Kansas
LTAP Fact Sheet
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Video-Based Fatigue Crack Detection of Steel Structures

Research at the University of Kansas may lead to better fatigue crack detection

By Steven Schrock, PhD

Local governments are responsible for the inspection of the bridges they own. In Kansas, inspections are often done by an engineering consultant and generally follow the KDOT guidelines for inspections. This is done to satisfy the Federal-Aid Highway Act of 1968, which created an inspection mandate for all Federal-aid highway system bridges (1). This Act came after many serious bridge failures in the US, and there was a need to improve the inspection processes used to find structural deficiencies. The Act also created the National Bridge Inspection Standards (NBIS) which explains how these inspections are to be conducted.

Photo courtesy of KDOT

Fatigue cracks – one kind of deficiency

One example of the kinds of deficiencies that can lead to a bridge failure are fatigue cracks on the steel members of a bridge. Fatigue cracks develop over time due to repetitive traffic loads, and are one of the major threats to the structural integrity of these kinds of bridges. Detecting structural impairments of in-service bridges is needed in order to ensure their continued functionality. Normally these inspections are done at intervals of every two years unless the bridge has a known deficiency - then it is inspected more often (2)

Automated video inspection has been developed

Human inspection is the most common way of looking for fatigue cracks, but is time consuming, labor intensive, and lacks reliability. Dr. Jian Li, an assistant professor in the University of Kansas' Department of Civil, Environmental, and Architectural Engineering, has recently applied for a patent for a computerized process of determining fatigue cracks using video. This method has the potential to improve the accuracy and speed of

performing these inspections. By automating the process, there is also the possibility of lowering inspection costs.

The method involves taking a short video stream of a structure in a crack-prone area under repetitive loading and processing the video through a computer (3). Specific features then can be detected in each frame, allowing fine movements to be tracked throughout the video stream. By comparing movements between adjacent feature points, the presence of a crack can be detected and evaluated to determine the full extent of the crack along with its dimensions. It's even possible to compare video feeds from different time periods to determine the speed at which these cracks are lengthening. According to Dr. Li, the method can also be used in other applications, such as detecting localized slippage or the loosening of structural components.

Figure 1. (a) Schematic of the test setup; (b) photo of the test setup. F is the applied fatigue load cycles and t is time; and (c) fatigue crack localized by a set of highlighted pixels. (3)

Results of testing

Dr. Li's preliminary lab results are promising. The effectiveness of his approach was validated through testing two experimental specimens with in-plane and out-of-plane fatigue cracks, respectively. Results indicate that the approach can identify fatigue cracks, even when the crack is under ambient lighting conditions, surrounded by other crack-like edges, covered by complex surface textures, or even if it is invisible to human eyes due to crack closure.

For more information

If you are interested in learning more, or if you have a bridge that you think might be a good candidate for a field study by Dr. Li, please contact Dr. Jian Li at jianli@ku.edu or at (785) 864-6850.

References

(1) Federal Highway Administration (December 2004). "National Bridge Inspection Standards." https://www.govinfo.gov/content/pkg/FR-2004-12-14/pdf/04-27355.pdf. Accessed February 26, 2019.

(2) Federal Highway Administration (December 2012). "Bridge Inspector's Reference Manual" https://www.fhwa.dot.gov/bridge/nbis/pubs/nhi12049.pdf. Accessed February 26, 2019.

(3) Kong, X. and Li, J. (February 2018). "Vision-based Fatigue Crack Detection of Steel Structures Using Video Feature Tracking." Computer-Aided Civil and Infrastructure Engineering, 33(9), pp. 783-799.