UAV-based Fatigue Damage Sensing for Steel Bridges through Image Feature Matching

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Abstract

Detecting and monitoring fatigue cracks are of critical importance for steel bridges to ensure structural safety. Human inspection is still by far the most common method for identifying fatigue cracks, despite its low reliability and efficiency as well as high cost. Recently, unmanned aerial vehicle (UAV)-based structural health monitoring (SHM) has shown great promise in bridge inspection for being able to remotely collect visual information of structures. Integrated with computer vision algorithms, UAV-based SHM could potentially offer an efficient methodology for detecting fatigue damage in steel bridges. Previously, the authors had proposed a computer vision-based fatigue crack detection method through a video taken by a stationary camera. The method is based on tracking the surface motion of a monitored structure under fatigue loading, and further searching distinct motion patterns caused by cracking. In this study, we further extend this vision-based sensing concept in a context of UAV-based fatigue detection, in which the on-board camera is subjected to additional movements from the flying UAV. To tackle this challenge, we first detect Shi-Tomasi feature points in the images from a video stream. Then we apply the geometric transformation to align the feature points in these images under the same coordinate system, so that the effect of the non-stationary camera movement can be compensated. Finally, a fatigue crack detection algorithm is established by analyzing the motion of the matched feature points and extracting the unique pattern due to the existence of a fatigue crack. The effectiveness of the proposed approach has been validated using a video recorded by an UAV from a laboratory fatigue test.

Keywords: structural health monitoring, computer vision, steel bridges, unmanned aerial vehicles, feature point tracking