



Image-driven Bridge Inspection Framework using Deep Learning and Image Registration

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Abstract

This paper proposes an image-driven bridge inspection framework using automated damage detection using deep learning technique and image registration. A state-of-the-art deep learning model, Cascade Mask R-CNN (Mask and Region-based Convolutional Neural Networks) is trained for detection of cracks, which is a representative damage type of bridges, from the images taken from a bridge. The model is trained with more than a thousand training images containing cracks as well as crack-like objects (hard negative samples). The images taken from a test bridge are input to a deep learning model trained to detect damages, which is further mapped on a large image of each bridge component registered using a commercial registration software. The performance of the proposed framework is evaluated on piers of existing bridges, whose external appearance was imaged using a DSLR with a telescopic lens. The results are compared with the conventional visual inspection to analyse the performance and applicability of the proposed framework.

Keywords: Bridge, Image-driven Inspection, Deep Learning, Mask R-CNN, Image registration.

1 Introduction

In South Korea, there are up to 270,000 structures that requires regular inspection annually. However, the budget and number of inspectors are decreasing gradually. Considering this social background, it is necessary to develop equipment and systems to efficiently manage the growing old structure. To develop an efficient and rapid structure inspection system, it is necessary to develop fast and automated inspection framework based on the images taken from the appearance of structures.

Many researches sought to replace visual inspection with CV-based inspection using remote imaging devices, such as drones and cameras. The CV-based inspection can be more reliable and objective, since it works on a designated computer algorithm. With a proper algorithm, the inspection

can be automated by a computer and the time and cost of inspection can be significantly reduced.

However, there are few examples that apply the CV-based inspection techniques to real structures that have diverse types of objects in the vicinity. Especially, separation of similar objects to the damages may be poorly performed, though the features are carefully crafted to distinguish damages from the objects. To overcome the limitations of human-crafted feature-based inspection methods, several damage detection methods have used deep learning techniques, which train a computer to automatically define features of damages from large number of images [1–2].

This study proposes a novel bridge inspection framework using images. The framework uses a deep learning model (Cascade Mask R-CNN) to detect multiple damages from images of bridge