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Optimal Framework for Multi-type Concrete Damage Inspection using Mask R-CNN

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ABSTRACT

In many developed countries with long history of urbanization, there is an increasing need for automated computer vision (CV) based inspection to replace conventional labor-intensive visual inspection. This paper proposes an optimal framework for automated detection of multiple concrete damage based on a state-of-the-art deep learning model, Mask R-CNN (Mask and Region-based Convolutional Neural Networks). To find the optimal framework, with different typical shapes, the annotation of damage in the training data, resolution and upsampling method of mask branch, and backbone networks are investigated in this study. The Mask R-CNN model is trained using 1419 concrete images including cracks, efflorescences, rebar exposures, and spallings. Firstly, three types of annotation styles (normal, separated, overlapped) were used to train the baseline Mask R-CNN model, and the overlapped annotation style resulted in best performance measured using AP (average precision) and IoU (intersection over union). Then, eighteen Mask R-CNN models were built using three sizes of mask branch (28 × 28, 56 × 56, and 112 × 112), two mask upsampling methods (deconvolutional layer and bilinear interpolation) and three types of backbone networks (ResNet-50, ResNet-101 and ResNeXt-101), and trained using images labelled by the overlapped annotation style. The test using 432 images shows that the overlapped annotation style can significantly improve the performance in detecting cracks, and the decent backbone network improves the performance in detecting multiple damages.

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