Mahindra University Research Symposium 2k20

Concrete Crack Detection from Video Footage for Structural Health Monitoring

Sushmita kadarla[1], Beeram Sree Keerthe[2], Venkata Dilip Kumar Pasupuleti [3], Prafulla Kalapatapu [4]

Introduction:

- Cracks are considered one of the most elemental damage and prominently seen in all the concrete structures but with varying severity.
- Early detection of cracks is essential for taking preventive steps and protecting structural health.
- A considerable amount of research carried worldwide in the last two decades. Machine vision-based methods have successfully detected early cracks as a part of advanced structural health monitoring systems.
- This study is motivated to find solutions through images using AI for robust and faster detection of early cracks with an extension of finding crack propagation and its length.

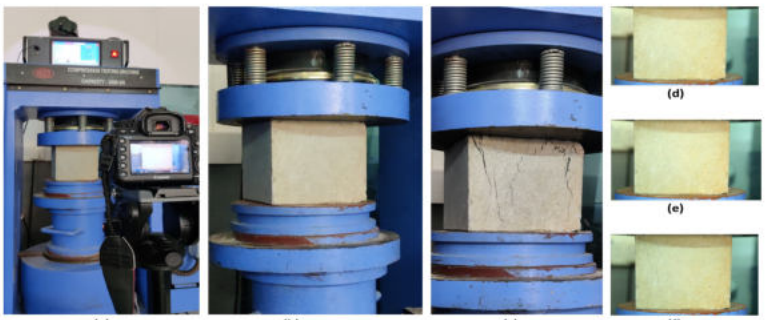

Figure 1. *Compressive strength testing of concrete cube in the laboratory (a) Test setup with recording (b) Application of load (c) Fully tested cube (d) Initial specimen (e) First crack appearance (f) Full crack formation*

Literature:

- Lee et al., has proposed a methodology based on a morphological technique that automatically detects and analyzes the cracks from the digital image and gives length, width, and orientation apart from pattern recognition.
- Cha and Choi [18] proposed deep learning-based crack detection using Convolutional Neural Network (CNN) and used a 256 x 256-pixel resolution classifier. It was a vision-based method using a CNNs for detecting cracks without calculating the defect features from the dataset of 40000 images.
- Mostly two folded crack detection areas have been an uprising, first neural networks for faster and robust crack detection, and second is digital image processing, which is best in quantifying the physical parameters of the crack.

Methods:

- Alex Net is a form of CNN that outperforms the rest of the architectures when used on a larger dataset and consists of eight layers: five convolutional layers and three fully-connected layers.
- The dataset is loaded into the model, and it automatically names the trained images based on their folder names (Crack and No Crack) and stores it as an Image Datastore object.
- Rgbgray function helps us remove the hue and eliminate the saturation information from the image while testing the dataset with retrained Fully Convolution Network (FCN) layers
- These grayscale images are converted to binary images, and then they are further skeletonized to find the crack length. All the pixels sum up and crack length is estimated.

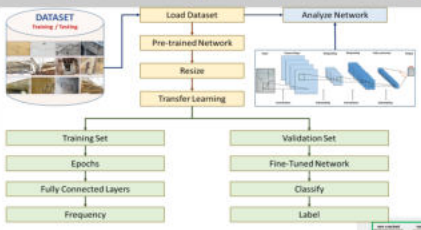

Figure 2. *Proposed architecture*

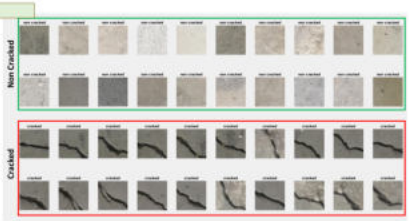

Figure 3. *Segregation of concrete crack and non-crack images*

Results:

- The proposed methodology has resulted in good accuracy for crack detection and the crack's physical characteristics.
- The Crack length is determined using the continuity function, which can trace single or multiple cracks on the crack surface. The increase in the crack's length compared between any two steps will give a clear picture of crack activity and propagation rate per each frame.

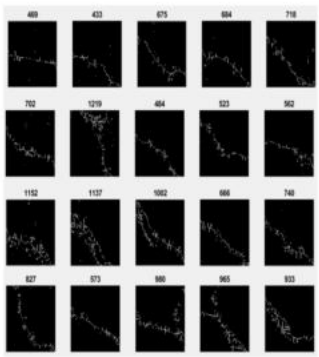

Figure 4. *Calculated length of the cracks in terms of pixels*

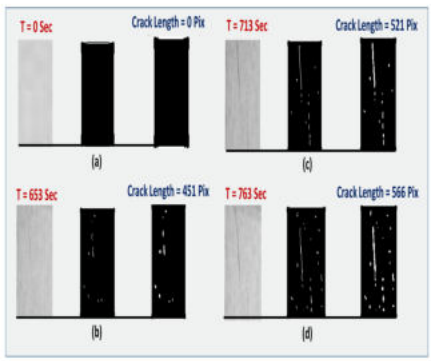

Figure 5. *Four sets of images were processed to find the length of the crack at different time steps*

Conclusions:

- By this fully connected network segmentation method, the cracks could be identified accurately.
- Further, this research work is being carried on the videos obtained from the surveillance cameras; even though there is a challenge in the orientation of camera and light on the concrete surfaces, more specific training and methods are being developed.
- If this can be implemented, all the critical structures that are being monitored, need no extra-special devices for structural health monitoring.

Important References:

- **Cha, Y. J., Choi, W., & Büyüköztürk, O.:** Deep learning-based crack damage detection using convolutional neural networks. Computer-Aided Civil and Infrastructure Engineering, 32(5), 361-378 (2017).
- **Lee, B. Y., Kim, Y. Y., Yi, S. T., & Kim, J. K.:** Automated image processing technique for detecting and analyzing concrete surface cracks. Structure and Infrastructure Engineering, 9(6), 567-577 (2013).
- **Mohan, A., & Poobal, S.:** Crack detection using image processing: A critical review and analysis. Alexandria Engineering Journal, 57(2), 787-798 (2018).

sushmita170107@mechyd.ac.in
sreekeerthe170102@mechyd.ac.in
venkata.pasupuleti@mahindrauniversity.edu.in
prafulla.kalapatapu@mahindrauniversity.edu.in

Internship/research carried at organization (Mahindra University)