Automatic Classification for Pavement Cracks for Mobile Mapping Data

FIG Working Week 2016

TS 08B **-** Advance in Photogrammetry and other Measurement Methods

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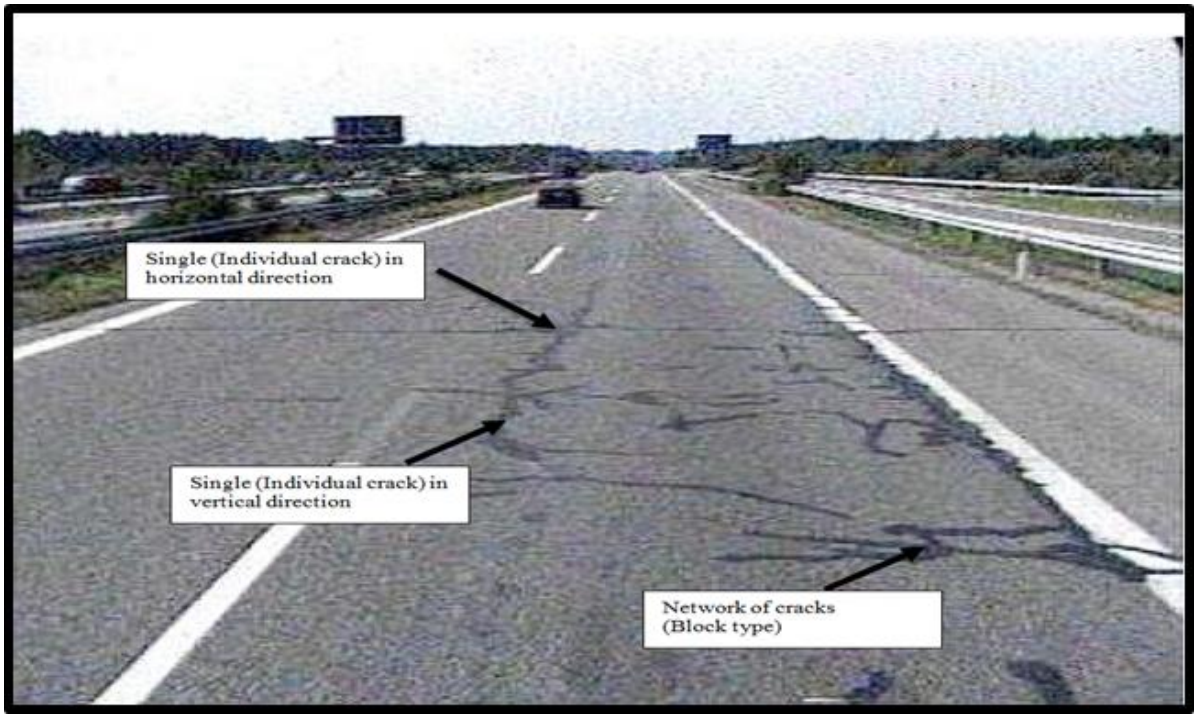
Structure

- Pavement Cracks
- Detection
- Classification
- Evaluation Criteria
- Experimental Results
- Conclusions and Outlook

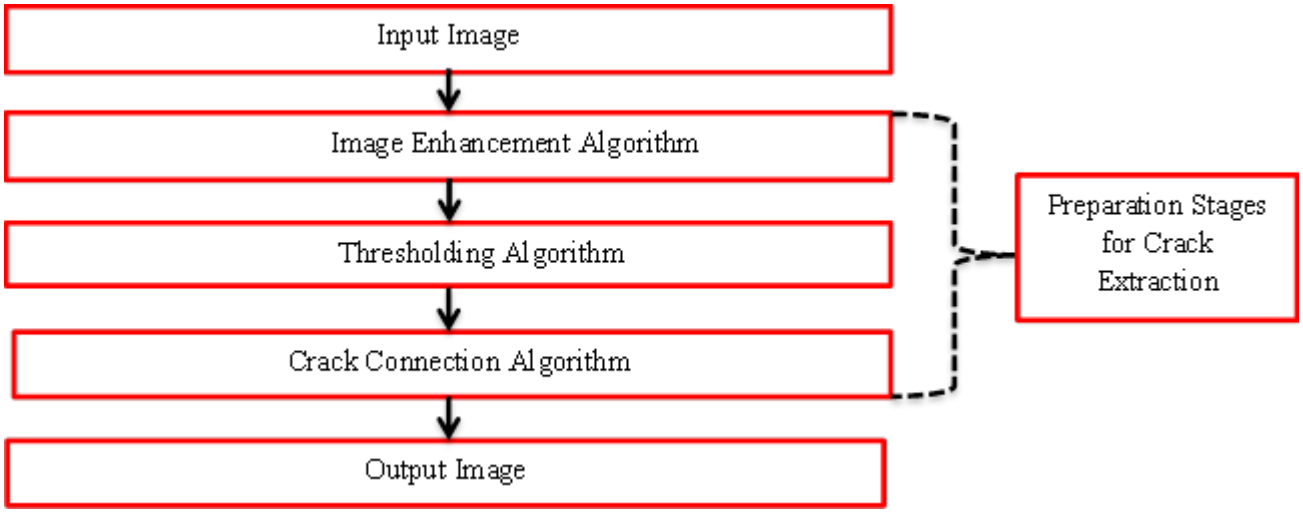
Pavement Cracks

Pavement management and maintanance requires
up-to-date acqusition of road data by mobile-mapping systems
and the detection and classification of cracks
and their severity level.



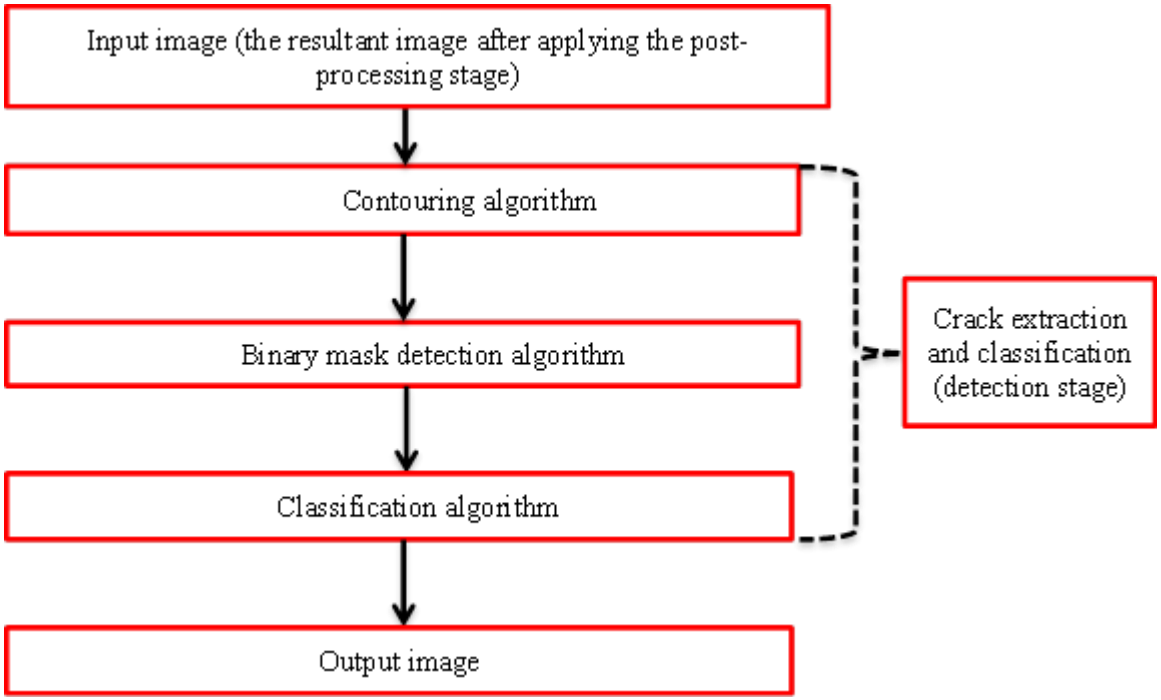
Cracking (FGSV 2006)

Detection - Summary



Focus on local dynamic theshold algorithm
determinig window size and contrast value
to take into account varying lightning conditions and shadows;
more details in Al-Mistarehi & Schwieger (2015).

Detection - Summary



Classification is the focus of this contribution,
more details regarding detection in Al-Mistarehi & Schwieger (2015).

Classification

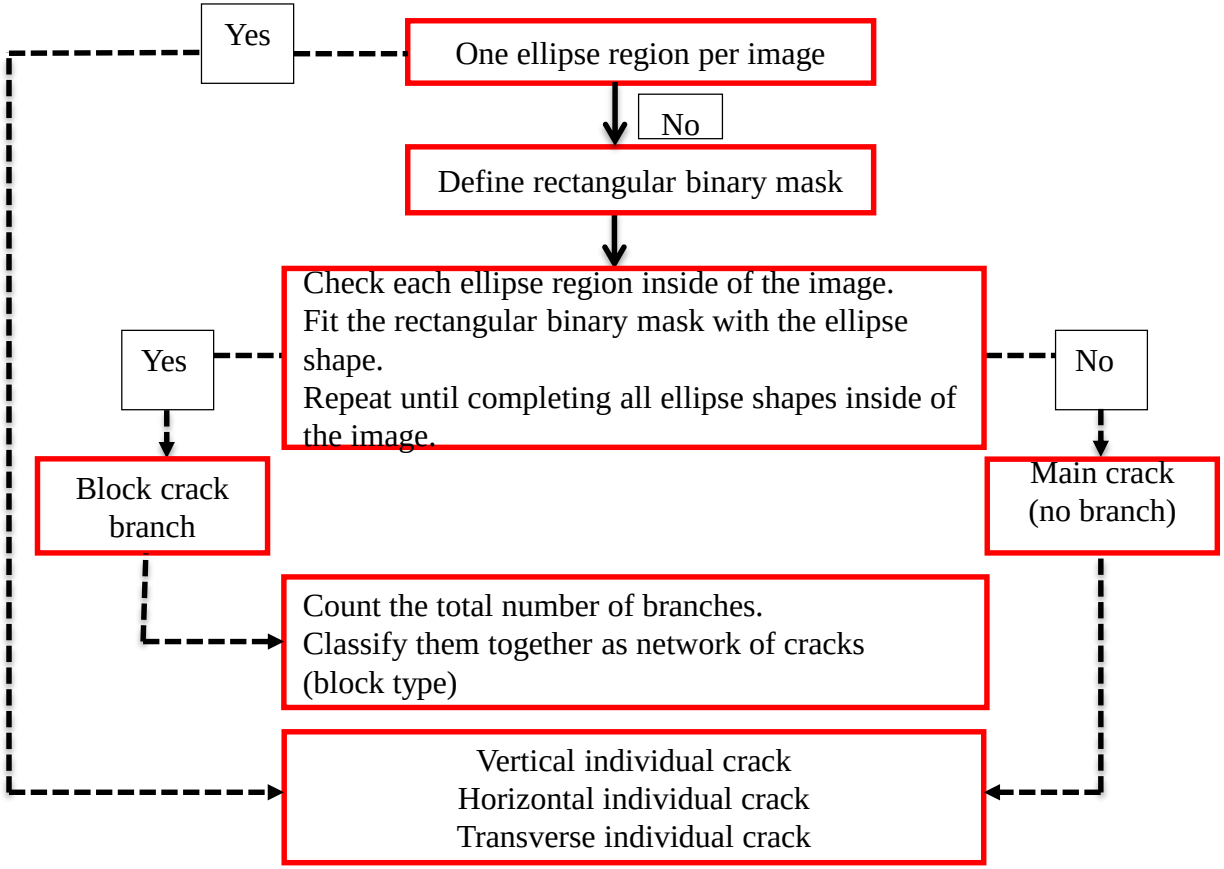
1. The vertical individual cracks have an orientation angle ($\Omega >= 60^o$).
2. The horizontal individual cracks have an orientation angle ($\Omega <= 30^o$).
3. The transverse individual cracks have an orientation angle ($60^o > \Omega > 30^o$).
4. The network of cracks (block type) have different orientations associated to different branches. There is no specified range for its orientation.

Severity level
by measuring
length and width (area)

Other crack shapes as
- patching,
- out-breacks,
- open work seams and
- binder enrichment

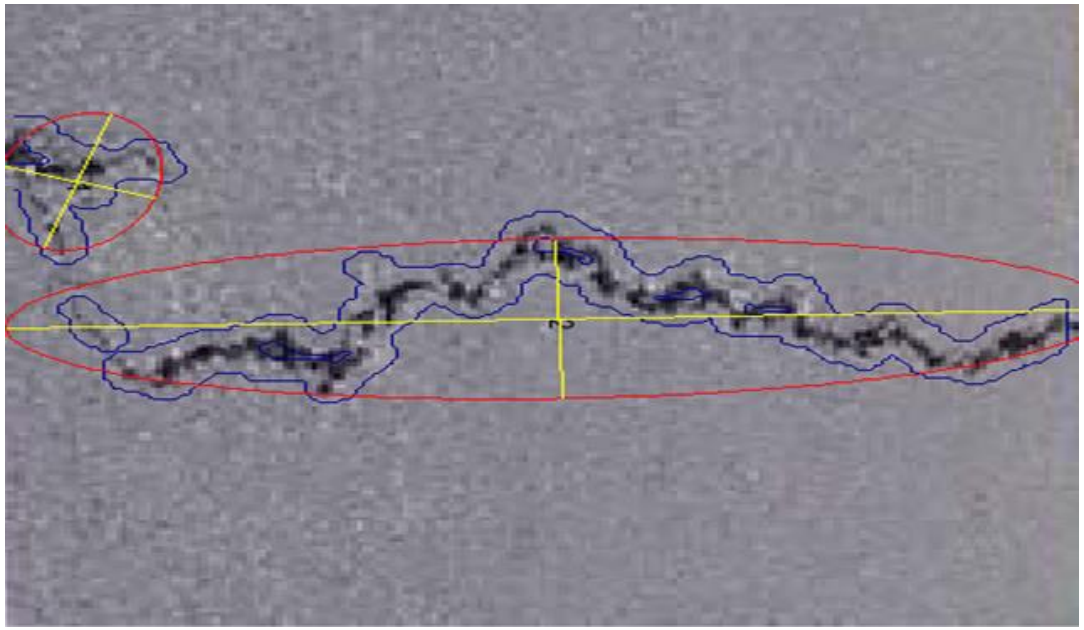
are not detected and classified.

Classification



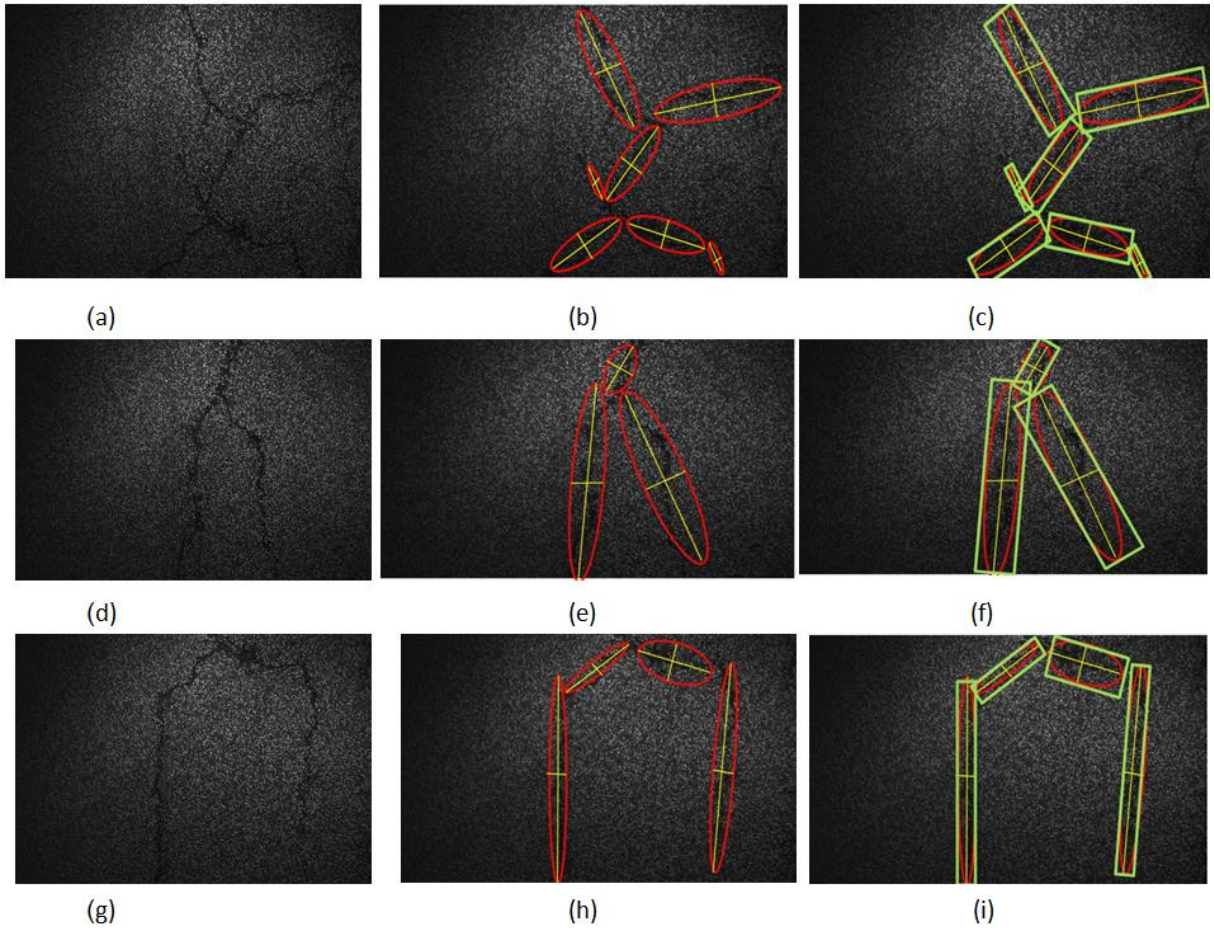
Classification algorithm

Classification



Orientation angles by axes orientation of major ellipse axis.

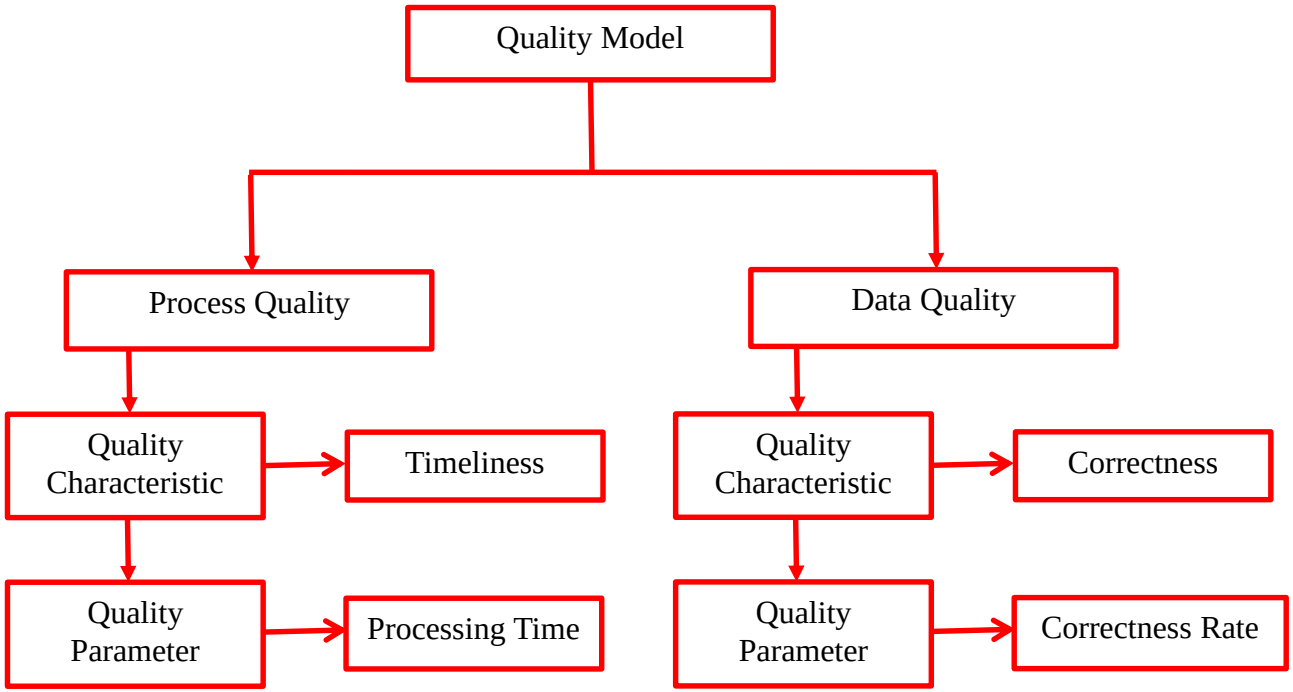
Classification



Block crack examples:
1st column: original images,
2nd column: block crack shape after modified binary mask algorithm,
3rd column: final detected block cracks.

Ecaluation Criteria

Evaluation of data needs a quality model
including quality characteristcs (defining quality)
and quality parameters (defining measurable quantities).



Focussing on timeliness and correctness!

Ecaluation Criteria

$$t_p = t_{end} - t_{beg} \qquad \text{timeliness}$$

t_p : **processing time** to complete crack detection and classification [s],
t_{end} : time at the end of the algorithm process [s],
t_{beg} : time at the beginning of the algorithm process [s].

$$B_i = \left(\frac{M_i}{S_i} * 100\right) \qquad \text{correctness}$$

B_i : **correctness rate** of the object entity (%),
M_i : number of correct identified object entities,
S_i : total number of the object entities,
i : indices for determining the correctness rate (i=1, 2, 3, 4).

Index (*i*)	Object	Entity
1	Cracks	Correct detected individual vertical cracks in all images
2		Correct detected individual horizontal cracks in all images
3		Correct detected individual transverse cracks in all images
4		Correct detected network of cracks (block) cracks in all images

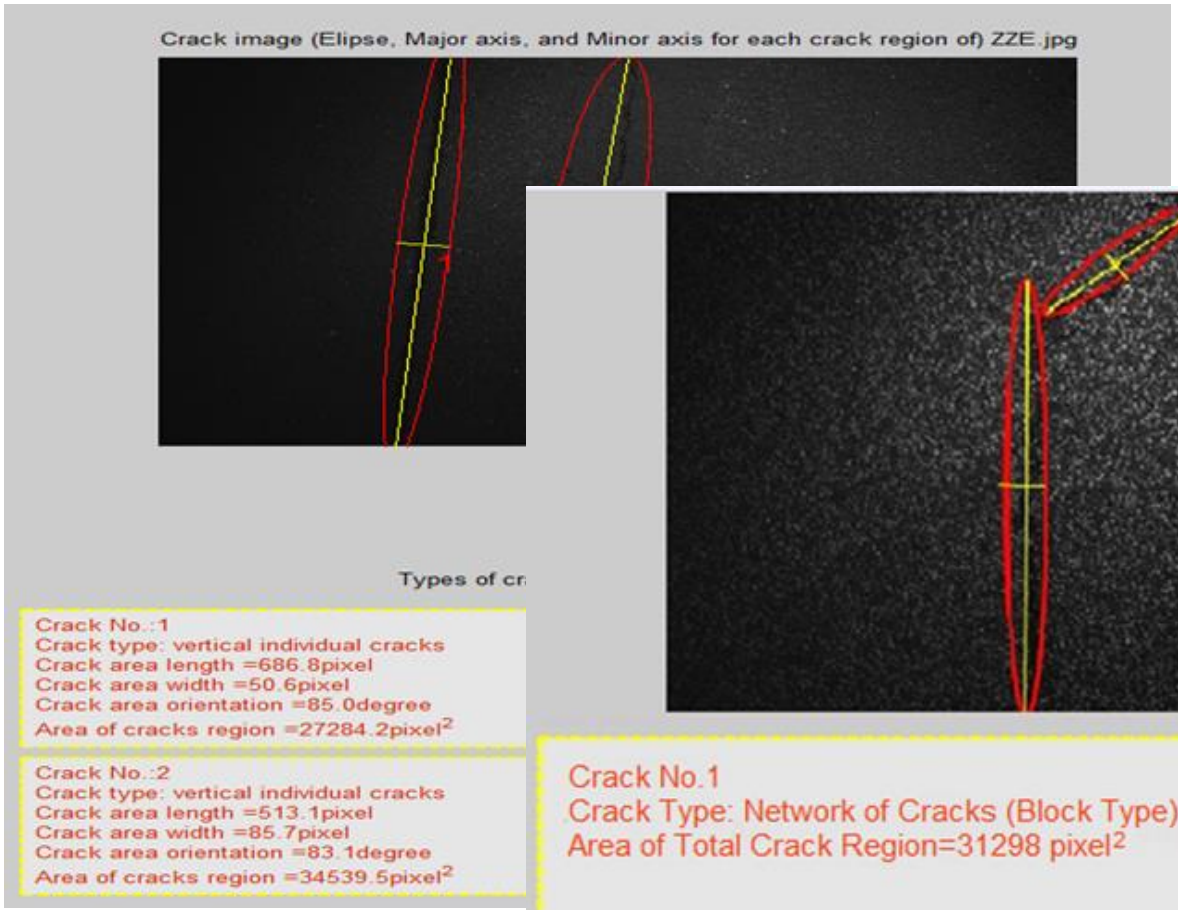
Case Study - Experimental Results

Resolution: 1920 x 1080 pixel; 1.2 mm^2 per ground point

Case Study of Lehmann + Partner
includes cracks with various shapes,
noisy pavement texture, lane markings, tire marks,
stop lines, repaired road, skid markings, railways trucks,
grates, sidewalk (curbs), manholes covers, signs on the ground, oil spot on the ground, line stripping, lighting columns, water pipelines, traffic loops and bicycles,
different lighting conditions, *shadows*.

Category	Quality
Number of images	96 images
Number of crack images	50 images
Number of vertical crack images	18 images
Number of horizontal crack images	2 images
Number of transverse crack images	10 images
Number of network cracks (Block type)	20 images
Number of non-crack images	46 images
Length of vertical cracks for all images (m)	18.9 m
Length of horizontal cracks for all images (m)	1.7 m
Length of transverse cracks for all images (m)	7.3 m
Area of network cracks (Block type) for all images (m^2)	0.57 m^2

Experimental Results



Detected and classified ve

Detected and classified network of cracks (block type)

Experimental Results – Conclusion

Category	Quality
Falsely detected cracks	0 crack
Falsely detected images	0 image
B_1 (%)	100
B_2 (%)	100
B_3 (%)	100
B_4 (%)	100
t_p [s]	227.70s≈3.8 min

- 100 % correctness rate for this example
- Correctness rate confirmed (98.9 to 100%) for other test cases (Al-Mistarehi 2016: more than 900 images)
- Faster than other comparable algorithms (Al-Mistarehi 2016)

Outlook

- Further confirmation by more data
- Extension to other crack types and other materials

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