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Optimization inspection method for concrete girder bridges using vision-based deep learning and images acquired by unmanned aerial vehicles

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Abstract

Traditional concrete girder bridge inspection and monitoring techniques are usually carried out by trained inspectors, which are time-consuming, dangerous and expensive. With the continuous development of unmanned aerial vehicle and computer vision techniques, the crack width identification of concrete girder bridge by unmanned aerial vehicles can meet the engineering precision requirements. Several image processing techniques have been implemented for detecting civil infrastructure defects to replace human-conducted on-site inspections. In this study partially, a deep learning algorithm based on a regional convolution neural network is applied, which combines deep learning techniques with image processing techniques to identify the surface crack of concrete girder bridges. The bridge detection images are captured by an unmanned aerial vehicle and transmitted to a computer. The sliding window algorithm is used to divide the bridge crack images into smaller bridge crack patches and bridge background patches. Based on the patches' analysis, the background patches and crack patches of concrete bridges are identified based on the ResNet convolution neural network. The detection process cracks identification of concrete girder bridge is executed in the computer through the proposed algorithm. The results show that the proposed method shows excellent performances and can indeed identify the shape of concrete cracks on the surface of concrete girder bridges.

Keywords: unmanned aerial vehicle; crack inspection; deep convolutional network; ResNet.

1 Introduction

The concrete bridges are always affected by the aging of materials and the deterioration of the environment. The carrying capacity of concrete bridges will also decrease when the traffic loads increase steadily. According to statistics, 40% of the 610,000 bridges built by the United States in the 19th century were aging [1]. In Japan, 40% of the bridges are expected to suffer severe aging or aging problems by 2030 [2]. In China, about 100,000 bridges have been dangerous. The main form of concrete bridge disease is concrete crack, which is essential to inspect. However, due to the concrete bridge structure's complexity, the inspection of cracks in concrete bridges has become a time-consuming and expensive task. In general, the inspection of concrete cracks needs bridge detection vehicles (Fig. 1) or temporary supports as platforms for manual operation of instruments. It takes a long time to set up supports that are impossible for bridges across

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