

MATRIÈRE LAUMIÈRE POUR NOS PARTENAIRES  
CHALLENGING LIGHT FOR OUR PARTNERS

**“Developing an automated crack measurement system: challenges and solutions”**

John Laurent  
INO, Québec, Canada

INTERNATIONAL WORKSHOP  
“AUTOMATED DETECTION OF PAVEMENT CRACKING”


Québec (Laval University, La Laurentienne Pavilion)  
Sunday August 13, 2006 (2:00 p.m. – 6:00 p.m.)

*Organized by PIARC Technical Committee 4.2*



**Summary**

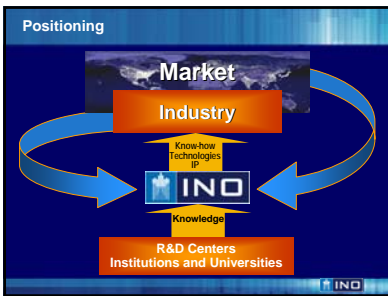
- INO
- 2D – Imaging systems for ACD
- 3D – Imaging systems for ACD
- Comparison



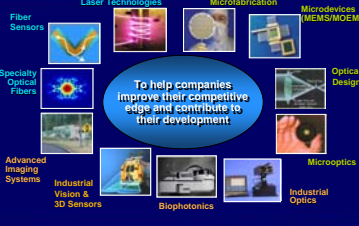
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INO facilities in the Québec Metro High Tech Park in a single 18 268 square meter building with specialised laboratories and equipment

**Mission and Development Programs**  
11 Fields of Expertise




To help companies improve their competitive edge and contribute to their development



**Crack detection problems**

To achieve the goal of automated crack detection a vision system should have the following features:


- It needs to be immune to the variable illumination conditions caused by the sun and shadows cast from road side objects such as trees, buildings, viaducts and the inspection vehicle itself.
- The system should be able to operate in both daylight and at night.
- The resolution of the images should be 1mm or better at highway speeds.
- The storage capacity of the system needs to be very high and realtime image compression is a must.
- Algorithms are the key ! They need to adapt automatically to different pavement conditions, macrottextures and colors.



**2D Imaging**


To achieve the goal of automated crack detection a 2D imaging system should have the following features:

- It needs to be immune to sun and shadows.
- The artificial light source should provide a uniform illumination over the entire image.
- The system should be set up in order to maximise the contrast of the crack images. This is done by projecting shadows.
- The system should use a minimal amount of power.

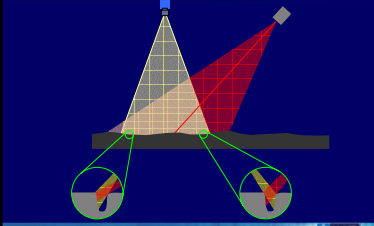



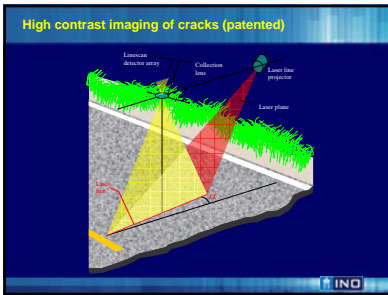
**Halogen vs Laser illumination**

	Halogen	vs Lasers
Sun/shadow immunity	Depends	Yes
Day/night operation	Yes	Yes
Uniform illumination	No	Yes
Crack image contrast	Low	High
Needed power	20000 W	200 W



**High contrast imaging of cracks (patented)**



### LRIS system specifications

- Number of lines per second: 28,000 lines/s
- Number of pixels per line: 4,096 pixels/line
- Field of view: 4 m
- Transverse resolution: 1 mm
- Longitudinal resolution (at 100 km/h): 1 mm

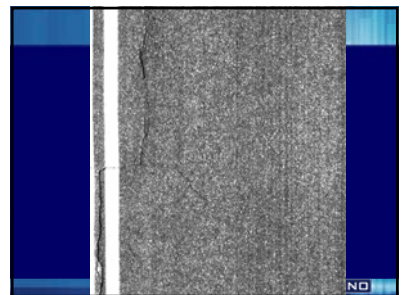
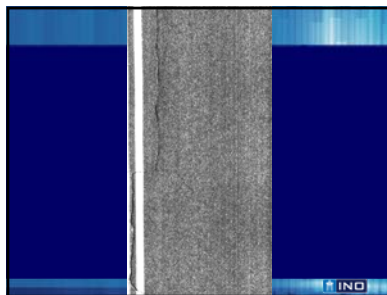


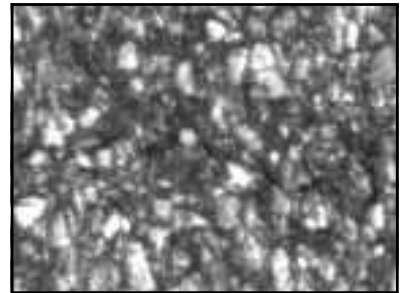
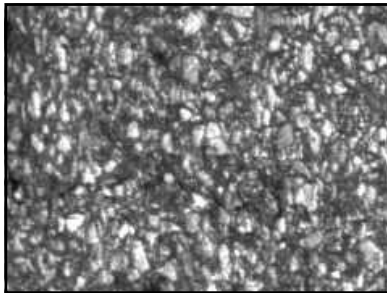
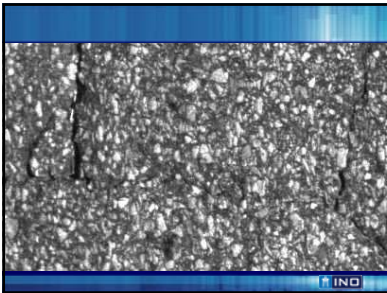
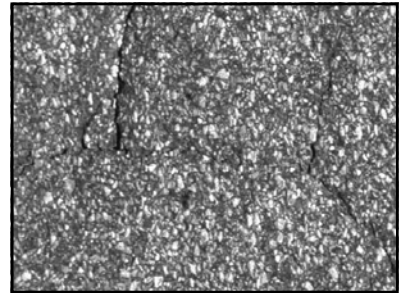
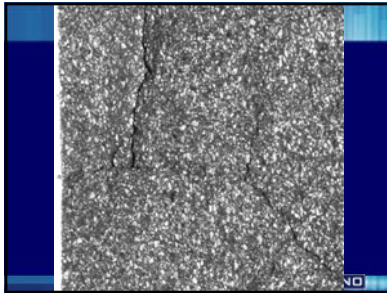
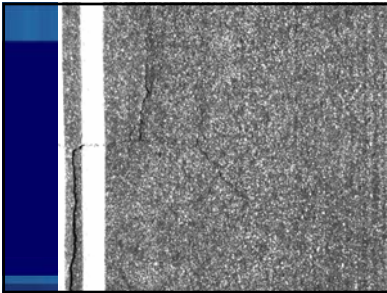
### Missing Key - Algorithms

Several companies offer manual and semi-automatic crack detection software.

Few companies offer fully automatic crack detection image and results will vary depending on lighting and road conditions.

INO has not worked on such software but we have looked at the images...

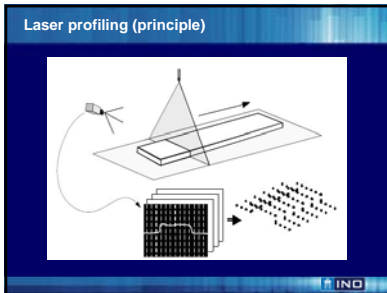




**3D Imaging**

3D imaging system have the following features:

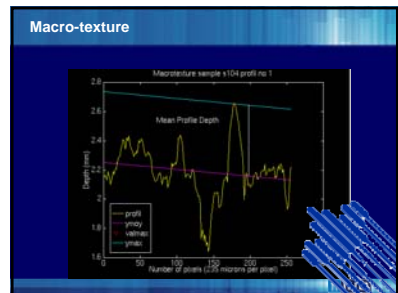
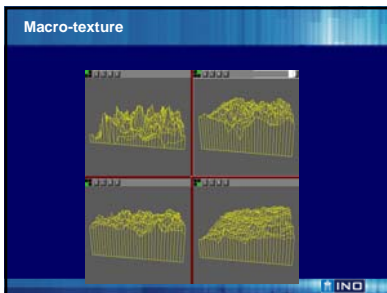
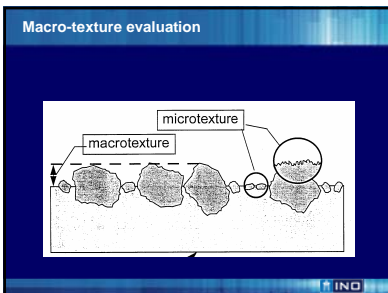
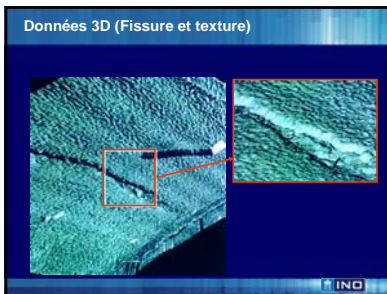
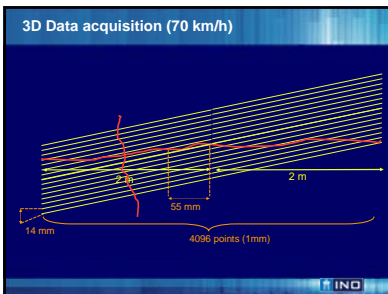
- Are immune to sun and shadows.
- Measure cracks directly using depth measurements instead of shadow projections.
- Simplifies data processing algorithms enormously.
- Allow the measurement of other important surface characteristics such as rutting and texture.
- Also give intensity information.
- Lack 1mm longitudinal resolution at highway speeds.

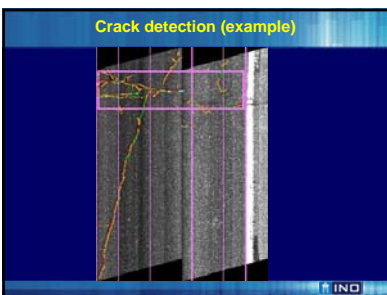
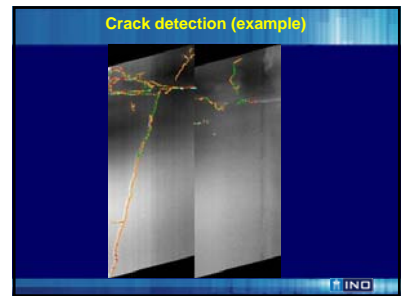
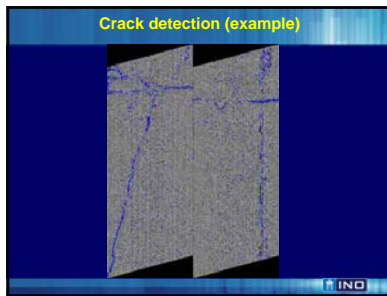
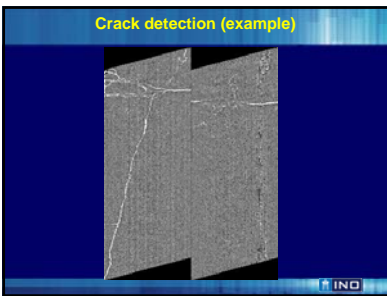
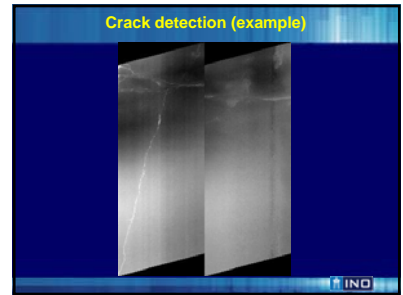
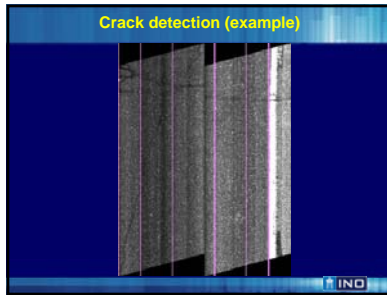
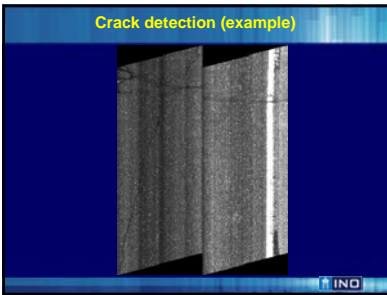




### Specifications (evolution)

	Laser Scanning (1996)	Laser Profiling (2002)	Laser Profiling (2006)
• Profiles per second:	150	350	1400
• Points per profile:	1024	4096	4096
• Field of view:	4 m	4 m	4 m
• Vertical resolution:	0.3mm	0.5mm	0.5mm
• Lateral resolution:	4 mm	1 mm	1 mm





2D vs 3D systems

	2D	3D
Sun/shadow immunity	Yes	Yes
Intensity information	Yes	Yes
Cracks detected	Shadows	Directly
Algorithms	Hard	Easier
Transverse resolution	1 mm	1 mm
Longitudinal resolution (100km/h)	1 mm	20 mm
Rutting and macrotexture	No	Yes

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