Surface Crack Detection

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***Abstract*— Surface damage is the main factor affecting road performance. Pavement cracking, a common type of road damage, is a key challenge in road maintenance. The crack segmentation network is applied to accurately segment the pavement cracks. By improving the feature extraction structure and optimizing the hyperparameters of the model, pavement crack classification and segmentation accuracy were improved.**

Automated crack detection and segmentation using deep learning are more efficient and accurate. A crack identification method based on a deep CNN fusion model.

Keywords—CNN, surface crack detection, models

INTRODUCTION

Cracks are of central issue for guaranteeing the security, sturdiness, and functionality of constructions. The explanation is that when brakes are created and spread, they will quite often cause the decrease in the successful stacking region which achves the expansion of stress and therefore disappointment of the substantial or different constructions . Since there consistently exist requirements in supported substantial designs and structures decay additional time, breaking appears to be unavoidable and shows up in a wide range of constructions, for instance, substantial divider, pillar, section, and block facadesie . Especially for substantial components, breaks make admittance to unsafe and destructive synthetics to infiltrate into the construction, which thus harm their uprightness just as feel.

Appropriately, quick and solid surface break identification and investigation through programmed systems is profoundly helpful to supplant the lethargic and abstract assessment of human monitors . Ongoing surveys done in brought up an expanding pattern of applying picture handling methods for supporting the efficiency of identifying break in structures. These works show that evaluating the visual state of vertical and flat underlying components become a crucial piece of structural designing. The data of break can be utilized for finding and to choose the fitting recovery strategy to fix the harmed structures and forestall horrendous disappointments.

A PROBLEM STATEMENT

Virtually, for all types of structures, surface cracks are critical indicators of structural damage and durability.Thus, as clearly stated by Thatoi et al. and Koch et al., it is crucial to visually inspect the building elements to detect cracking and appraise the physical and functional conditions. However, the task of crack detection in buildings, especially in developing countries, is often carried out manually. Hence, more time and effort is needed to obtain the measurements of cracks and to compile or process relevant data . In addition, manual visual inspection is inefficient in terms of both cost and accuracy because it involves the subjective judgments of inspectors.

Accordingly, fast and reliable surface crack detection and analysis by means of automatic procedure is highly useful to replace the slow and subjective inspection of human inspectors Recent reviews done in pointed out an increasing trend of applying image processing technique for boosting the productivity of detecting crack in structures. These works show that assessing the visual condition of vertical and horizontal structural elements become a vital part of civil engineering. The information of crack can be used for diagnosis and to decide the appropriate rehabilitation method to fix the damaged structures and prevent catastrophic failures.

LITERATURE SURVEY

[1] **Machine learning model for predicting the crack detection and pattern recognition of geopolymer concrete beams by Aravind.N , Nagajothi.S and Elavenil.S**

This paper depicts that one of the biggest challenges in the construction industry is the presence of cracks in concrete structures and the identification of the types of failures in these structures that lead to their damage. Manual quality testing is prone to human error, and requires a long time to respond with specialized knowledge and knowledge. Therefore, visualizing cracks and identifying failures in concrete structures using computer techniques has now become the preferred option. The current work focuses on identifying cracks using image processing and methods of recognizing failure patterns using appropriate machine learning algorithms, as well as validating strategies using the Python system

[2] Detection of Surface Crack in Building Structures Using Image Processing Technique with an Improved Otsu Method for Image Thresholding by Nhat-Duc Hoang (2018)

This study developed a model for image processing to detect crack errors on the surface of building structures. Since digital images taken from crack analysis incorporate a variety of complexity (e.g., low contrast, uneven light, and noise contamination) in the image analysis process, the discovery of cracks based on the normal Otsu method cannot produce satisfactory results. The new model uses an image-enhancing algorithm called Min-Max Gray Level Discrimination (M2GLD) to improve the Otsu method. The newly developed model is able to identify fragments and analyze their characteristics including location, cycle, width, length, and shape. Test results ensure that cracked test images are accurately identified. M2GLD could really improve the performance of the Otsu method**.**

[3] Automated pavement crack detection and segmentation based on two-step convolutional neural network by Jingwei Liu,Xu Yang,Stephen Lau,Xin Wang,Sang Luo,Vincent Cheng-Siong Lee and Ling Ding (2020)

They suggest that Cracking may be a common road stress that may cause major issues if not repaired in time, which suggests that it's vital to accurately take away pavement cracking info with detection and separation. Automatic detection of road cracks and cacophonous exploitation in-depth reading works far better and a lot more accurately than standard ways, which may be more improved. Although several of the present studies have used in-depth study to tell apart cracks in made-up roads, separating cracks in non-cracks, few studies have thought-about the invention of cracks within the road, characteristic cracks in pictures from alternative materials. The invention of a ballroom dance pavement fragmentation and a way of segregation supported the convolutional neural network was projected during this paper. The machine-driven crack detection formula was developed to exploit the third changed version of Look on just one occasion within the opening.

[4] Deep learning with Python for crack detection: using Artificial Intelligence to bring the inspection of structures to the 21st century! by Dimitrios Dais (2001)

Although new technologies have changed almost every aspect of our lives, the construction industry seems to be struggling. Currently, the condition of the building is being monitored manually. In simple terms, even today when the building needs to be inspected for damage, the engineer will personally inspect the entire surface and take large quantities of photographs while keeping notes of any cracks. Then it takes a few more hours in the office to sort out all the photos and notes trying to make a meaningful report about it. Obviously this is a tedious, expensive, and independent process. In addition, concerns about safety arise as there are parts of buildings that have limited access and are difficult to access.

PROPOSED WORK- ALGORITHM

In this paper, we have implemented crack detection using different DL models. Firstly we loaded the dataset and checked if the surface was cracked or not. Using libraries like keras,

1. Load the dataset
2. Train the dataset.
3. We developed the model using keras.
4. optimizer="adam", loss = 'binary_crossentropy', metrics = ['accuracy']) -We fitted the model.
5. Epoch is part of keras preprocessing library and it is a step by step process to increase accuracy.
6. Prepare the classification report to show final accuracy.(precision, recall, f1 score and support.
7. In the alternative code, we tried to test 2 to 4 images and checked if it was cracked or not.

We even explored LeNet model and checked for the accuracy.

EXPERIMENTAL SETUP-DATASET

We have taken the dataset from Kaggle. It consists of 20000 crack positive and crack negative images.

SOFTWARE-HARDWARE NEEDED

A. SOFTWARE

Python, Jupyter Notebook.

B. HARDWARE

Memory and disk space required per user: 1GB RAM + 1GB of disk + .5 CPU core. Server overhead: 2-4GB or 10% system overhead (whatever is larger), .5 CPU cores, 10GB disk space. Port requirements: Port 8000 plus 5 unique, random ports per notebook.

ML/DL MODEL

CNN: A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other.

LeNet: LeNet is a simple convolutional neural network. Convolutional neural networks are a kind of feed-forward neural network whose artificial neurons can respond to a part of the surrounding cells in the coverage range and perform well in large-scale image processing.

SUMMARY

a) RESULTS OBTAINED-FIGURE AND TABLE

CNN model

Figure 1: Accuracy of the model

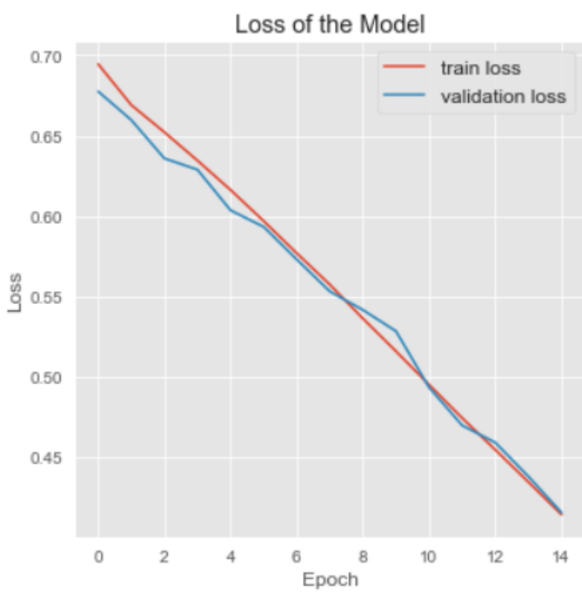
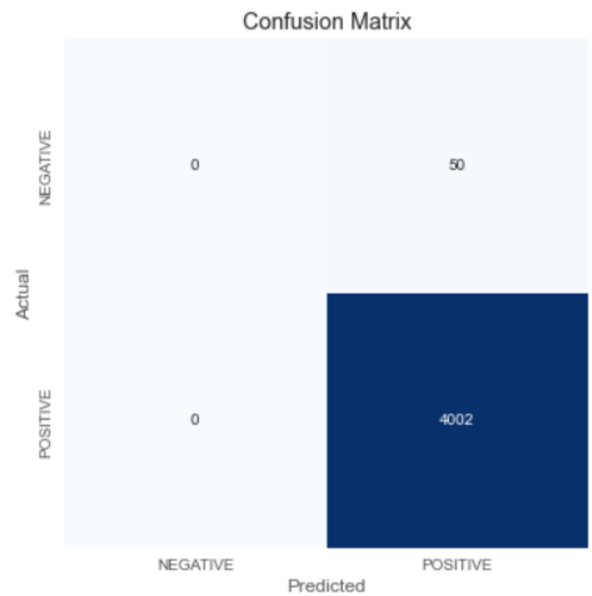


Figure 2: Loss of the model

Crack detection using CNN

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 128, 128, 3)]     0

 conv2d_3 (Conv2D)           (None, 126, 126, 16)      448

 max_pooling2d_3 (MaxPooling  (None, 63, 63, 16)       0
 2D)

 conv2d_4 (Conv2D)           (None, 61, 61, 32)        4640

 max_pooling2d_4 (MaxPooling  (None, 30, 30, 32)       0
 2D)

 global_average_pooling2d (G  (None, 32)               0
 lobalAveragePooling2D)

 dense_2 (Dense)             (None, 1)                 33

=================================================================
Total params: 5,121
Trainable params: 5,121
Non-trainable params: 0
_________________________________________________________________
test loss: 0.07402
test acc: 98.77
```




```
Classification Report:
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              precision    recall  f1-score   support

    NEGATIVE       0.00      0.00      0.00        50
    POSITIVE       0.99      1.00      0.99      4002
```

Figure 3: Depicts the precision, recall, f1-score and support of the above model.

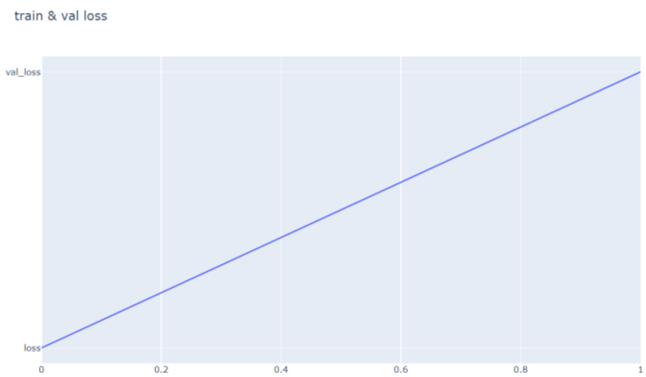


Figure 4: Train and value loss

<u>Lenet Model</u>

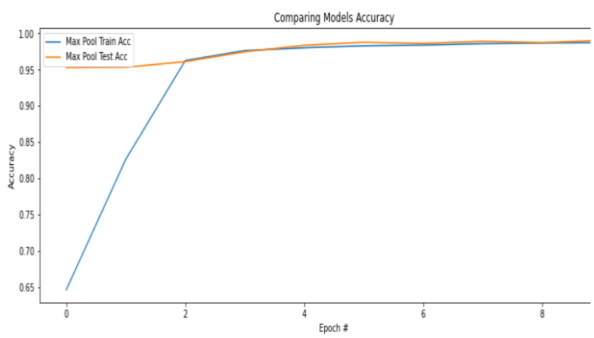


Figure 5: Shows graph of Max Pool Training Accuracy and Max Pool Test Accuracy with increasing no of epochs.

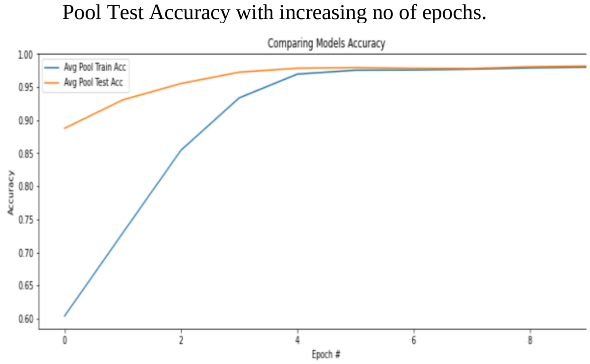


Figure 6: Shows graph of Average Pool Training Accuracy and Average Pool Test Accuracy with increasing no of epochs.

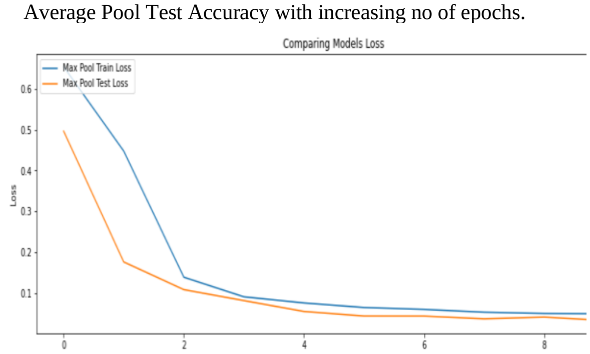


Figure 7: Shows graph of Max Pool Training Loss and Max Pool Test Loss with increasing no of epochs.

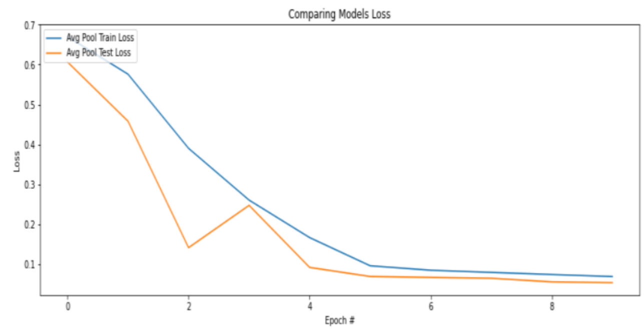
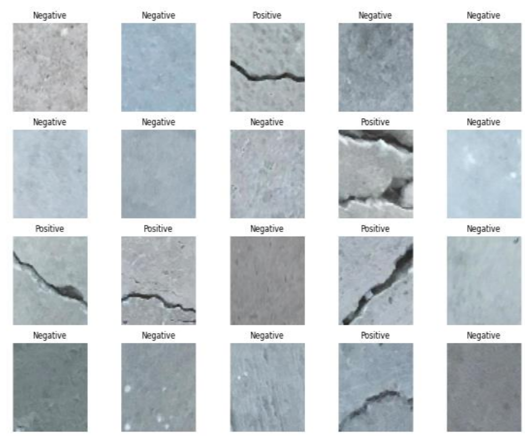


Figure 8: Shows graph of Average Pool Training Loss and Average Pool Test Loss with increasing no of epochs.



DLL Models

<--------------0 image----------------->

cracked

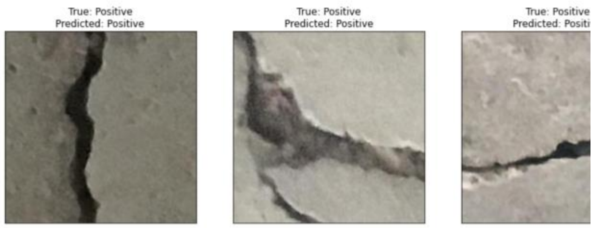


Figure 9: shows the cracked and non cracked images.

b) CONCLUSION

In this project, we have explored different ways for crack detection. We have done LeNet and CNN models and calculated the accuracy of different models. We also found precision recall, f1-score and support.

c) REFERENCES

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