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YOLOv4 BASED POTHOLE DETECTION SYSTEM

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Abstract - Potholes are very commonly found these days and they found everywhere. This leads to major disturbances to our society in the form of vehicle damages, accidents and it also effects the economy of that countries where potholes are present. To solve the problem, the solution is created using YOLO (You Only Look Once) algorithm for pothole detection. It is a pretrained model which detects the pothole using YOLO v4 algorithm. In last decade many different techniques are proposed but YOLO gave better results and the speed and accuracy is also high. In the object detection system, the input is given in the form of images or videos and the respective output is to detect the object.

Key Words: YOLO v4 algorithm, Pothole.

1. INTRODUCTION

Potholes are bowl-shaped openings on the road that can be up to 10 inches in depth and are caused by the wear-and-tear and weathering of the road. They emerge when the top layer of the road, the asphalt, has worn away by lorry traffic and exposing the concrete base. Once a pothole is formed, its depth can grow to several inches, with rain water accelerating the process, making one of the top causes of car accidents. Potholes are not only main cause of car accidents, but also can be fatal to motorcycles. Potholes on roads are especially dangerous for drivers when cruising in high speed. Because, the driver can hardly see potholes on road surface. Moreover, if the car passes potholes at high speed, the impact may rupture car tires. Even though drivers may see the pothole before the bypass it, it is usually too late to react. Any sharp turn or suddenly brake, may cause car rollover or rear-end. Motivated from the above reasons, we decided to investigate a system to detect potholes on roads while driving. The proposed system will produce the 3-dimensional information of potholes and determine the distance from pothole to car for informing the driver in advance. Currently, the main methods for detecting potholes still rely on public reporting through hotlines or websites, for example, the potholes reporting website in Ohio. However, the focus has been mostly on autonomous agents avoiding impediments, which has been confined to extruding obstacles. As a result, the detection mechanism became exceedingly system-specific and unsuitable for widespread use. Road transportation has been very simple and cost-effective, albeit the comfort of the ride is determined by the state of the road. Potholes on roadways are a big source of frustration for people who travel by car. Accidents and loss of human lives are caused by potholes generated by severe rainfall and heavy vehicle activity. As a result, potholes are becoming a significant concern to drivers, who risk accidents and car damage. Unexpected humps and ditches on the road could lead to more collisions.

2. RELATED WORKS

Kshitija Chavan et al., [1] proposed “Pothole detection using YOLO v4 Algorithm”. In this work, they developed a model using the YOLO (You Only Look Once) algorithm for real time object detection. It is a pretrained model which detects the pothole using YOLO v4. Previously sequential CNN (Convolution Neural Network) Algorithm was used but later they figured out after a comparative analysis that YOLO gave better results in real time. A GUI (Graphical User Interface) was added to the model so that we can simulate the model using the start and stop button. The system consists of a camera that, when activated, extracts images from live camera recording in order to detect potholes. It will display potholes in real time, and the pothole will be highlighted with boxes, as seen in real-time object detection systems. This system provides us with an accuracy of 80- 85%.

Sneha Gosavi et al., [2] describe "Design paper on Pothole Monitoring System". In this work, the data gets read from the accelerometer sensor and detect when the phone has been shaken and detection of potholes on the road: 1. The first thing to do is check whether the phone has an accelerometer in the first place. If not, you can notify your user. 2. Alternatively, if your user must have an accelerometer to use your app properly you can notify the user and then close the app. This system retrieves the values of the x, y, and z axis from the accelerometer sensor. It also indicates when the device has been shaken. If your Android device is laid face up on a table top, the ZAccel value from gravity will be positive. Turning the device on its left side will make the XAccel value positive Standing the device upright will give YAccel a positive value. Gravity (9.81 m/s/s) and we can view this with an Android app. If the accelerometer value changes the shaking function is called. And instantly the coordinates will be taken through GPS where the jerk took place by calculating longitude and latitude of the specific position where the event occurred. The coordinates will be located and will be entered into database containing exact shaking positions where the potholes are present.

Bhoraskar R et al., [3] has discuss "Traffic and Road Condition Estimation using Smartphone Sensors". they propose Wolverine a nonintrusive method that uses sensors present on smartphones. the extend a prior study to improve the algorithm based on using accelerometer, GPS and magnetometer sensor readings for traffic and road conditions detection. They are specifically interested in identifying braking events - frequent braking indicates congested traffic conditions - and bumps on the roads to characterize the type of road. they evaluate the effectiveness of the proposed method based on experiments conducted on the roads in Mumbai, with promising results. Therefore, they use accelerometer for detection of potholes with magnetometer and gps is implemented. However, this project does not have a real time access to the location where the detection was triggered.

Kanza Azhar et al., [4] has explain "Computer Vision Based Detection and Localization of Potholes in Asphalt Pavement Images". This paper addresses the detection and localization of one of the key pavement distresses, the potholes using computer vision. Different kinds of pothole and non-pothole images from asphalt pavement are considered for experimentation. Considering the appearance-shape based nature of the potholes, Histograms of oriented gradients (HOG) features are computed for the input images. Features are trained and classified using Naïve Bayes classifier resulting in labeling of the input as pothole or non-pothole image. To locate the pothole in the detected pothole images, normalized graph cut segmentation scheme is employed. Proposed scheme is tested on a dataset having broad range of pavement images. Experimentation results showed 90 % accuracy for the detection of pothole images and high recall for the localization of pothole in the detected images. In future, a bottom-up approach with more robust features can be investigated for the defect analysis in the asphalt pavement images. Distresses other than potholes will be visually analyzed and detected using structural features and classifiers. Implementation of the proposed scheme in real-time environment on pavement videos is also pipelined.

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3. METHODOLLOGY

Here's a general methodology for pothole detection using YOLO v4 algorithm. The proposed system is pothole detection using YOLO v4 algorithms in this we can prevent the uncertainty happens due to pothole and it predicts the pothole with great accuracy.

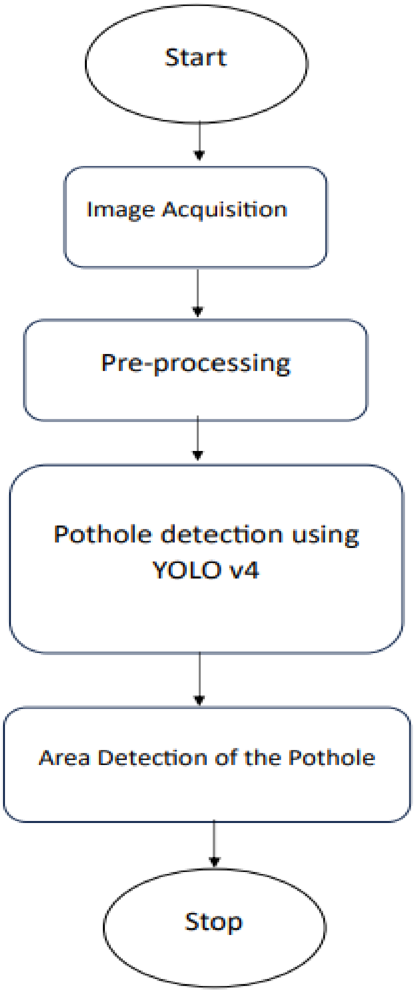

Fig 1. System architecture of pothole detection

A. Image Acquisition:

In this the image is taken from the video input where we can predict the pothole. The video is nothing but group of images in this we extract an image by pixel to pixel and it is given to next step for preprocessing.

B. Pre-processing:

Preprocessing is a crucial step in YOLOv4 based pothole detection as it prepares the data for optimal performance by the deep learning model Image Resizing will happen YOLOv4 expects images of a specific size (e.g., 416x416 pixels in many configurations). Images are resized to this target size before feeding them into the network. Resizing methods like bilinear or bicubic interpolation are used to maintain image quality during scaling. Data get normalize in Deep learning models often perform better with normalized data. This typically involves scaling pixel values to a specific range (e.g., 0-1 or mean=0, standard deviation=1). Normalization helps the model focus on the relative intensity differences in the images rather than absolute values.

C. Setting Up the YOLOv4 Environment:

The Deep Learning Framework **is** chosen like PyTorch or Darknet to implement YOLOv4 in this case Darknet is used. Select a suitable YOLOv4 configuration file (.cfg) that defines the network architecture. You might use the default configuration or modify it for specific needs (e.g., number of classes).

D. Detection of pothole and area calculation:

After the setting up the YOLOv4 environment the model gives a detected images where the pothole is present then we make box like structure around the detected class, in this case the class is a pothole. After this we calculate the area of that box to predict the pothole area then the area will display on the screen or interface.

4. RESULTS AND ANALYSIS

A comparative analysis of two Algorithms was done. YOLOv3 and YOLOv4 were tested and the table 1 below, explains the results.

Table 1. Comparative analysis of YOLOv4 and YOLOv3

Algorithm Used	Description	Accuracy
YOLOv3. [9]	YOLOv3, a deep learning model, trains on pothole images to identify them directly in photos. This automatic detection approach offers a faster and more accurate way to assess road conditions for maintenance.	YOLOv3 model easily achieved an accuracy of 72% on average in pothole detection system.
YOLOv4	Single-stage CNN model for real-time object detection. Predicts bounding boxes and class probabilities directly from the input image.	YOLOv4 model easily achieved an accuracy of 85% on average in pothole detection system.

Below are the results of the project.

Fig 2. Snapshot of pothole

The Fig 3. shows the detection of pothole with a bounding box and also an area of the pothole which is 32 sq. ft with higher accuracy than other models.

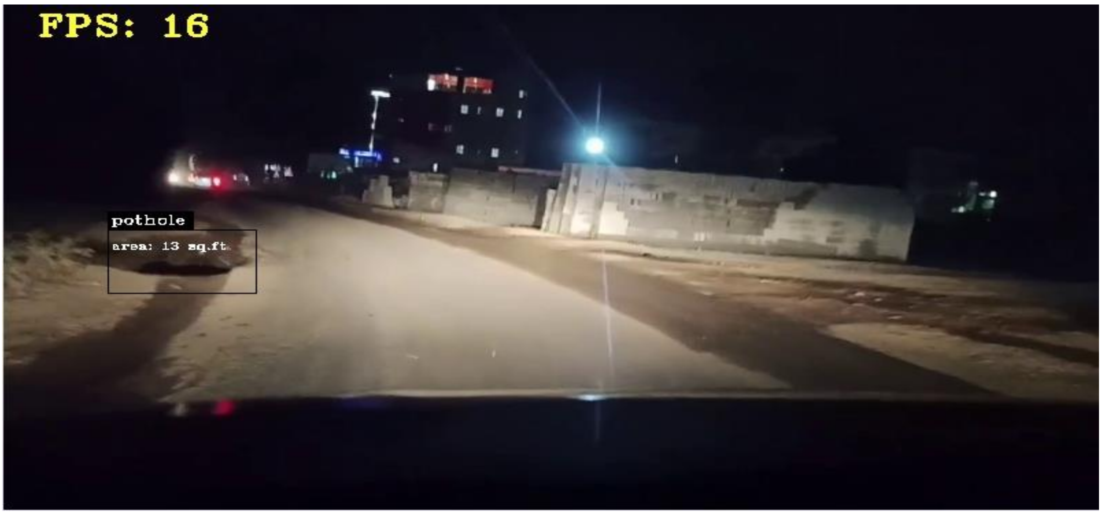

Fig 3. Snapshot of Pothole in the night

The Fig 4. shows the detection of pothole with bounding box in the night and also calculate the area of pothole which is 13 sq. ft. Even with the adverse weather and light conditions the model proves to be successful in detection of potholes.

Fig 4. Snapshot of pothole with some water in it.

The Fig 5. shows the pothole with some water in it and the area of the pothole is 52 sq. ft. Even if the potholes are filled with water and other stuff the model proves to be successful in detecting them with greater efficiency.

5. CONCLUSION

In this model we have discussed the pothole detection system using YOLO V4 Algorithm. Decision of using YOLO V4 was great because the biggest advantage of using YOLO is its superb speed – it's incredibly fast and can process 45 frames per second. YOLO also understands generalized object representation. It is one of the best object detection algorithms, with a performance that is comparable to that of the R-CNN algorithms. The system provides several benefits and can operate with less manpower. Hence, we have successfully completed the training and testing of our model using YOLO V4. The system successfully detects the potholes with a good accuracy of approx. 85%.

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