AI Car With Real-Time Detection of Damage Road And Lane Detection

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Abstract- *The present article proposes the deep learning concept termed ―Faster-Region Convolutional Neural Network‖ (Faster-RCNN) technique to detect cracks on road for autonomous cars. Feature extraction, preprocessing, and classification techniques have been used in this study. Several types of image datasets, such as camera images, faster-RCNN laser images, and real-time images, have been considered. With the help of GPU (graphics processing unit), the input image is processed. Thus, the density of the road is measured and information regarding the classification of road cracks is acquired. This model aims to determine road crack precisely as compared to the existing techniques.*

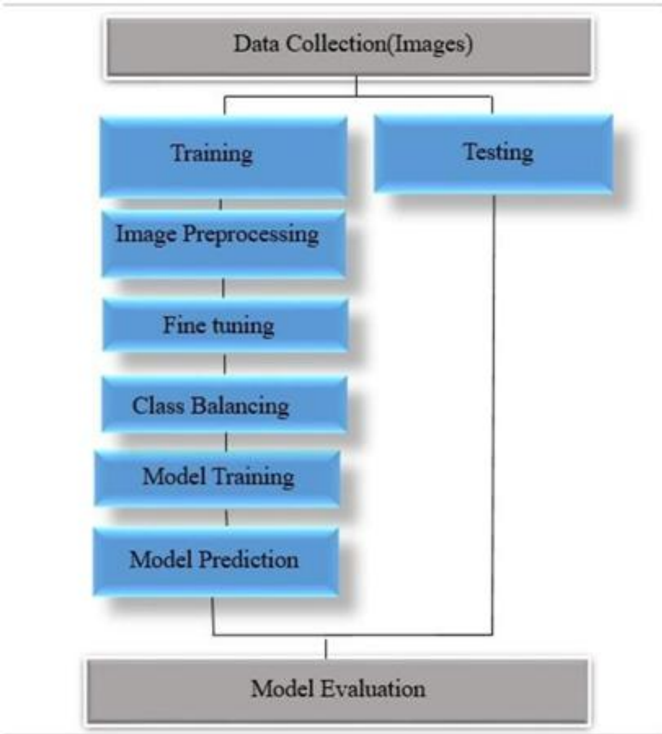
Keywords- Deep Learning, Faster-RCNN, GPU, Autonomous Driving, Feature Extraction

I. INTRODUCTION

Nowadays, to ensure diving safety, the road crack detection technique has become very much popular in transportation industry. It occurs due to heavy rainfall, transportation, weather changes, cyclones, weightage vehicles, etc. For detecting road cracks, a deep-learning-based approach is basically introduced, which uses computer vision to identify each image from the collected data set and this paper is equipped with a Faster region convolution neural network. A data set is signified by a quantitative assessment in an increasingly globalized world. Road cracks are a significant problem for autonomous driving. With the help of Faster-RCNN, images can be classified, and road cracks can be detected. According to some Sino, it is necessary to develop a road crack detection system due to the increase in the number of accidents in our country. Realistically speaking, transportation is the main reason for road cracking. It causes traffic jams, noise and air pollution, unwanted fuel waste, and wastage of time. Hence, if a country has a well road transportation system, it is beneficial for its economy. Many studies have been conducted based on Faster-RCNN for road crack detection, which are discussed in this paper. The purpose of this paper is to develop a highly sophisticated road crack detection system in the context of Faster-RCNN. In the modern industrialized world, the number of heavy vehicles is augmenting, which is reason behind the road cracks. In Indian cities, such as Hyderabad and Mumbai, as the demands for the optimization and efficient operation of social systems are rising, many awareness programs have been conducted for efficient and safe driving. This includes more sophisticated transportation systems, fewer accidents, and reduced fuel consumption with the help of modern technology in the transportation field. The road crack detection system can reduce road accidents due to road cracks. Consequently, transportation will become easier. This research aims to propose a more advanced technique that can detect damage on the road efficiently. However, this approach has several drawbacks including high costs and the fact that this machine is required for all geographical areas.

Therefore, it is an optional solution for reducing road crack issues. This methodology reliably identifies any crack on highways with the aid of an algorithm for road division, pre-processing, and feature extraction techniques used to create up-and-comers.

The primary goal of this thesis is to analyse road crack detection methods, which include image processing with a GPU and a camera. In the proposed work, input images are extracted from acollection of standard and road crack images. Afterward, it is decided whether there is a road crack or not based on the prediction and learning rate. The images are converted from RGB (red-green- blue) to grey-scale, which allows the system to process digital data. This technique is very versatile, accurate, and cost-effective. This paper presents a pre-processing image technique for road crack detection focusing on the faster-region convolution neural network method. Figure 1 shows the flow of the considered road crack detection model. At first, the standard and road crack detection images are collected. The pre-processing of those images is conducted afterwards for removing the irrelevant data. Thus, all the images will be of enhanced quality and same size. after training the model, image classification is carried out to determine whether there is a crack or not and the result will provide better accuracy. Then the conclusion with a brief analysis of future directions is illustrated.



II. BACKGROUND STUDY

In the industrialized world, In Indian cities like Hyderabad, Mumbai, and elsewhere, progress is being made toward demands for the optimization and efficient operation of social systems. Many awareness programs have been conducted for efficient and safe driving. These are more sophisticated transportation systems, fewer accidents, and reduced fuel consumption with the help of modern technology in the transportation field. The road crack detection system can reduce road accidents, making transportation easier. This research aims to propose a more advanced technique that can detect damage on the road efficiently. However, this approach has several drawbacks, including high costs and the fact that this machine is needed for all geographical areas, including the nation's states and other countries and cities. It is an optional solution for reducing road crack issues. This methodology reliably identifies any of the cracks on highways by using an algorithm for road division, pre-processing, and feature extraction techniques used to create up-and-comers that are highly referred to as road cracks, and the primary goal of this thesis is to study road crack detection methods that include image processing with a GPU and a camera. It will use typical and road crack images taken by the camera, with a laser camera as the input dataset. In the proposed work, we extract input images from a collection of standard and road crack images, and we decide whether there is a road crack or not based on prediction and learning rate; the images are converted from RGB (red-green-blue) to grey-scale, which allows the system to process digital data. It is very versatile, accurate, and cost-effective. This paper presents a pre-processing image technique for road crack detection, focusing on the faster-region convolution neural network method. Figure 1 shows the flow of the road crack detection model. Then conclude with a brief analysis of future directions; it can take place on time.

III. LITERATURE REVIEW

Mei et al.[1]presented in their study, which takes into account pixel connection, has the potential to supplement the costly, ineffective, and time-consuming optical inspection practice currently in use, and transposed convolution layers are employed for multiple properties and convolutional layers are tightly coupled in a feed-forward manner and remodel the properties from several layers, the output of transposed convolution layers, a novel loss function that takes into account pixel connection is proposed after study this paper founded it is more costly to implement. Dung et al. [2] demonstrated a crack identification method semantic segmentation on concrete defect images based on deep fully convolutional networks (FCN) encoder—is assessed for image classification and used pre-trained model VGG 16 although the pothole has been reasonably recorded by the suggested method.

Li et al. [3] used traditional computer vision and convolutional neural network based on deep learning. The author proposes a pyramid pooling to extract the accuracy of lane detection and the address of the detection problem. It used a feature map for binary output and a clustering technique to separate the pixels of the images, which can classify the output. Bang et al. [4] suggested methodology is reliable for detecting road lane markings 2D images help measure and evaluate pavement distress along roads, such as pavement cracking detection and classification and rutting measurement.

Bello et al. [5] observed cracks in pavement and road bumps. This paper aims to survey the body of work in the field of Vehicular Ad-hoc Network Technology (VANET), focusing on pothole or road defect identification using image processing techniques. This paradigm approach has recently attracted interest in this field. The advantages and disadvantages of specific image processing techniques, and particular areas for development, as part of an ongoing study, and the primary goal is to provide an overview of this developing field of image processing applications. Future work aims to increase the effectiveness and performance of the image processing and road defect identification approach. Future research will consider these elements during the design phase; after the study, the overall paper based on ad-hoc networks needs to be properly suited for detection. A dataset of 1500 images on Indian highways has been developed for this work. YOLO algorithm was used to train the dataset (You Only Look Once), and in the future, they will use a raspberry pi equipped with a camera to implement the system in real-time in a car dashboard. Additionally, the system may be integrated with a GPS to track the location of the Road crack detection found. After using Yolo, they achieved 78 per cent of accuracy [6].

Dharneeshkar et al. [7]used CNN Convolutional Neural Network and 3D asphalt data surface and using the investigation using test 3D images show that Crack Net can simultaneously achieve Precision (90.13 per cent), Recall (87.63 per cent), and F-measure (88.86 per cent). They used GPR analysis and sweep rectification for crack detection. The proposed demonstration, drawn from a sizable sample, displayed high repeatability to prove that the methodology can be regarded as competent to assess damaged roads with cut and fill portions [8].

Also,Dharneeshkar et al. [7] used the commercial solutions covered in this evaluation, and a gap analysis was then carried out. It determined that, to be implemented cost-effectively, considerably more research is required, particularly regarding the distresses associated with pavement micro- texture; however, there is always the possibility that new methods will result in gains in both accuracy and efficiency. The author proposed in the study, which takes into account pixel connection, has the potential to supplement the costly, ineffective, and time-consuming optical inspection practice currently in and transposed convolution layers are employed for multiple properties and convolutional layers are tightly coupled in a feed-forward manner and remodel the properties from several layers, the output of transposed convolution layers, a novel loss function that takes into account pixel connection is proposed after study this paper founded it is more costly to implement [7].

The author concluded that there are two families of commonly used algorithms based on minimal cost path analysis and picture percolation, and we draw attention to their drawbacks in this situation. Additionally, provide an enhanced method based on a contrario model that can resist giant motion blur in the absence of several thresholds that are often needed to deal with different crack appearances and levels of degradation and propose an approach based on acontrario model that eliminates the requirement for several thresholds to be defined to identify crack segments and reconnects them under various scenarios of image and structure (road or concrete) degradation [9].

Iyer et al. [10] described a three-step process for extracting crack-like patterns from pipe photos with increased contrast. The suggested approach uses curvature evaluation and mathematical morphology to find crack-like features in noisy environments. Careful examination reveals that the cracks typically have a tree-like geometry, which can be used as a feature to help register photos of the same location acquired at different depths along the thickness of the buried pipe (3D visualization) and, finally, using alternating filters to create the final segmented binary crack map. This research presents a low-cost method for road tunnel inspections based on a straightforward approach that can be applied to tunnels with regular traffic flow and does not necessitate extensive preparation work. This work proposes the design, creation, and testing of a low-cost prototype for automatic crack identification on surfaces inside road tunnels. The initial findings are essentially encouraging, and a test accuracy of 94.5 percent was achieved with a tiny dataset and a GPU [11].
Guo et al. [12] proposed a study that compares the perceptions of occasional drivers with frequent drivers to examine how consumers perceive autonomous driving (FDs). It used content analysis, and their comments were divided into thematic groups or subjects. The topics were organized using the core-periphery paradigm, and the author used Ten topics were used to group respondents' understanding of autonomous driving. Between ODs and FDs, there were notable variances in the subjects and their connections. In this paper, the author maintains vehicle safety in these situations; an Advance Driver Assistant System (ADAS) is required to evaluate the driving space and warn of the impending road crack detection proposed, and its focus is on a novel based framework to detect the Road crack detection [13].

Rastogi et al. [14] demonstrated a Road crack detection technique based on mobile sensing that is suggested in this work, and to get pothole information, the accelerometer data is normalized using the Euler angle computation and used in the pothole identification algorithm. Additionally, the spatial interpolation technique is employed to minimize the location mistakes in GPS (Global Positioning System) data. Findings from trials demonstrate that the suggested approach performs with higher accuracy and can precisely detect Road cracks without producing false-positive results [15]. As a result, the suggested real-time pothole detecting method can increase ITS traffic safety (Intelligent Transportation System). The author trains a pothole detector using the most recent VR (virtual reality) technology and creates a Road crack detection system that can produce holes of different depths, widths, and shapes. The training dataset is expanded with the virtual pothole images, and the detector's performance is assessed using actual data [16].

Fan et al. [17] described road crack detection as based on estimation and segmentation of the road disparity map. To generalize perspective transformation, we first add the stereo rig roll angle into the shifting distance computation. After that, semi-global matching is used to effectively estimate the road disparities, and the proposal is put into practice using CUDA on an NVIDIA RTX 2080 Ti GPU. The trial outcomes show the state-of-the-art accuracy and effectiveness of our suggested road pothole identification system.

Dhital et al. [18] described crack detection as the process of detecting the crack in the structure due to heavy snowfall, poor drainage, or heavy-weighted vehicles. For that purpose, we use any preprocessing techniques used in the CNN algorithm and some related models like Resent, VGG 16, and VGG 19.

Kheradmandi and Mehranfar [19]conducted a literature review to establish the development and interpretation of previous studies. They heavily concentrated on the three major approaches in the field of image segmentation, namely thresholding-based, edge-based, and data driven-based methods. This research compared and analysed different image segmentation methods, which gave researchers working on improved segmentation strategies useful information that could eventually lead to a fully automated distress identification process for pavement photographs under varied settings.

Previously, many techniques, like ground-penetrating radars (GPR), the Internet of Things (IoT), Vehicular Ad-hoc Network Technology (VANET), a-contrario, and YOLO FGPS systems, were used for detecting the road crack and were also costly. This paper aimed to develop a robust and adaptable model that could be easily implemented on any hardware. We studied the most effective algorithms for building robust models. We came up with the FCNN deep learning technique, which is both affordable and accurate when used for road crack detection in autonomous vehicles [20].

IV. PROPOSED WORK

Initially, traditional CNN extracts only the texture with the highest value from the max-pooling layers and produces the output. Nevertheless, the exact positions of the cells with the highest values are sometimes lost in the max-pooling, which stores the position data. We proposed conducting work to inspect road crack detection methods, by which the model will be very flexible, reliable, and cost-effective. The object detection has occurred based on Faster-RCNN. In this paper, we present an image pre-processing technique that focuses on faster-region convolutional Neural networks. Initially, we collect datasets of normal road images and cracked road images, then we pre-process the images so that all images come in the same size. The proposed work is to identify the cracks on the road and how their accuracy can be improved by a depth image surface. The prediction is based on a deep learning concept subjected to Faster-RCNN. It comprises a convolutional Neural Network that takes spatial information from the pictures and layer of surface encoding to recognize and, segmentation is a tool for removing boundaries and separating an image from a cognitive perspective into meaningful units.

These are a few objectives that include:

1. To use deep learning concepts for road crack detection.
2. To design a model to achieve accuracy.
3. To augment the model by using relevant images or datasets.
4. To implement the model on a dataset for validation of results.

4.1 Methodology

This research aims to review road crack detection methods, where we take images with the camera and monitor the road crack.

The steps to implement the model are as follows:

*Data Collections:*The image will be selected from open source Kaggle and will be gathered to prepare the CNN. Such image datasets consist of different kinds of images, e.g., camera images and laser images.

*Image-Preprocessing:*The above architectural diagram consists of many phases that are described in the flowchart of road detection and separation for self-driving vehicles.

*Data Augmentations:*In order to accomplish a fair execution, a fix will be created for each example picture by utilizing some testing procedures, for example, an irregular point pivot between poor coverage degree across two positive patches, 00 to 3600, and so on ―a picture with break will show a Real (1) in the picture marking measure, and correspondingly images will clearly show a False (0)‖.

*Fine Tuning and Normalization:*The photos are normalized after converting them into an n-dimensional array and the range of values is altered for pixel intensity. Examples of applications would be photos with low contrast from glare. Normalization is often referred to as histogram stretching or contrast stretching. Dynamic range expansion is the term used in more general data processing disciplines like digital signal processing.

*Class Balancing:*To check the class, predict the output, and train a model, we need to have balanced classes. If the classes are not balanced, we must first employ a class-balancing strategy. Therefore, class balance is explained in this article and use of Python is exhibited to implement class balancing approaches.

*Model Training:*The model architecture is created subjected to compiling and fitting.

*Prediction:*A managed learning-based grouping procedure is utilized to arrange the pictures according to their order as pictures with and without cracks are divided into two classes,―Autonomous Driving Cars‖. To apply the proposed approach to the real-time videos in order to locate road crack detection for the test process, this project will use this view to collect frames from the videos.

V. RESULT DISCUSSION

In this paper, we discussed the classification by using F-RCNN algorithm to predict the crack on the road and also elaborated the result of the proposed work.

5.1 Deep-learning-based outcomes

We used several different algorithms in order to get the best possible result from the categorization. Therefore, since we only have a limited amount of data to work with, let us begin by selecting the smaller dataset. In the beginning, we captured 100 image datasets of a normal road and 300 image datasets of a cracked road. After confirming the reliability of the results, we expanded the image dataset to include 700 images of cracks and 300 images of typical road conditions. After adding more images to the dataset, the level of accuracy reached its highest possible level.

5.2 Comparative result of classification

Several different algorithms are discussed and described in the Table- 1. In addition to that, the accuracy of the model is evaluated, and predictions are made using it.

Table.1. Comparison among the models. From the table it is shown that our proposed model gave the best result.

Methods	***Precision***	***Recall***	***F-1 score***
YOLOV2	87%	89%	94%
RCNN	97%	94%	93%
CNN	98%	97%	95%
F-RCNN(proposed)	**99%**	**96%**	**96%**

It was discovered that the proposed F-RCNN-based method produces more accurate precision when compared to the YOLO, RCNN, and CNN models [14], although they have the same issue.

5.3 Analysis and Validation

This work has been performed with changing the Epochs and different results are obtained. Initially, we took 15 Epoch and saw that the accuracy of our model is 0.85 percent and loss function is 0.38 (It is seen in Fig.-2).

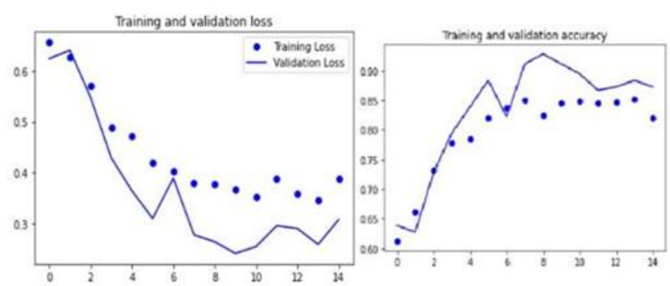


Fig. 2. Classification performance of first Epoch Loss and Accuracy Function

Second Analysis: Afterward, we took 25 Epoch in second time and we got Accuracy =0.89 Loss Function= 0.34, which is below 0.9. It gives very high accuracy in 25 epochs. So, the accuracy of the model is increased (Fig. 3).

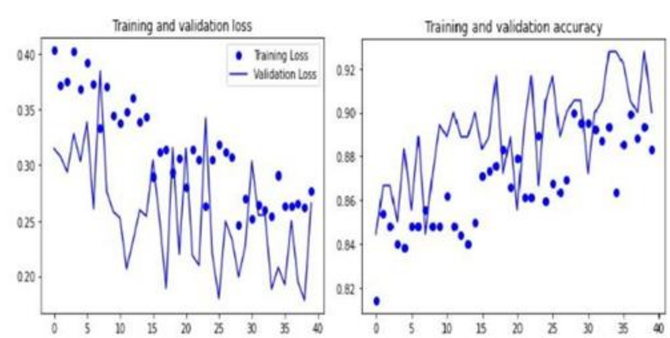


Fig. 3. Classification performance of first Loss and accuracy Function

Third Analysis: We take 40 Epoch in the second time then there Accuracy =0.92 Loss Function=

0.22 that shows below (Fig. 4).

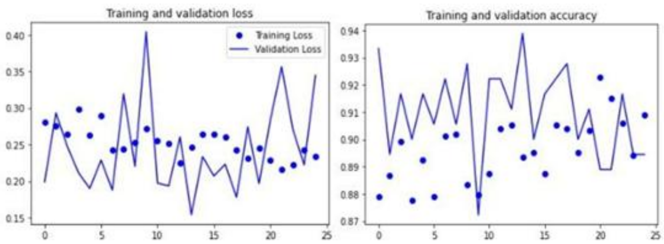


Fig. 4. Classification performance of Third Epoch Loss and accuracy Function

VI. CONCLUSIONS

This research has provided a novel method that makes use of artificial intelligence (AI) for the purpose of detecting road cracks in autonomous vehicles. This method is both effective and unique. The suggested system displays a high level of accuracy and reliability in spotting road cracks by utilizing advanced computer vision techniques and machine learning algorithms. As a result, autonomous driving systems will be safer and more efficient as a result of their implementation. It is anticipated that the incorporation of AI-enabled road crack detection would offer tremendous potential for the prevention of accidents, the reduction of expenses associated with maintaining infrastructure, and the improvement of the overall transportation infrastructure.

More research and development in this area is necessary if we are going to improve the algorithms, increase the efficiency of the computational resources, and tackle real-world problems. The continuous development of AI-based road crack detection has the potential to play a significant role in making it possible for autonomous vehicles to be operated in a manner that is both safer and more dependable, which will ultimately have a transformative effect on the future of transportation.

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