IJIRCCE

e-ISSN: 2320-9801 | p-ISSN: 2320-9798

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

Volume 11, Issue 4, April 2023

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.379

9940 572 462 | 6381 907 438 | ijircce@gmail.com | www.ijircce.com

International Journal of Innovative Research in Computer and Communication Engineering

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104112 |

Image-Based Concrete Crack Detection Using Convolutional Neural Network and Computer Vision

Prof. Sachin C. Rathod, Harshal Dabhade[1] , Smit Patil[2] , Ketaki Satav[3] ,Shruti Sawant [4]

Department of Information Technology, Sinhgad College of Engineering Pune, India

ABSTRACT: Crack is the main indication of security in the infrastructure. Cracks are found in all aspects of the framework because everything which gets regularly utilized gets disintegrates because of ecological conditions like sun, climate, violent winds, tidal waves, quakes, and the human-conditions like the consistent utilization of things, abuse of things, low quality of material and so forth. A split is the partition of a partner in the material into at least two sections under the activity of stress. On the off chance that these splits are found on the streets, at that point it could be extremely hazardous for people given that the arrangement of the streets assumes a vital part in the development of the nation. To maintain and preserve the quality of the road first find the cracks and start the maintenance of the road. Manual inspection of the crack requires an expert, but it also has drawbacks like the invisibility of cracks, time-consuming, and expensive. Due to technological advancements, image processing can automatically detect cracks.

The damage to the road surface reduces its service life. To improve the road maintenance and management efficiency, the detection and recognition of pavement are studied based on images in this study. We collect a large number of road surface images of two different conditions including cracks and no cracks separately to construct road surface conditions. The ResNet50 model was trained and tested on collected data.
The accuracy of the result was found to be 0.98 on hold-out data.

I. INTRODUCTION

The damage to the road due to different conditions such as climate, earthquake, sun, or poor quality of the material used in the process reduces the service life. To maintain roads for smooth traffic flow, pavements should be monitored and fixed. In this project, we detect the pavements based on the images provided by the system. We took large number of images of both having cracks and having no cracks at all. These images are used to picture the condition of the road surface.
Traditional road crack detection methods are highly dependent on manual efforts and are thus very much time-consuming. These methods are as well prone to human errors. On the other hand, automatic crack detection is time, and cost-saving, and most importantly, it has very high accuracy. The main objective of this project is to deliver a system that will detect a crack on the surface using convolutional neural networks. With this, engineers and supervisors will be able to identify crack in the road in less time and with less human effort.

II. LITERATURE REVIEW

1.1 Road Crack Detection using a Single Stage Detector Based Deep Neural Network.

(Thomas Arthur Carr, Mark David Jenkins, Maria Insa Iglesias, Tom Buggy* & Gordon Morison)
Publish Date: 2018
The Conditions of the road is very much essential for the smooth flow of traffic. This paper proposes using Residual Neural Network to detect the pavements on the road surface automatically. The system uses ResNet as an underlying feed-forward architecture. The feature pyramid then provides two outputs, first sub-network associates a class with the output from the feature pyramid, while the second sub-network regresses the offset from each of the output bounding boxes of the feature pyramid to the corresponding ground truth boxes during training. This network has been-trained on real-world data from the pre-existing dataset. The data used in the model to train and test the system is limited due to the lack of availability of such datasets in the public domain. Although having the constraint of limited-data, the system can generate accurate results with very few errors by using a single-stage detector.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104112 |

1.2 Automated Road Crack Detection Using Deep Convolutional Neural.
(Vishal Mandal, Lan Uong, Yaw Adu-Gyamfi)
Publish Date: 2018
Maintaining the proper conditions of the roads is essential for safe driving and transportation. Many researchers have proposed various methods for automatic crack detection using deep learning algorithms. Effective crack identification is as important as the timely detection of cracks to maintain the quality of the road and protect it from mass destruction. This paper presents the use of the YOLO v2 deep learning framework to automatically detect the cracks on the road surface with very great accuracy. This system has trained over 7,240 images captured from mobile cameras and tested on 1,813 images of the road. The main objective of this system is to detect any crack automatically. The classification accuracy of the given distress analyzer is measured using the average F1 score taken out from the precision and recall values.

1.3 Road Crack Detection Using Deep Neural Network With Receptive Field Block.
(Jing Yang, Qin Fu, Mingxin Nie)
Publish Date: 2019
This being the subject of emerging computing technology, automatic crack detection can be treated as a vital aspect of digital image processing. This paper presents the core technologies and key-algorithms that can be used to define the characteristics of the crack image and the environment to detect such cracks. This paper focuses on studying the algorithms having to pre-process the images having cracks. The image pre-processing is carried out by two methods namely, Graying arithmetic, Image denoising, and Image enhancement. This paper also provides a study of ubiquitous crack detection methods.

1.4 Road Crack Detection Using Convolutional Neural Network
(Sharmad Bhat, Saish Naik)
Publish Date: 2021
This paper eyes on studying and comparing different methods and technologies used in crack detection based on digital image processing technology. The glass crack detection algorithm is open to many opportunities and challenges with the vast need for glass surface and quality. The system uses Visual Basic 6.0 programming language to achieve the crack detection system by using pre-processing, image segmentation, and feature extraction on the glass crack image. About the images of the glass, there can be possibly a lot of interference in the test, as the non-uniformity of light makes the image grey making it more concentrated. So it is given to use image smoothing filtering that can reduce the noise of the image. The system also uses neighborhood average methods to use several adjacent pixel-grey values of the average.

II. METHODOLOGY

A. Objective :

The objective of our method is to detect any crack from given images.
Toattain our goal, we used the ResNet-50 model.

B. System Overview

Dataset
The system has a primary and a secondary data source. The set of data on various roads will require studies and surveys to be conducted in different areas and over a significant time. Since this is time-consuming, we used a secondary data source to train our model.

System Architecture
The proposed work plots a machine-learning model for detecting cracks on roads and buildings. The following figure gives the pictorial presentation of the machine learning model and how the process passes from one phase to another.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104112 |

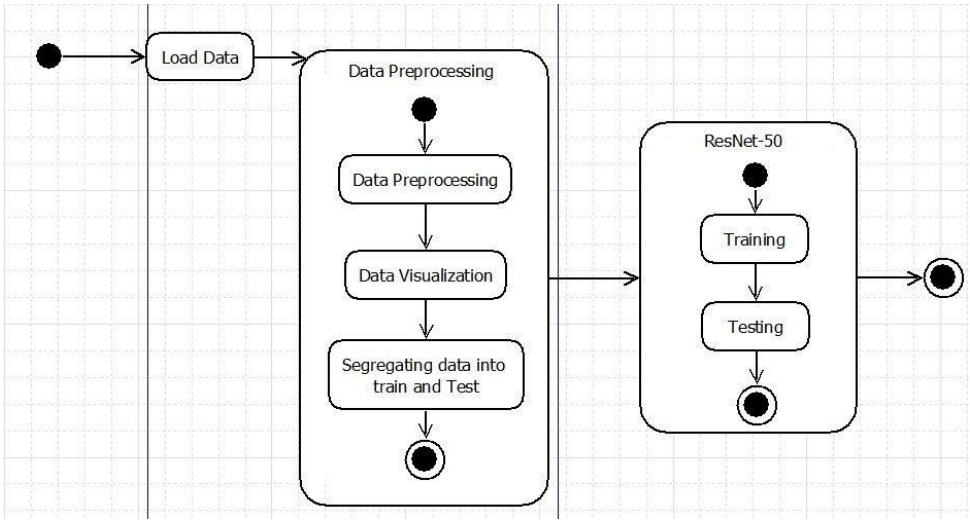

Fig. 3.1: System Architecture

The system developed utilizes an underlying feed-forward ResNet architecture. The system takes the input image of size 227 x 227 x 3 and passes it to the ResNet-50 model and the output is the image with the detection of cracks in the image. ResNet-50 model with the architecture shown below:

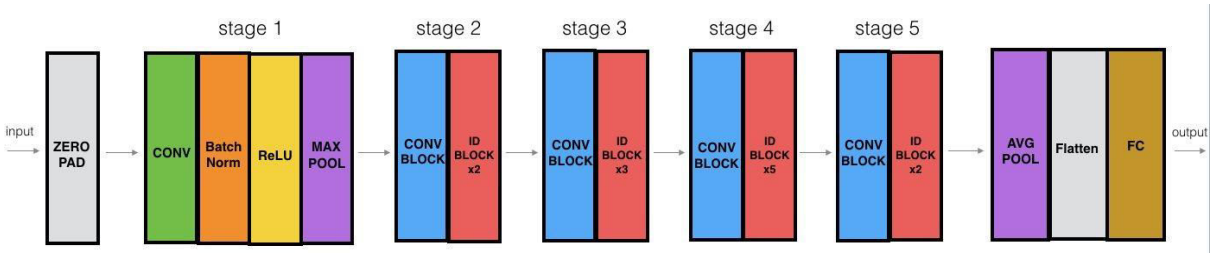

Fig. 3.2: ResNet-50 Architecture

The ResNet-50 model consists of five stages. Each stage has a convolutional and identity block. Convolution blocks consist of 3 convolution layers and also Identity blocks consist of 3 convolution layers.

To speed up training and improve the performance of ResNet-50, transfer learning was used. Transfer learning has been widely applied in deep learning and computer vision applications. We used pertained ResNet-50 model and froze all the model parameters and only changed the output layer so that it would detect cracks from our image. As an optimizer, we use Adam Optimizer. Adam optimization is one of the most effective optimization algorithms for training neural networks. It combines ideas from RMSProp and Momentum. And for the loss function, we use the cross-entropy loss function. Cross-entropy loss calculates the performance of a binary classification model.

III. IMPLEMENTATION

Data Description:

The dataset consists of 32,226 images out of which 16,174 are positive images meansimages that havecracks and16,025 are negative meansimages that don'thave
cracks. As we haveless number ofimages we performdata augmentation techniques toincrease the dataset. In data augmentation, we crop the images, rotate the images, and make someimages blur.
Here are some samplesof augmented images:

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104112 |

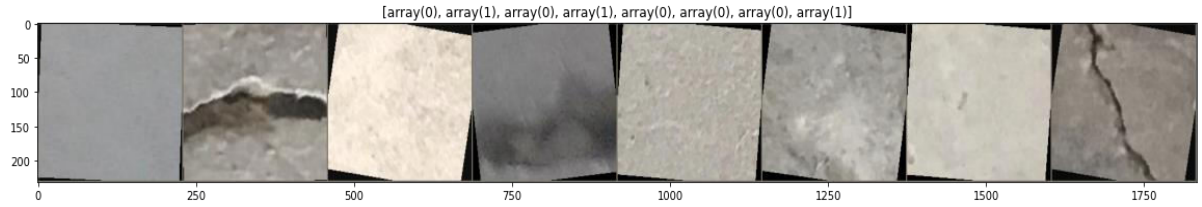

Fig. 4.1: Augmented Data

- Adam Optimizer :

Adamisoneofthemosteffectiveoptimizationalgorithmsfortraining neural networks. Itcombines ideas from RMSPropand Momentum.

RMSProp:
RMSProp is a very clever way to deal with the problem. It uses a movingaverage of squared gradients to normalize the gradient itself[6][7]. That has theeffect of balancing the step size decreasing the step for the large gradient to avoidexploding and increasing the step for the smallgradient to avoid vanishing.

Momentum :
Momentum takes into account the past gradients to smooth out the update.We will store the 'direction' of the previous gradients in the variable v. Formally,this will bethe exponentially weightedaverage of thegradient on previoussteps.

- Cross Entropy LossFunction :

Cross-entropyloss,orlogloss,measurestheperformanceofaclassificationmodelwhoseoutputisaprobabilityvaluebetween0and1.Cross-entropy loss increases as the predicted probability diverge from the actuallabel.

- Transfer Learning(Fine Tuning):

Transferlearning(TL)isaresearch problem in machine learning(ML)thatfocusesonstoringknowledgegainedwhilesolvingoneproblemand applying it to a different but related problem. In this project, we have used a pre-trainedResNet-50 model because we have less training data. We freeze all themodel parameters and change the final layer so that it can detect cracks on theroad.

V. RESULTS

We evaluated the performance of our proposed model on a set of over 40,000 roadimages with cracks and non-crack images mixed. We divided the data into trains andvalidated parts. The training was done on 32,226 images.We trained our model on Six epochs.The accuracy remained almost the same even after increasing the number of epochs to trainour model. The accuracy obtained after the completion of the training is 98.04%. Whichmeans 98% of the cracks in the given image were detected. Compared to other models likeConvNet, the accuracy of the ResNet-50 model was better.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104112 |

The following image shows the input and output image produced by the modelfor a given imageof a cracked surface.The red-colored partor positive part inthe outputimage shows that the crack is present on a given surface.

VI. CONCLUSION

Input Image:

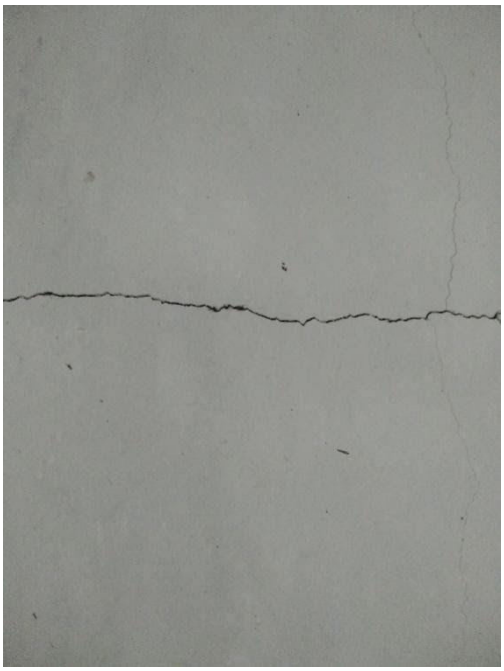

Fig.5.1:Input Image

Output Image:

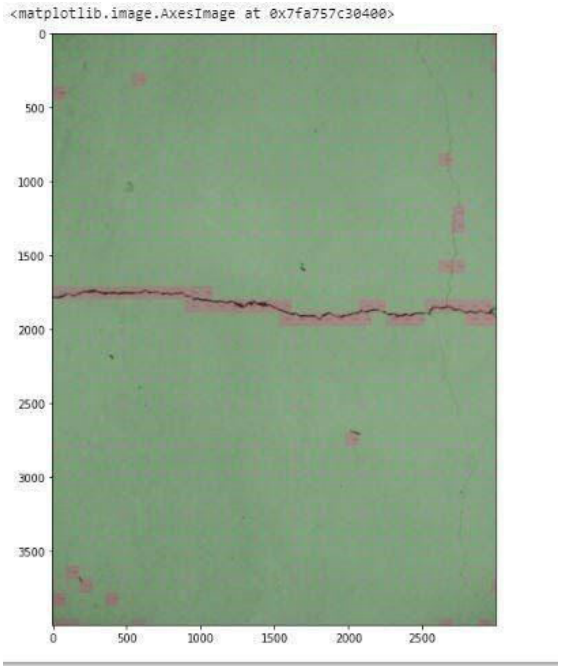

Fig.5.2: Output Image

The rapid advancement in the tract of machine learning and high-performancecomputinghashighlyaugmentedtherangeofautomaticpredictionsystems.Weproposedanautomaticdetectionmethodbasedondeep convolutional neural networks in which the features are automatically learned frommanually annotated images provided as input. In the future, we will optimize theproposed detection method and build an integrated low-cost system for real-timeroad crack detection.

| e-ISSN: 2320-9801, p-ISSN: 2320-9798| www.ijircce.com | |Impact Factor: 8.379 |

|| Volume 11, Issue 4, April 2023 ||

| DOI: 10.15680/IJIRCCE.2023.1104112 |

ACKNOWLEDGMENT

The Authors are extremely Thankful to Prof. S. C.Rathod Sir, Sinhgad College Of Engineering, for his continued support throughout the implementation of the system.

REFERENCES

1. Road Crack Detection Using Single Stage Detector Based Deep Neural Network, Thomas Arthur Carr, Mark David Jenkins, Maria Insa Iglesias, Tom Buggy* & Gordon Morison
2. A Study of Crack Detection Algorithm, Jingyi Li, Ning Wang, Ying Liu, Yuemei Yang
3. Automated Road Crack Detection Using Deep Convolutional Neural Networks, Vishal Mandal, Lan Uong, Yaw Adu-Gyamfi.
4. The Design of a Glass Crack Detection System Based on Image-Preprocessing
5. Technology, Zhang Yiyang
6. https://towardsdatascience.com/detection-of-surface-cracks-in-concrete-structures-u sing-deep-learning-f8f85cd8ac8b
7. https://dr.ntu.edu.sg/bitstream/10356/104468/3/thesis_LIU%20Lili.pdf
8. https://www.hindawi.com/journals/jat/2020/6412562/#experiments-and-analysis

INNO SPACE
SJIF Scientific Journal Impact Factor

Impact Factor: 8.379

doi cross ref

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN COMPUTER & COMMUNICATION ENGINEERING

9940 572 462 6381 907 438 ijircce@gmail.com

www.ijircce.com

Scan to save the contact details