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Some advances/results in monitoring road cracks from 2D pavement images within the scope of the collaborative FP7 TRIMM project

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Monitoring road surface conditions is an important issue in many countries. Several projects have looked into this issue in recent years, including TRIMM 2011-2014. The objective of such projects has been to detect surface distresses, like cracking, raveling and water ponding, in order to plan effective road maintenance and to afford a better sustainability of the pavement.
The monitoring of cracking conventionally focuses on open cracks on the surface of the pavement, as opposed to reflexive cracks embedded in the pavement materials. For monitoring surface condition, in situ human visual inspection has been gradually replaced by automatic image data collection at traffic speed. Off-line image processing techniques have been developed for monitoring surface condition in support of human visual control. Full automation of crack monitoring has been approached with caution, and depends on a proper manual assessment of the performance.
This work firstly presents some aspects of the current state of monitoring that have been reported so far in the literature and in previous projects: imaging technology and image processing techniques.
Then, the work presents the two image processing techniques that have been developed within the scope of the TRIMM project to automatically detect pavement cracking from images. The first technique is a heuristic approach (HA) based on the search for gradient within the image. It was originally developed to process pavement images from the French imaging device, Aigle-RN. The second technique, the Minimal Path Selection (MPS) method, has been developed within an ongoing PhD work at IFSTTAR. The proposed new technique provides a fine and accurate segmentation of the crack pattern along with the estimation of the crack width.
HA has been assessed against the field data collection provided by Yotta and TRL with the imaging device Tempest 2. The performance assessment has been threefold: first it was performed against the reference data set including 130 km of pavement images over UK roads, second over a few selected short sections of contiguous pavement images, and finally over a few sample images as a case study.
The performance of MPS has been assessed against an older image data base. Pixel-based PGT was available to provide the most sensitive performance assessment. MPS has shown its ability to provide a very accurate cracking pattern without reducing the image resolution on the segmented images.
Thus, it allows measurement of the crack width; it is found to behave more robustly against the image texture and better matched for dealing with low contrast pavement images.
The benchmarking of seven automatic segmentation techniques has been provided at both the pixel and the grid levels. The performance assessment includes three minimal path selection algorithms, namely MPS, Free Form Anisotropy (FFA), one geodesic contour with automatic selection of points of interests (GC-POI), HA, and two Markov-based methods. Among others, MPS approach reached the best performance at the pixel level while it is matched to the FFA approach at the grid level.
Finally, the project has emphasized the need for a reliable ground truth data collection. Owing to its accuracy, MPS may serve as a reference benchmark for other methods to provide the automatic segmentation of pavement images at the pixel level and beyond. As a counterpart, MPS requires a reduction in the computing time.

Keywords: cracking, automatic segmentation, image processing, pavement, surface distress, monitoring, DICE, performance