Announcing the Final Examination of Liuliu Wu for the degree of Doctor of Philosophy

Time & Location: March 26, 2015 at 10:00 AM in Engineering 2 211
Title: APPLICATIONS OF COMPUTER VISION TECHNOLOGIES OF AUTOMATED CRACK DETECTION AND QUANTIFICATION FOR THE INSPECTION OF CIVIL INFRASTRUCTURE SYSTEMS

Many components of existing civil infrastructure systems, such as road pavement, bridges, and buildings, are suffered from rapid aging, which require enormous nation's resources from federal and state agencies to inspect and maintain them. Crack is one of important material and structural defects, which must be inspected not only for good maintenance of civil infrastructure with a high quality of safety and serviceability, but also for the opportunity to provide early warning against failure. Conventional human visual inspection is still considered as the primary inspection method. However, it is well established that human visual inspection is subjective and often inaccurate. In order to improve current manual visual inspection for crack detection and evaluation of civil infrastructure, this study explores the application of computer vision techniques as a non-destructive evaluation and testing (NDE&T) method for automated crack detection and quantification for different civil infrastructures.

In this study, computer vision-based algorithms were developed and evaluated to deal with different situations of field inspection that inspectors could face with in crack detection and quantification. The depth, the distance between camera and object, is a necessary extrinsic parameter that has to be measured to quantify crack size since other parameters, such as focal length, resolution, and camera sensor size are intrinsic, which are usually known by camera manufacturers. Thus, computer vision techniques were evaluated with different crack inspection applications with constant and variable depths. For the fixed-depth applications, computer vision techniques were applied to two field studies, including 1) automated crack detection and quantification for road pavement using the Laser Road Imaging System (LRIS), and 2) automated crack detection on bridge cables surfaces, combined with a cable inspection robot. For the various-depth applications, two field studies were conducted, including 3) automated crack recognition of concrete bridges' cracks using a high-magnification telescopic lens, and 4) automated crack quantification using wearable glasses with stereovision cameras.

From the realistic field applications of computer vision techniques, a novel self-adaptive image-processing algorithm was developed using a series of morphological transformations to connect fragmented crack pixels in digital images. The crack-defragmentation algorithm was evaluated with road pavement images. The results showed that the accuracy of automated crack detection, associated with artificial neural network classifier, was significantly improved by reducing both false positive and false negative. Using up to six crack features, including area, length, orientation, texture, intensity, and wheel-path location, crack detection accuracy was evaluated to find the optimal sets of crack features. Some guidelines of applying computer vision techniques are also suggested for each crack inspection application.

Major: Civil Engineering

Educational Career:
Bachelor's of Water Resources Engineering, BS, 2009, Hohai University
Master's of Water Resources Engineering, MS, 2011, Hohai University
Master's of Civil Engineering, MS, 2013, University of Central Florida

Committee in Charge:
Hae-Bum Yun, Chair, Department of Civil, Environmental and Construction Engineering, UCF
Necati Catbas, Department of Civil, Environmental and Construction Engineering, UCF
Hassan Foroosh, Department of Electrical Engineering and Computer Science
BooHyun Nam, Department of Civil, Environmental and Construction Engineering

Approved for distribution by Hae-Bum Yun, Committee Chair, on March 26, 2015.
The public is welcome to attend.