# Automatic Crack Detection Process using Deep Learning

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Abstract

The number of concrete buildings is steadily increasing even as construction materials have diversified due to the development of construction technologies. However, because of the material properties, cracks occur due to various causes over time, and these cracks adversely affect the safety and function of the building. Therefore, the inspection and management of cracks in concrete buildings is a significant part of the maintenance field of buildings. Currently, crack investigation work is carried out in the form of visual inspection using simple equipment, such as a crack scale. This inspection method has the disadvantage of ensuring accuracy and objectivity of measurement results. To solve these problems, this study proposes an automated process for detecting cracks using deep learning and image processing technology.

Keywords –
Concrete Crack, Detection, Deep Learning, Image Processing

## 1 Introduction

Most of the buildings on Earth have used concrete as a major building material since the invention of artificial cement. The number of concrete buildings is steadily increasing even as construction materials have diversified due to the development of construction technologies. However, because of the material properties, cracks occur due to various causes over time, and these cracks adversely affect the safety and function of the building. Therefore, the inspection and management of cracks in concrete buildings is a significant part of the maintenance field of buildings.

Currently, crack investigation work is carried out in the form of visual inspection using simple equipment, such as a crack scale. This approach requires a lot of expertise and cannot avoid errors from the researcher's experience and subjective judgments. To address these problems, the use of deep learning technology has emerged for more efficient and objective evaluation of facilities. Therefore, in this study, we propose an automated process for detecting cracks using deep learning for more efficient and objective development of facility defect diagnosis technology.

## 2 Literature review

Crack investigation work is carried out in the form of visual inspection using simple equipment, such as a crack scale. This inspection method has the disadvantage of ensuring accuracy and objectivity of measurement results. To solve this problem, various studies have been conducted since the early 2000s to apply image processing and deep learning technology to crack investigation.

Image processing is a method of performing some operations on an image to get an enhanced image or extract some useful information from it [7]. The process of detecting cracks using image processing is typically through processes such as pre-treatment, segmentation, feature extraction, and crack detection. Byun et al. (2005) and Lee et al. (2008) applied a morphology technique to this process to detect cracks. In addition, Kim et al. (2010) conducted a study to detect cracks by applying Fuzzy logic to the values of the R, G, and B channels to utilize the contrast of intensity of the images. However, these studies had limitations in that they could not classify the form of various cracks and are susceptible to noise as a method of producing results by modeling filters that eliminate noise in images.

To compensate for the limitations of these studies, recent studies on deep learning-based detection techniques have been conducted. Deep learning is a subfield of machine learning concerned with algorithms inspired by the structure and function of the brain, called artificial neural networks [3].

These deep learning algorithms can be classified into detailed algorithms, depending on the form of connectivity between nodes and the numerical model used, and are mainly used in the field of image recognition, called a convolutional neural network (CNN). A CNN is not only used for applying image

recognition but also in many research areas, such as object classification and image segmentation. A variety of studies have been conducted recently to apply a CNN to detect cracks (Young-jin Cha et al., 2017; Kim el al., 2017; Cho et al., 2018).

However, these studies were insufficient to extract the characteristic information of cracks or to derive whether they were accompanied by surface deterioration that was the basis for estimating the cause of the cracks. Therefore, we propose a process that can detect cracks, characteristic information, such as width, length, and shape, and surface deterioration, such as leakage, white coating, and rebar exposure, by using deep learning and image processing.

## 3 Crack detection process using deep learning

This study proposes a crack detection process using deep learning and image processing technology to detect cracks in concrete structures more objectively and efficiently. This process consists of three detailed processes, the crack detection phase, characteristic information extraction phase, and deterioration detection phase (Figure 1).

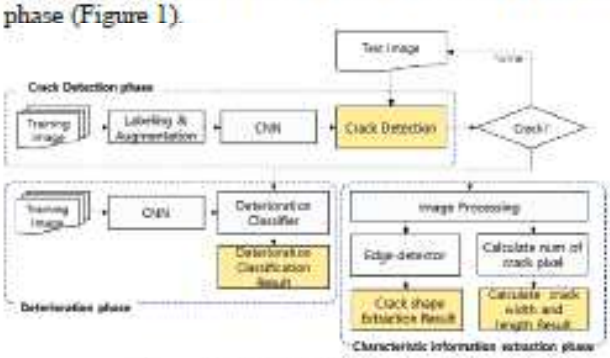


Figure 1. Crack detection process

- The crack detection phase is the first step in the entire process to check for cracks in the image. A crack image data set is required to perform this step. To produce this dataset, a large number of crack images must be collected and labeling and image augmentation performed. After completing the dataset, the CNN learning process is performed.
- The characteristic information extraction phase is a step to calculate the width and length of a crack and to extract the form of a crack. To perform this step, image processing techniques, such as edge detection and pixel calculation, can be used.
- The deterioration detection phase is a step to check if there has been surface deterioration, such as leakage, white coating, and rebar exposure, around a crack. At this stage, the CNN will be applied in the same way as in the crack detection phase.

## 4 Conclusion

This study proposed an automated process for crack detection using deep learning to develop objective and accurate crack inspection technology. The results of this study can be used as basic data for the development of the imaging-based facility defect diagnosis automation system and to develop facility state assessment technology.

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