# Comparative Study of Pothole Recognition Using CNN and YOLOV5

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***Abstract*: Methods for recognizing potholes on roadsides goal is to evolve plans for real-time or else offline proof of identity potholes, to support real-time resistor of a vehicle (for driver help or independent driving) or else offline data gathering for road preservation.** [1]**It causes accidents in very high numbers. Therefore, it is a need to carry out timely inspection and maintenance to avoid the problem for road users. This paper projected a deep learning-based model that can perceive potholes initially using images, which can decrease the probability of a fortune. This model is mostly based on Convolutional Neural Network (CNN) and YOLOV5** [2]**. The project can reduce the manpower for the maintenance of the roads. This project will be useful for the government for better road maintenance with less manpower in a small period. The Accuracy for the same with image processing techniques such as CNN and YOLO. using this approach, it was possible to detect potholes with an accuracy of 88% and 95% respectively.**

**Keywords – Deep learning, Pothole Detection, CNN YOLO, Image processing, TensorFlow.**

## I.INTRODUCTION

Potholes are a major problem in many countries. It is a depression in a road surface, usually the pavement, where traffic has removed broken pieces of the pavement. It is mainly in monsoons the waters first weaken the underlying soil; traffic then fatigues and breaks the poorly supported asphalt surface in the affected areas. The unfortunate preservation and service of the highways have led to the formation of potholes. According to a review by the computerization association, one of the main specifics for road accidents is potholes. When a driver reduces the rapidity of the vehicle there is a high probability of a crash with the vehicle subsequent to it. Hence, we reflect data input plays a significant character in sidestepping the effects of potholes and falling accidents. [3] The size of the pothole and the visibility in the image is also underlined in these projects. Thereafter, the proposed methodology will be discussed in this paper in detail. implementation will be including the result that will be presented and the conclusion on the effectiveness will be drawn from the results will be the accuracy of the image that has potholes in it or not. The dataset is taken from Kaggle and Roboflow.

### *A. Pothole Dataset*

The pothole dataset has been taken by 2 different places that are Roboflow and Kaggle. As the Dataset was taken from different sources, we gathered the data and stored one data mart that is directly in google drive we have stored the data. We have got the data in 3 folders i.e., training, testing, and validation in which we are having around 800 images with different folders of labels. Now we are having all the pothole images for YOLOv5, CNN module.

First, we will discuss the Roboflow Packages dataset is a collection of packages located at the doors of various apartments and homes. Some images contain multiple annotated packages.

Kaggle is a popular online data science community that publishes datasets and some new competition projects.

### *B. Image pre-processing*

The image pre-processing is used for getting a clear image of the pothole for detecting it easily and letting the algorithms get more accuracy. We have used some of the Algorithms that are used for the classification of our image dataset, which is already pre-processed by CNN, yolo.

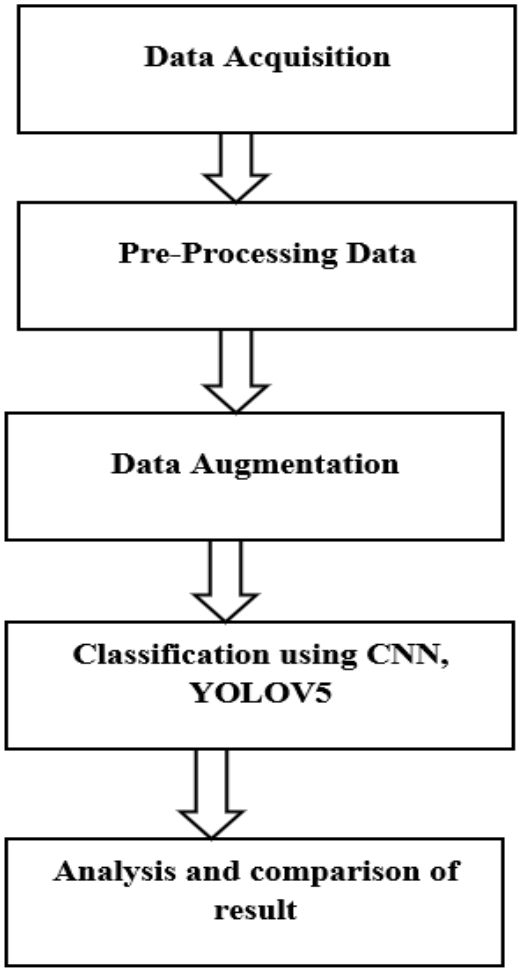


Fig. 1. Workflow for the proposed work

In demand to assign out the proposed work, we have selected deep learning especially Neural Networks on Road with pothole images dataset since it is state-of-the-art technology it can be used for solving most of the problems that can be a classification or object detection in practically every domain. The plan was to collect a dataset that is holding thermal images of roads with and without potholes. After the data acquisition, the images were pre-processed to eliminate the temperature scales and other marks and brought to the same dimensions by resizing and cropping. Now after various methods were applied to enhance the collected data to increase the number of images in the dataset. Finally, classification using Algorithms YOLO v5, and CNN was done and the accuracy was compared. Fig. 1 depicts the workflow of the proposed work.

*C. Data acquisition*

The dataset we have taken from the Roboflow and Kaggle the two data sources. We are having images that contain potholes and also do not. In the proposed work, we have used 3 algorithms. The visible images create enhanced pictures and videos that reveal what the naked eye can't see it is with the help of the Neural Network. For instance, you can add the modified images to the training set. As a result, the model is forced to be more understanding of changes in the placement, orientation, and size of the items in the images. You may similarly produce multiple photos with differing contrasts for a model that is more tolerant of diverse lighting situations. In general, you can also horizontally flip the images. You can significantly expand your training set by combining these modifications.

Various places in Mumbai city where potholes were available, were visited and pictures of roads with and without potholes were clicked. Images of the pothole and non-pothole roads are going to be kept back to get a strong assessment of the actual state. Fig. 2.1 and Fig 2.2, show sample images of the pothole and non-pothole road images from the dataset.

Fig. 2. Normal Road

Fig. 3. Pothole Road

## II.LITERATURE REVIEW

Proposed by S Nienaber, M Booysen, AND R Kroon in the year 2015. The projected technique for recognizing a pothole road starts by translating the extracted road image to a grayscale image. For clearing up the images and to remove some of the unwanted objects from the given images that could be a car (noise), a Gaussian filter was applied to the grayscale image. Then after the grayscale filter, they are using simple distinction-based edge detection algorithm that is (Canny edge detection) is then performed for the mined road surface. The Canny edge detector method produces a black-and-white image. The research paper is presented a good primary method for pothole detection which is by using a single optical camera it can detect potholes within a range of ≈ 2 m - 20 m and it does not depend on any of the training models. The outcomes of such work will be supportive in controlling the upcoming research. [3]

Proposed by Aparna, Yukti Bhatia, Rachna rai, Varun Gupta, Naveen Agarwal, and Aparna Akula in the year 2019. Various methods have been implemented reaching from manual reporting to authorities to the use of vibration-based sensors to 3D reconstruction using laser imaging. But all these methods have some the drawbacks such as the high setup cost, risk or there will be no providing for the night or foggy vision. Therefore, the unbiased of this work is to analyze the feasibility and accuracy of thermal imaging in the field of pothole detection. The results show that images were very correctly identified with the best accuracy of 97.08% by using the pre-trained convolutional neural networks (CNN) based residual network models. It was found that the method works relatively well in discarding other vehicles although further research must be performed to improve some of the aspects. [4]

Proposed by Automatic Detection of Potholes Akshat P1, Chaitra Paul2, Lakshmi Suresh3, Richard Lincoln Paulraj4 in the year 2019. This system provides a cost-effective that is low-cost maintenance solution for the detection of potholes and humps on the roads and that will indicate the road maintenance authority for maintenance like an address and the photo will be shared by these applications to the authorities for better reach. This system is also very useful for the driver an indication that there is a pothole ahead and the desired action can be taken. This project helps with maintaining the proper condition of the roads and the major problem due to the potholes accidents that are caused due to potholes in unexpected parts of the roads. Many enhancements can be made to this device like hump detection; adaptive speed avoidance and avoiding drink-and-drive case systems that are planned to give the driver an alert message whenever a pothole is detected. The potholes can be detected on any that can be wet, dry, or any other roads and the GSM and GPS will immediately detect the location, and a signal is directed to the driver that drives that vehicle. [5]

Proposed by Lokeshwor, HuidromLalit, Kumar Dusk. Sud in the year 2013. In this paper, we have presented an efficient and robust method for the automated detection and measurement of potholes, cracks, and patches from a sequence of the road surface. The presented CDDMC algorithm can detect the three specific distresses professionally and accurately in one pass using various image processing techniques supported by the heuristically derived decision logic. This algorithm includes and founds the importance of using a very collective set of the visual properties of road surfaces that are very distressed in the situation of automated road video data processing for speedy and inexpensive road condition assessment and this information can be used for determining maintenance levels of Indian roads and taking further some of the suitable action such as bleedings, manholes, the black colored road that will be markings and stain spots appear very similar to that visual features of potholes, cracks, and patches. In the future, there is a scope for further development of algorithms for the automated classification of images. [6]

After studying the current work, we found out that there are various methods such as computer vision [8] to detect potholes but there is an absence of active communication between the citizens and the government administrators. The proposed solution aims to develop an integrated system that detects potholes on the roads. In the existing solutions, it was noticed that even after the complaints were registered. some of them might be ignored by the officials and they do not have any clear vision of the cruciality of it. Also, reports are generated for all the complaints which are displayed on the website and can be sent to higher authorities.

## III.ALGORITHMS/TECHNIQUES

### *A. CNN*

So in the first Module, we used CNN for pothole detection. As CNN is a deep learning API algorithm

that is written in Python, running on the highest of the deep learning platform is TensorFlow. Being able to go from idea to result as fast as possible is a key to undertaking good research on some topics. In addition. TensorFlow can also help load the data to train the model, and also deploy it using TensorFlow Serving. First, we imported all the required libraries like TensorFlow image data generator, NumPy,cv2, and os after that we loaded the data from the drive after that we have to reshape because some of the images were big so we have done the pre-processing that is Rescaling the images then provided the dataset to the neural network with the specification for the training the label generated with function after generating the label using CNN with the maximum pooling and applying filters to it for getting better accuracy .compiling the modules and then training the same by fitting it in the model with epoch as 33 and we got the accuracy of 88%. Then the final stage was testing the module and we got the potholes detected in our model.


Fig. 4 Pothole Road detected (CNN).


Fig. 5 Normal Road detected (CNN).

*B. YOLOv5*

In the second module, we are going to use YOLOv5 It divisions the input image into SxS grid cells where each cell is accountable for noticing an item and forecasting. The confidence score with the class label. The self-assurance score is the identical percentage of the real labeled object bounding box with the predicted bounding box and tells the correctness of the forecast of the bounding box. It can sense, categorize, and limit numerous objects in one step, while other procedures require much scanning of an input image. [9]

First, we have mounted the google drive then the cloning from the GitHub repository should be done for Yolov5 implementation then the requirement modules like Ipython. display images and utils. google_utils has been used for the download of the images from google drive. Then the dataset has been downloaded from the Roboflow site which is a very useful site to get the labeled data that is a supervised dataset. Then we downloaded the YAML module that is used for YAML is the abbreviated form of

"YAML Isn't a markup language" is a data series language that is planned to behave human -friendly and all of it with other programming languages is used for normal tasks. Dissimilar stripe magical function, they can function on numerous lines below their demand. Also, they can make random changes to there input they received, which need not be uniform to a valid Python code. They accept the entire chunk as a solo string. Parameters the backbone, anchors, and head are some of the elements we have to edit as per our model requirement. Then we train the yolov5 on custom data for 200 pouches and the time its performance. Then we got our model report with an accuracy of 95% which is very good compared to our first module that is CNN

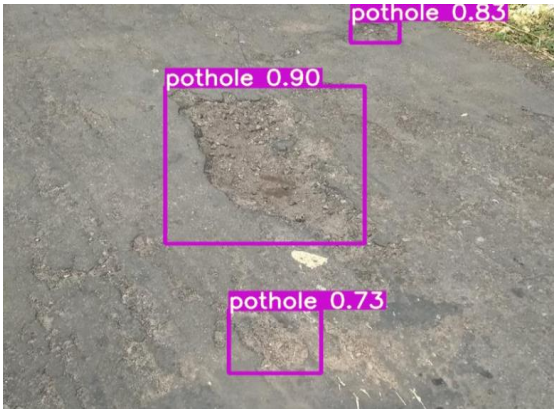


Fig .6. Pothole detected (YOLOv5)

## IV.METHODOLOGY

Image recognition is the responsibility in which deep neural networks (DNNs) excel has been playing an important role. Neural networks are computing systems that are planned to identify patterns. Their planning is inspired by the human brain structure. They contain three types of layers: the input layer, hidden layers, and output layer. The model was clever to notice potholes and road knocks with the restrictions of accuracy and sureness though they recommended it for real-time detection as FPS (frame per second). Recently, convolutional neural networks (CNNs) have become well-recognized for difficulties like object classification. [10] The input layer takes a signal, the hidden layer processes it, and the output layer makes some of the decisions such as a forecast/prediction about the input data.

How is a neural network deep?
With the help of the number of hidden layers: Traditional neural networks can go up to three hidden layers only, but deep networks may contain hundreds of layers.

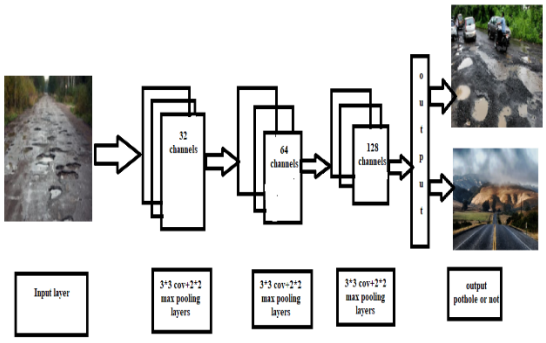


Fig. 7. Layers for detection

The Convolutional layers can be also applied to the output of the other layers rather than applying to input data only. The arrangement of the convolutional layer permit classification into inputs.

Contemplate that all the filters that are pilot directly on the underdone pixel values will gain an understanding of extracting low-level features such as lines. The filters that ply on the outturn of the initial line layers may uproot traits that are the amalgamation of the bottom layer such as the properties that can be composed of numerous lines to convey shapes. The interpreted data are divided into training and testing data before transitory it to deep learning models such as the YOLO family and CNN for practice model training. The bulks obtained after training donate to model presentation estimation on testing data [9]

This procedure is carried out until extending far down layers that are drawn out potholes, gaps, or normal roads. This precisely gets a glimpse of the practice. The abstraction of characteristics to the uppermost order as the vertical extent of the network is escalated. This is predominantly due to the recurring descend convolution and information contraction bivariate layers. As the overabundance is shortened we end up with a scrunched features portrayal of the matter of images. This way the bottommost layer can be plotted in a particular route format. So this route is associated with the classifier(output classifier). This classifier has different hidden layers namely a max pool and an output layer with an obligatory number of yield neurons that plot to the output space.

## V.RESULT

Pothole detection using 3 Modules. The sample of dataset reading was divided into train, test, and validation data. Cross-validation is performed on the test data and has been scrutinized from the sample dataset. several evaluation measures have been taken into consideration for choosing the most appropriate model. The manually annotated dataset was also trained with CNN modules for the epoch of 33 the model obtained was used to detect the potholes of different textures and different angles. We have taken over 200 epochs in yolov5.To evaluate the performance of these three modules, accuracy was calculated. from table 1 it was observed that the accuracy of the Yolov5 is higher than the other two modules.

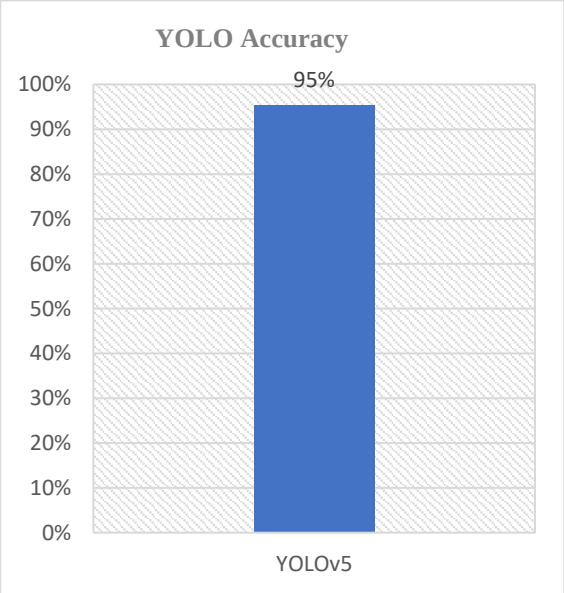


Fig.8. Yolov5 Accuracy

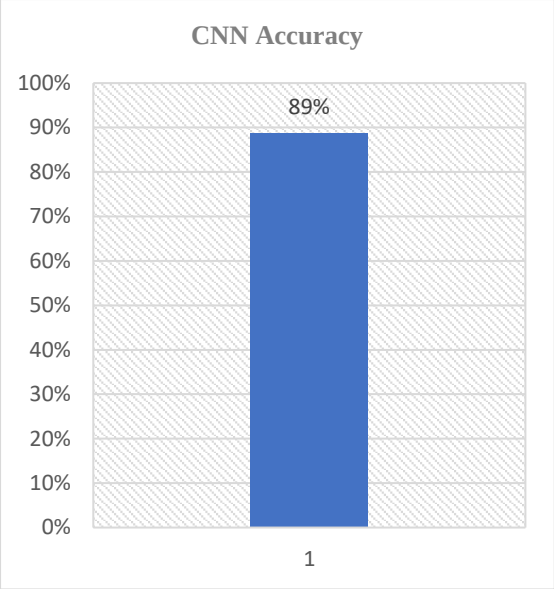


Fig.9. CNN Accuracy

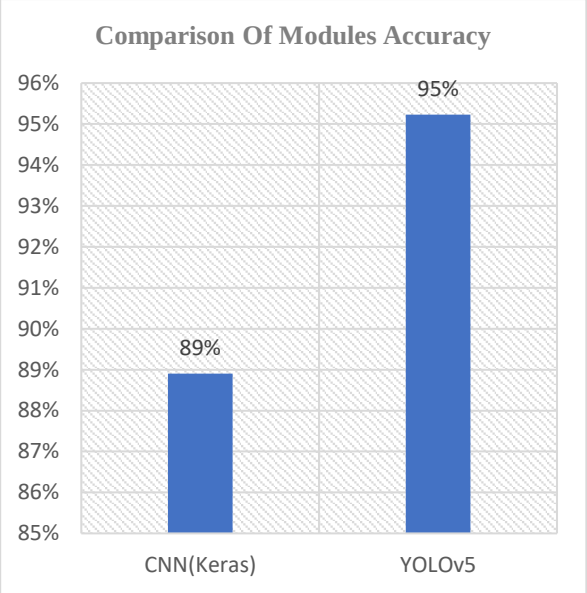


Fig.10. Comparison of modules Accuracy

| Algorithm | Accuracy |
|---|---|
| CNN | 88.9 |
| YOLOv5 | 95.23 |

Table 1. Accuracy Report

## VI.CONCLUSION

In India, the medium which is put into service to renovate the potholes does not give longevity, because, the chunk which is renovated gets dribbled through the bottom and the peak facet gets water ingress from derivation like rain, and ice. This effort offered high-tech deep learning models (YOLO family and CNN) for real-time pothole detection. [11]Which will afresh harm the toil and bind would diminish thus permanence will reduce and one more time we have to make an entreaty identical procedure to restore it. The petition of geo sheet in potholes renovation work provides longevity to the work. Posterior to registering it, the dribbled via pedestal will take the edge which will refine the longevity of renovated pothole. Alike as for adhesive, it gives well-impenetrable water arrival from the summit. Modified pothole stuffing trucks are preferable to standard pothole stuffing trucks when they are compared, to Indian conditions. They can work skilfully for the two blistering and glacial amalgams. This paper identifies the important issue-the detection of potholes. Using data classification was performed and compared with three different algorithms: CNN, and YOLO. Upon testing, it was revealed that the YOLO algorithm performed the best out of the two, with an accuracy of 95 %.

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