A Framework for Automated Bridge Inspections and Assessments with Visual Sensing Technology

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Abstract

The use of visual sensing technology and autonomous robotic platforms provides significant capabilities to inspect, document and assess bridges for both routine inspection and after significant natural or manmade events. To advance these capabilities, this study presents an end-to-end framework for automated conversion of raw visual sensor data into meaningful information that is directly related to bridges. Three categories of information are considered: 1) object information that includes object identity, shapes, and spatial relationships; 2) surface damage information that includes both small deformations (e.g., cracks) and large deformations (e.g., bent members, alignment issues); 3) as-built bridge models that include solid geometry models and volumetric finite element meshes. With a focus on steel girder bridges, robust algorithms have been developed and used to validate the proposed framework based on real-world data collected in situ.

Keywords: visual sensing technology; automated data processing; object detection; surface damage; as-built bridge models

1 Introduction

Recent advances in visual sensors have enabled an efficient, cost-effective, and non-intrusive way for creating digital documentations of the as-is conditions of structures, for both routine inspections and post-event evaluations. Such digital documentations have been widely exploited as a complement to human observations and measurements to enhance state-of-the-practice bridge inspection and management. In this practice, one of the most important processes is to post-process the data and to extract meaningful information that is directly related to bridges. To reduce or avoid manual operations in this process, which can be labor intensive and error prone, a variety of research studies have been put forward to develop automated post-processing strategies and algorithms, each focuses on one specialized data processing step towards bridge inspection and management.

A vast majority of the developed strategies are focused on processing visual sensor data for structural health monitoring and condition