Image-based real-time techniques for damage monitoring using machine learning and computer vision algorithms

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Abstract. Traditionally the accuracy of measurements and quantitative analysis for structural monitoring were limited by labour and operator's skills [1]. Recent technological developments in geomatics provide the tools to remotely detect and quantify damages with little or no human intervention, enhancing analysis objectivity and allowing for cost-effective monitoring strategies. While laser scanning technology has become a commonly adopted approach to produce high quality 3D products for a broad range of engineering fields [2, 3], video/photogrammetry techniques have the potential to acquire information with a comparable level of detail, providing cost-effective and less cumbersome solutions with automation capabilities [4]. Image-based approaches to monitor building damages (e.g. cracks) has been largely demonstrated in recent research works [5], showing damage monitoring potential for single case sites [6, 7]. However, a monitoring scheme for damage analysis integrating data from multiple sites (and multiple sensors) must cope with the difficulties involved in developing generic algorithms [6]. An automated procedure based on remotely controlled cameras [8], machine learning and image processing algorithms is under development to create a reliable damage identification and quantification workflow for real-time crack monitoring in concrete structures. Preliminary tests with a single DSLR camera showed that the adoption of reliable crack detection algorithms is the first critical step for precise multi-temporal analysis of cracks characteristics. Initial detection results obtained combining computer vision algorithms available in ImageJ [9] produced interesting outputs (Fig. 1(b, e)). The previous results were imported in MATLAB as inputs data to estimate crack characteristics (e.g. length and width) (Fig. 1(c, f)). Further work is being conducted to evaluate the adoption of machine learning algorithms and to assess the performances of the proposed method. Comparisons will be carried out with outputs generated with more established ground-based remote sensors (e.g. Terrestrial Laser Scanner and Total Station) and traditional contact instruments (e.g. crack-meters).

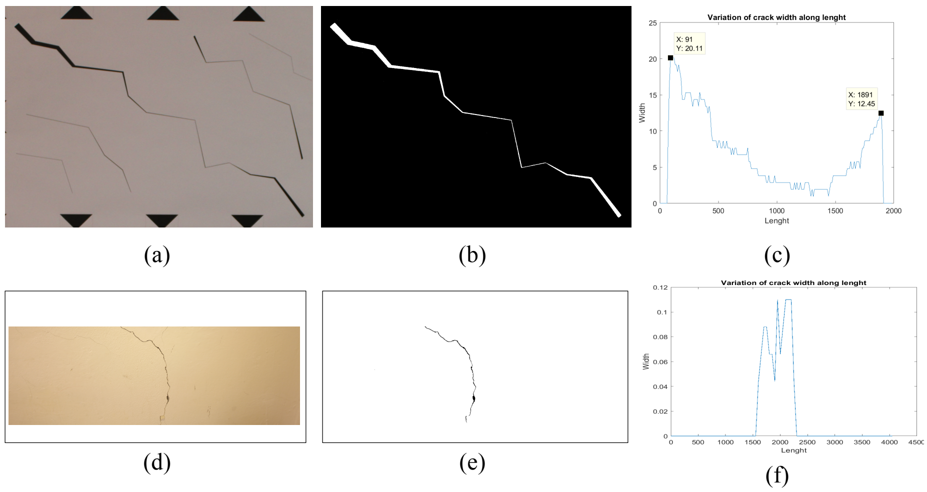

Fig. 1. Examples of ImageJ segmentation outputs (b, e) obtained with images captured under controlled and real site conditions (respectively 'a' and 'd'). Pixel analyses of the segmented cracks conducted in MATLAB are shown also (c, f).

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