Concrete Crack Detection using CNN

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Abstract

Concrete Cracks are a common problem in our everyday lives, which may lead to serious complications if they go unnoticed and the damage becomes severe. It is better to detect surface cracks at an early stage so that maintenance and repairs can be done cheaper, using less resources and also sustaining the longevity of the concrete surface. This will also avoid potholes which may cause damage to cars, equipment and potentially cause harm to individuals. In larger areas, it may be difficult and often tedious to rely on humans to scan the whole area and detect surface cracks. This paper discusses a technique to detect cracks on concrete surfaces using deep learning and convolutional neural networks. Tensaflow and Keras libraries are used to train the models to classify whether an image of a concrete surface contains a crack or not. The resulting accuracy is 96.5 percent.

1 Introduction

Concrete cracks are a big problem and usually the main cause of injuries, hazards, fatalities, and damage of expensive equipment. Every year insurances, companies and individuals lose a lot of money due to undetected cracks on structures, surfaces, bridges, and domestic houses. Undetected cracks eventually grow and weaken the structure, which then becomes vulnerable during bad weather, natural disasters, heavy use. Detecting cracks on these surfaces may save lives, money, and ensure that safety of the people using them is guaranteed. The result of this may include more productive staff, less accidents on roads/bridges, and safer homes.

Traditional manual surface crack detection can be very tedious and time-consuming, thus automated are gradually replacing the old methods of surface crack detection. A few other benefits of automated systems is that they offer reliable, quicker analysis. Deep Learning and computer vision techniques have given engineers and data scientists a wider scope to investigate, thus coming up with different and more advanced techniques of detecting cracks. The traditional framework for crack detection consists of several gradient features for each image pixel, and then followed by a binary classifier that determines whether or not an image pixel contains a crack.[8] A new algorithm(GP Algotithm) is proposed in [1] for concrete surface crack detection algorithm based on the GP and percolation model in three steps. The first step the cracks are pre-extracted by the crack detection model of GP, which is used to train the best crack detection model. Multiple concrete surface images of different crack characteristics are selected as the training set to get this model[6]. Then the thin cracks are detected by the percolation algorithm based on the results of the previous test. Finally, the error detection area is removed by calculating the roundness and the length characteristics of the connected region in the detection results. [4] proposes to gray intensity adjustment method is to meliorate the accuracy of the crack detection results. A local binary patterns (LBP) based algorithm for crack detection is developed in [2]. A fully integrated system for crack detection and characterization is introduced in [3].

2 Methodology

The proposed method for crack detection consists of two stages: Image classification and segmentation. These images are first classified into negative and positive. Using Convolutional Neural Networks, all images that do not contain cracks are classified as negative and all images with cracks are classified as positive. Positive cracks are processed using adaptive threshold method. The cracks in the positive images can then be extracted.

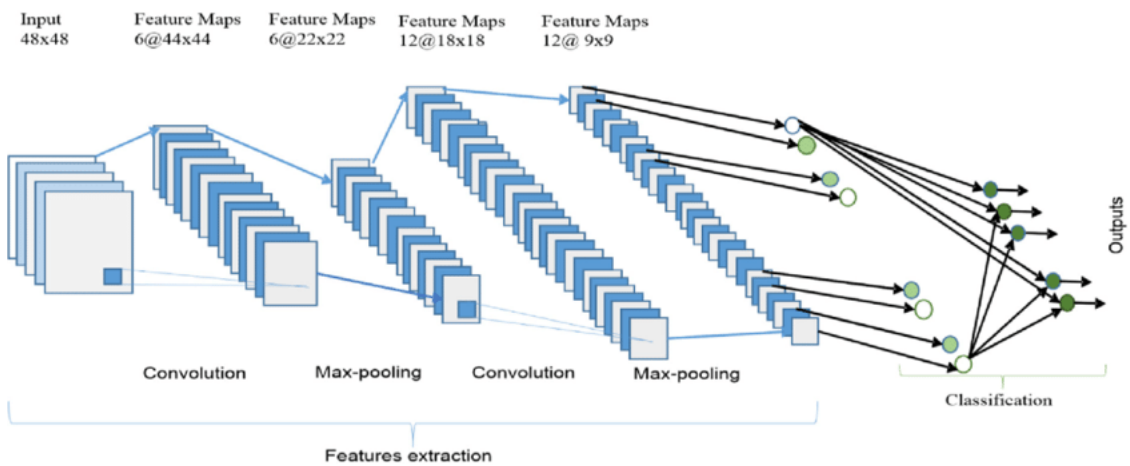

Figure 1: Typical structure of a neural network for classification

2.1 Image Classification

The structure of the proposed deep convolutional neural network is illustrated in Fig. 1. A Convolutional Neual Network is normally considered as a hierarchical feature extractor [6]. A convolutional layer performs a convolution operation on the image input and passes the extracted features to the next layer [9]. Batch normalization is then performed on the output of the convolutional layer, whereby the extracted features are normalized by adjusting and scaling the activations. Max pooling downsamples the input representations [6], whereas the softmax function translates a vector into a probability distribution. Finally, a fully connected layer computes the score of each class and infers the category of the input image.

2.2 Image Segmentation

Since the images have already been classified using our proposed deep neural network, only the positive images are considered for processing in this subsection. Before performing image segmentation, we first utilize a bilateral filter to smooth the input images. Bilateral filter outperforms other image filters in terms of edge preservation.[7]

3 Results

The dataset for training the proposed network was created by the researchers from Middle East Technical University. The dataset contains 50000 RGB images.The number of positive and negative images are 25000 per set. In our practical experiments, we randomly select 1500 positive images and 1500 negative images from the dataset, to train the neural network. The rest of the images are utilized to as validation and test images for the proposed method. The model has an accuarcy of 96.25

4 Conclusion

The proposed automatic concrete crack detection method based on deep convolutional neural networks in which the features are automatically learned from manually annotated image patches acquired from data sources of different image angles and resolutionsThe neural network classified the input images as either positive (crack present) or negative (crack absent). The positive images were then processed using a bilateral filter, which minimized the number of noisy pixels. After conducting the experiments, the Final Accuracy : 96.24999761581421 Final Loss : 0.19928126755735207.[5]

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