Detection Algorithm of Structural Surface Cracks Based on Class Activation Map

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Abstract

The computer vision algorithm based on deep learning has achieved excellent performance in structural surface damage detection, but the accurate detection algorithm has high requirements for the quantity and quality of data sets. This paper presents a method based on class activation map (CAM), which can detect the crack position and distribution only by image-level data labeling. Firstly, a classification model Vgg16-Crack is trained based on the transfer learning method, and the accuracy and generalization ability of the model are tested by the confusion matrix. Then, based on the CAM algorithm, this paper improves and optimizes the current Grad-CAM++ algorithm, and takes the CAM generated by Vgg16-Crack as the result of crack detection. Finally, the method proposed in this paper is tested in the field. The test result shows that the method proposed in this paper can realize the accurate detection of structural surface cracks.

Keywords: crack detection; computer vision; transfer learning; Convolutional Neural Networks (CNN); Class Activation Map(CAM)

1 Introduction

The identification and detection of structural surface damages, especially cracks, can provide reliable data support for the operation and maintenance of the structure. The traditional crack detection adopts manual detection, and the detection results are often subjective. Furthermore, the traditional detection method is often lack of universal standard, which leads to low accuracy. With the development of computer vision technology, the crack detection algorithm based on computer vision has the advantages of automation, high efficiency and no contact [1] to better solve the problems existing in the manual detection method [2]. Especially with the rapid development of deep learning technology in recent years, Convolutional Neural Network (CNN) model greatly improves the accuracy and efficiency of detection. At present, the detection algorithm based on CNN model has been used to detect the surface damages of buildings [3], bridges [4] and tunnels [5].

The functions of CNN models are mainly distributed into three types: image classification [6], object detection [7] and semantic segmentation [8]. The image classification model can judge the category of the input image, the object detection model can roughly judge the position of objects in the image, and the semantic segmentation model can detect the objects in the image pixel by pixel. In terms of accuracy, the semantic segmentation model is the most accurate, but it needs pixel-level labeled data as the training set, which requires a lot of manual work and has become an important factor restricting the application of CNN models in

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