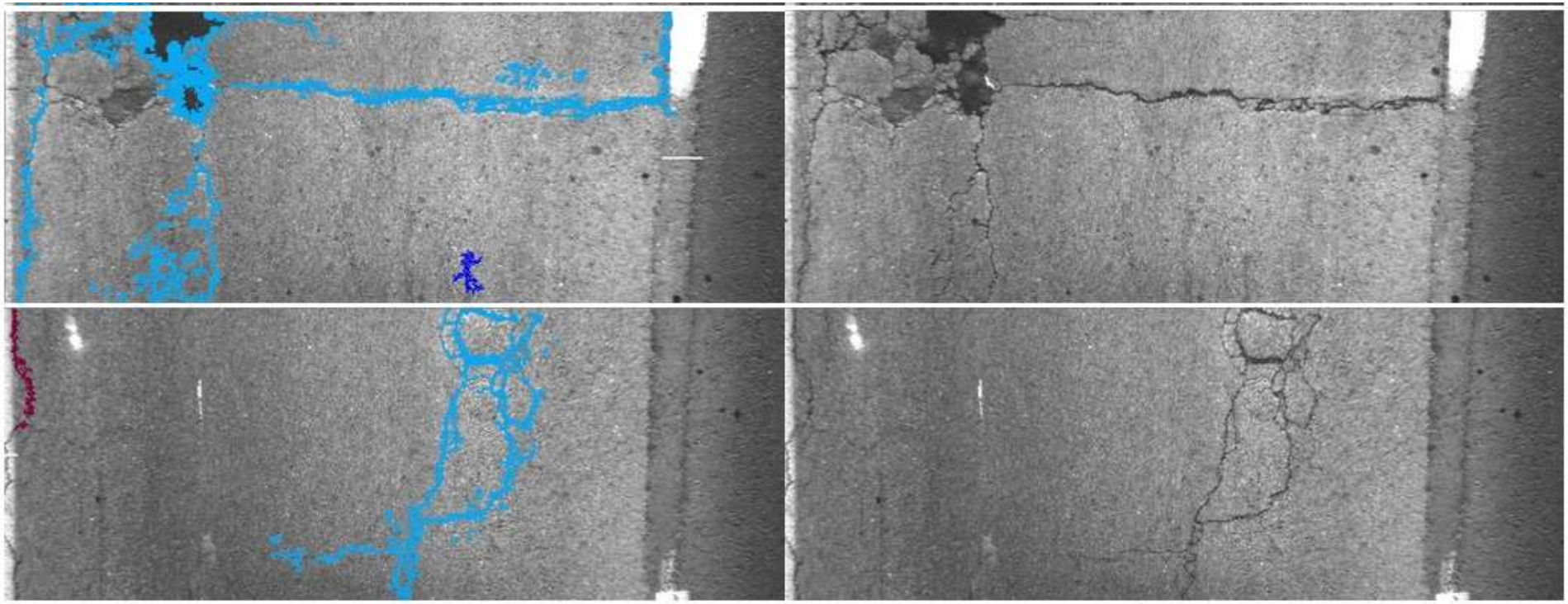
Proof of automated system

- Quality control will always go over imagery since this is what people understand instantly and intuitively.
- Automated analysis should therefore paint the cracks on the image automatically accurately and repeatably

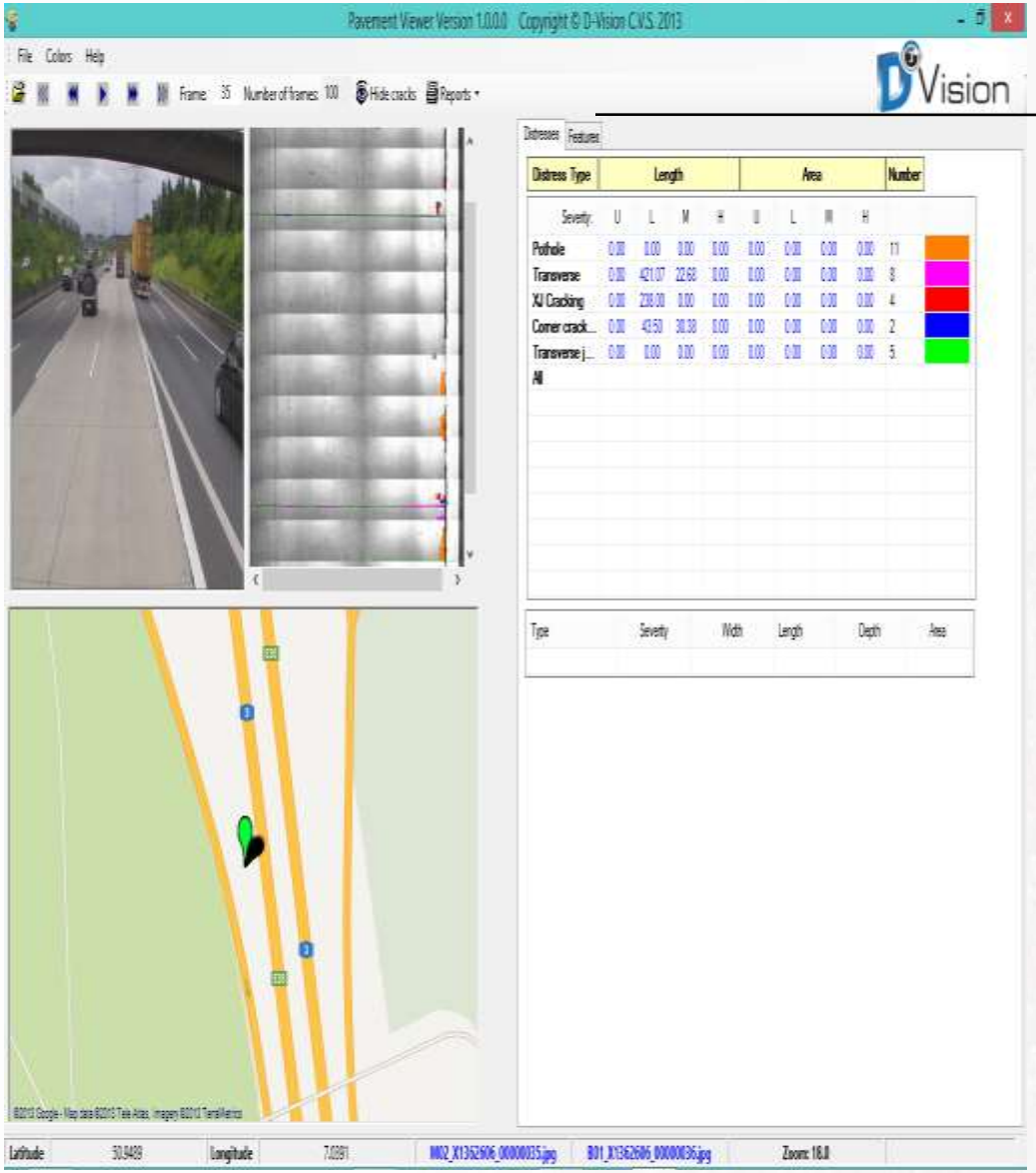
Analysis results

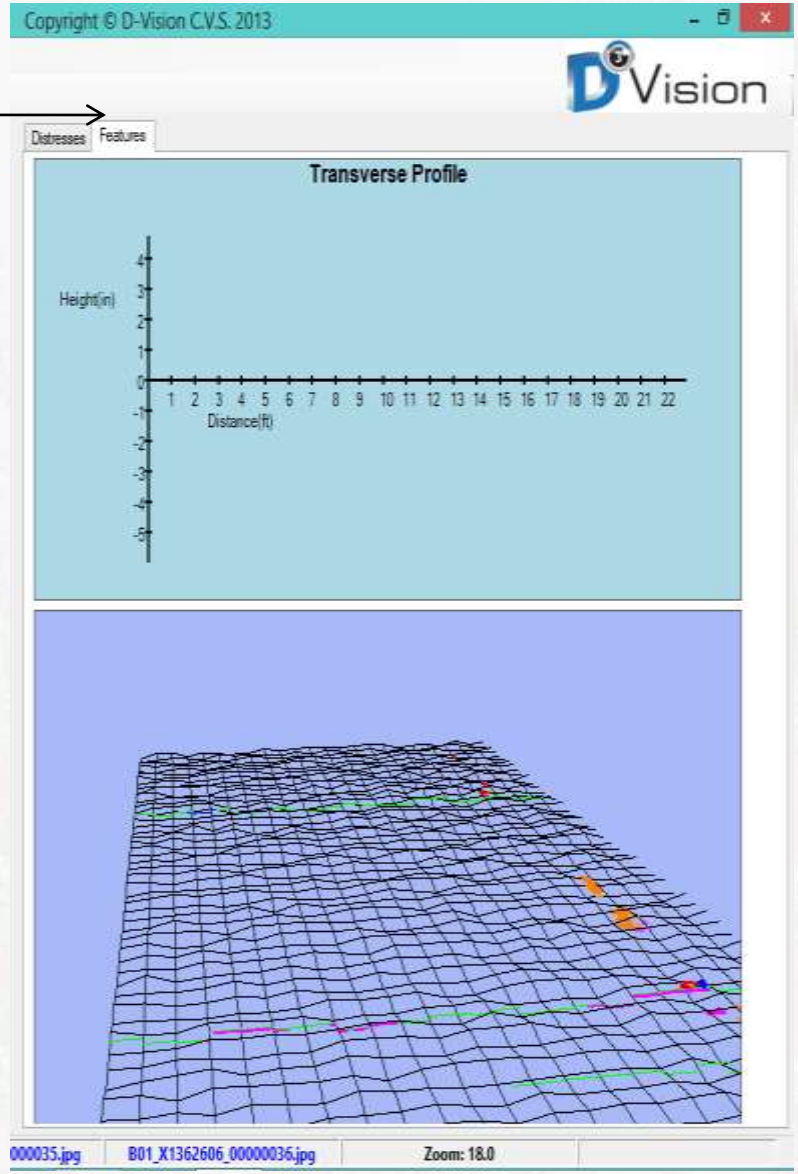


Analysis results



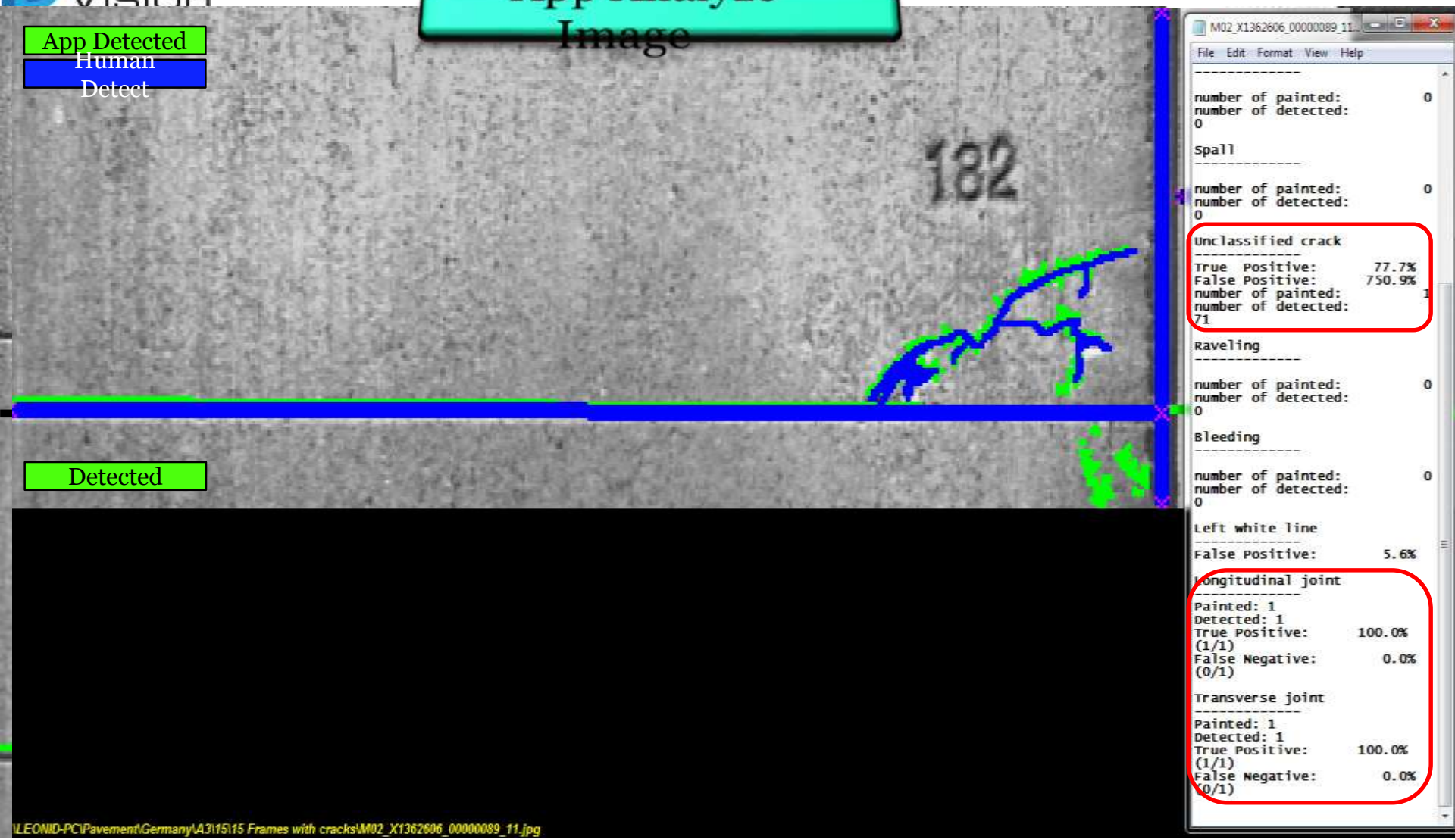
viewer





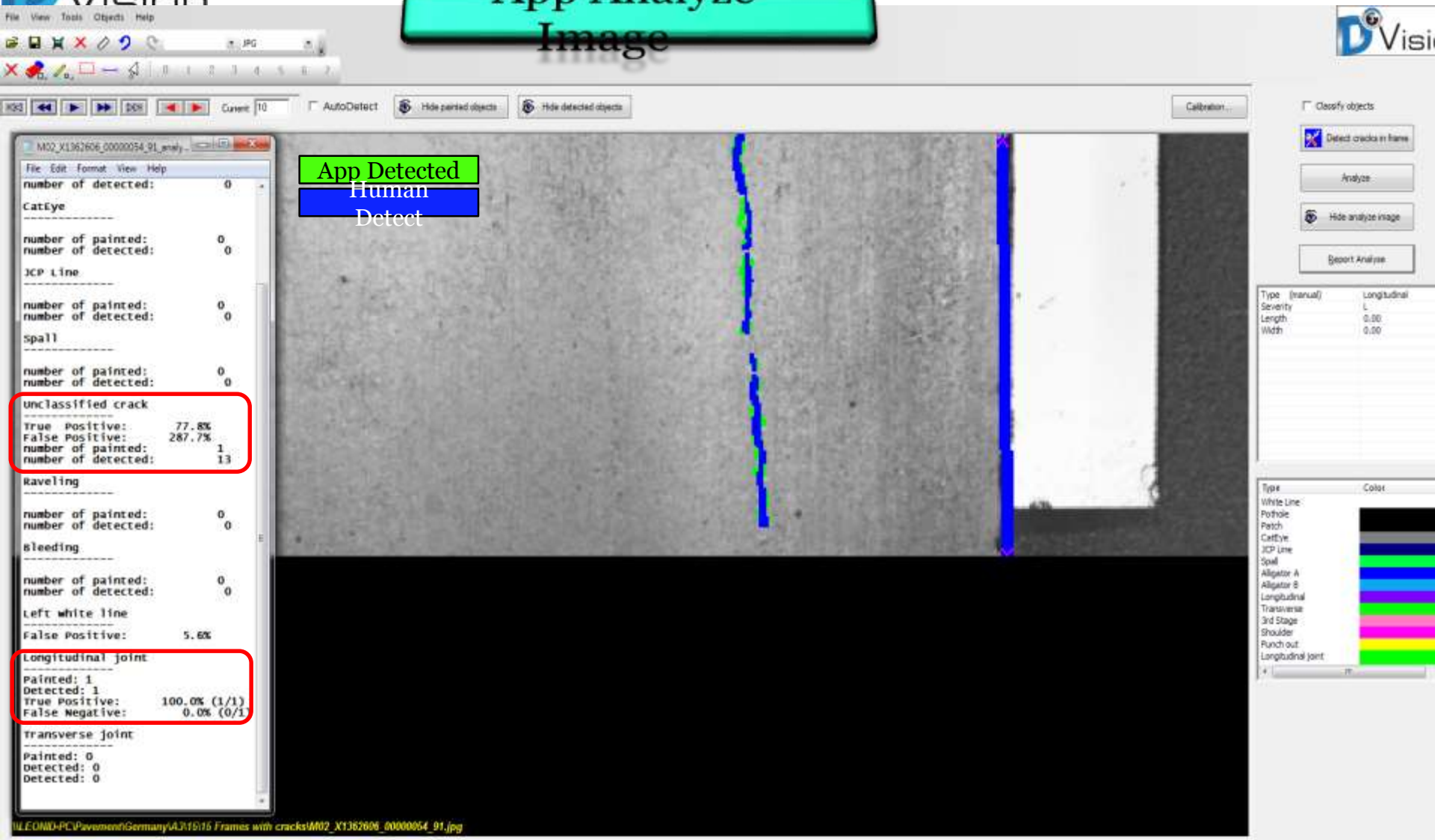
D Vision | We bring the missing dimension

Detection and Analyze Results



Analyze

App Analyze Image



Analyze

Image advantages

Everyone can show slides of technology and example images. How do you know, **as a client**, if they really have a good automated system?

Our technology

- Automatic analysis runs quickly, e.g. 10 seconds(!) per frame. If 1 mile should produce some 1000 images, analysis should last 10,000 seconds, or 3 hours. If you use parallel computing, e.g. 6 processors, it should take half an hour.

A survey of 20,000 miles will take 10,000 hours to analyze. 416 days. Use 60 parallel processors (~10 computers), or 1 second per frame, you get 41 days analysis.

Assume some QA, data storage and management.. You get 2 months.

The bottle neck for an automated system is data collection and not analysis!

Performance?

- All distresses should be marked on the image!

- Low cost – everyone can make the calculation how much the above example should cost.
- I'd like to quote 2 sentences from this presentation: Quality control will always go over imagery since this is what people understand instantly and intuitively. The variety of distress appearances is enormous - these 2 combine into suggesting that Advanced Computer Vision is the right approach

First Customers

Cal Trans HPMS survey, starting September 25

German BASt use of the solution starting Oct. 7

Residual life?

- Plot some graph of the impact of correct analysis on pavement residual life

- Variance of PCI in a section