Automated fatigue crack identification through motion tracking in a video stream

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250 words:
Fatigue cracks occurring in metallic materials are of critical safety concerns for mechanical, aerospace, and civil engineering structures. For fracture-critical structures, if not appropriately inspected, excessive growth of fatigue cracks can lead to catastrophic structural failures. Current crack detection technologies developed for non-destructive testing (NDT) or structural health monitoring (SHM) often require costly testing equipment, extensive human involvement, or complex signal processing algorithms. Recently, computer vision-based methods have shown great promise in damage detection for being contactless, low cost, and easy-to-deploy. In this paper, we propose a novel video-based method for detection and quantification of fatigue cracks. The method is based on tracking the surface motion of structural members under cracking in a video stream, and identifying fatigue cracks by extracting discontinuities in the surface motion caused by fatigue cracks. The effectiveness of this method was validated through an experimental test of a steel compact, C(T), specimen. Results indicate that the proposed approach can robustly detect the fatigue crack, even when the crack is under insufficient light conditions, surrounded by other crack-like edges, covered by complex surface textures, and invisible to human eyes due to crack closure. Traditional edge detection-based methods would not guarantee well performance under these harsh conditions. Moreover, the method is able to quantify fatigue crack opening with submillimeter accuracies. Compared with Digital Image Correlation (DIC) techniques, the proposed approach is more flexible and cost-effective as it uses a consumer-grade digital camera and does not require special light sources, or surface treatment prior to the test.

Key words:
Computer vision; motion tracking; video stream; fatigue crack detection; structural health monitoring; feature point detection

100 words:
Timely detection of fatigue cracks is critical for preventing excessive damage. Based on motion tracking of structural surface under service loading, we propose a computer vision-based fatigue crack detection method using a consumer-grade digital camera. The method is based on detecting discontinuities caused by fatigue cracks in the surface motion through a short video stream. Test on a steel compact specimen indicate that the approach can robustly identify the fatigue crack, even when it is under insufficient light conditions, surrounded by other crack-like edges, covered by complex surface textures, and invisible to human eyes due to crack closure.