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PROCEEDINGS

Damage Evaluation of Building Surface via Novel Deep Learning Framework

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ABSTRACT
Damage evaluation is an important index for the evaluation of buildings health. To provide a rapid crack evaluation in practical applications, a crack identification and damage evaluation via deep learning framework is proposed in this paper. We built a combined dataset from Kaggle and site photos. A pre-trained U-net model is used to perform the training of model. With updated weights, the identification of cracks could be performed on non-labelled photos.

KEYWORDS
convolutional neural network; crack detection; deep learning.

With the development of computers, automatic crack detection methods based on computer vision (CV) have emerged and received a lot of attention [1]. Machine learning method, such as support vector machine, random forests, and clustering algorithms, have been used to perform automatic crack detection. Although digital image processing and machine learning methods can achieve a rapid detection of surface damage, but they still face a lot of limitations in practical applications and are difficult to cope with complex environments and situations. Deep learning framework can provide more accurate feature with a wide range of applications in damage evaluation of buildings.

In this work, the framework U-net [2] was chosen to perform the damage identification progress. This deep learning framework is lighted weighted and fast in deployment which will be easily applied to practical applications.

A Kaggle dataset [3] (Structural Defects Network (SDNET) 2018) is selected as the training dataset together with 640 newly taken photos. The shooting device used in this paper is Canon 5D with a resolution of 3456×3456 and 6960×4640, shutter speed range of 1/4000-/125 s, focus range of about 88% long×100% wide area, exposure compensation adjusted in 1/2 or 1/3 steps between ±3 steps, auto bracketing, and ISO range of 100-2000. To ensure the consistent image quality of the new combined dataset, a pixel conversion is firstly introduced. The image containing cracks are converted to 256×256 pixels by bilinear interpolation. To improve the number of training images, data augmentation was performed on the training data set, by employing horizontal and vertical image flipping, median filtering processing, random contrast change, etc. Each crack pixel in the crack image is converted into a label with a highlighted region of interest, dividing two kinds of labels – Blue as regional cracks and Green as linear cracks (Fig. 1).

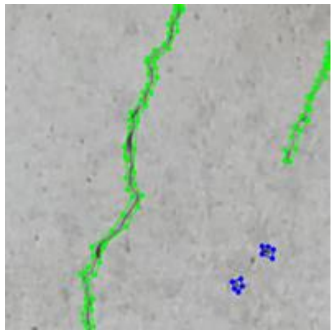

Figure 1: Input image with labelled cracks

The dataset is put into the pre-trained U-net classification model for training. The classification model is trained with the pre-trained weights of the backbone network of Xception. The model is not trained from 0, which prevents the weights from being too random and the classification effect is not obvious. Traditional model parameters (MIoU, Accuracy and F1 score) are used to evaluate the quality of the deep learning model.

The model is updated on the prediction dataset using the selected weight parameters, and it can be directly used as a crack detector for images acquired from real practical projects. The final output is a segmented image where cracks are highlighted on a black background (Fig. 2). Moreover, a connected domain analysis can be further applied to calculate the total area of cracks so as to evaluate the building state.

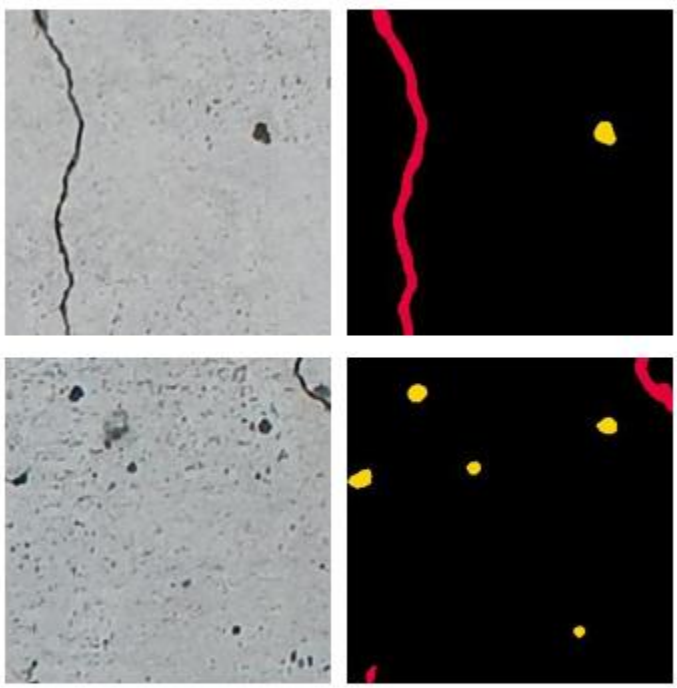

Figure 2: Segmented image of prediction results

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