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Pothole Detection System using Ultrasonic Sensor

Pingle Omeshwari Dattatray[1], Wankhedkar Akshada Hemkant[2], Varpe Akash Bhausaheb[3], Patil Mayur Vasant[4], Prof. Dighe A. L.[5]

B.Tech Students, Department of Electrical Engineering[1,2,3,4]

Assistant Professor, Department of Electrical Engineering[5]

Vidya Niketan College of Engineering, Bota, India

Abstract: *This project aims to develop a tool for predicting accurate and timely traffic flow information. Traffic environment has everything that can affect the traffic flowing on the road, whether it's traffic signals, accidents, rallies, even repairing of roads that can cause a jam. If we have prior information which can affect traffic then, a driver or rider can make an informed decision. Currently, traffic data is exponentially generating every day and thus we have moved towards the big data concepts. The available traffic prediction models are unsatisfactory to handle real world applications. This fact inspired us to work on the traffic flow forecast problem build on the traffic data and models. In this project, we planned to use machine learning, genetic and deep learning algorithms to analyze the big-data for the transportation system with much-reduced complexity. Also, Image Processing algorithms are used in traffic sign recognition, which eventually helps for the right training of autonomous vehicles.*

Keywords: Lung Disease, X-ray, Deep Learning, Pneumonia, Tuberculosis, Lung Disease.

I. INTRODUCTION

The strain on the infrastructure has increased as the world's population has grown. Traffic on the roads is at a record high. It has been harder and harder to control this traffic. This is the main driving force behind creating a car with enough intelligence to help the driver in several ways. Road conditions getting worse is one of the issues that are getting worse for the roadways. The road is challenging to drive for a variety of reasons, including rain, traffic accidents, or normal wear and tear. Unexpected obstacles on the road could lead to more collisions. Additionally, the vehicle's fuel usage rises as a result of poor road conditions, wasting valuable gasoline. Due to these factors, learning about such dangerous roads is crucial. Due to these factors, it is crucial to gather information about these hazardous road conditions and warn the driver about the road condition. We in this project try to design and build such a system which can help drivers find the road condition. This system collects information about potholes and road conditions and sends an alert to the driver.

1.1 Objectives

- To manage road maintenance in a smarter way.
- Detection of potholes can help road authorities to optimize their resources by identifying areas that require immediate attention.
- To reduce vehicle wear and tear.
- Data Collection.
- Improved Driving Experience.

1.2 Problem Statement

The purpose of a pothole detection system is to alert drivers to the uneven potholes and roadways in its route. We examine the various means via which the system's objective can be accomplished. We provide justification for the methods we used in this project. We utilized the following ways to test this model:

- Building a model that will detect the potholes in its path.
- Highlighting the potholes so that the person is alerted.

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1.3 Scope of Project

So many technologies will benefit from our effort. Some of them are that we will utilize our model to test different colours on the same sort of clothes before beginning the real task so that we can decide whether or not to begin. We can also design various sorts of automobiles based on the parameters provided. We can make genuine paintings and turn our imaginations into pictures. All This occurs in a very short period of time, thanks to our flawlessly trained model.

II. SYSTEM REQUIREMENTS

Software Requirements

- Operating System **:** Windows 10 or above
- Programming **:** Python 3.7
- IDE **:** Microsoft vs code

Hardware Requirements

- Processor **:** Any processor above 500MHz(Intel i3)
- RAM Capacity **:** 8 GB RAM or more
- Hard Disk **:** 256GB
- CPU: quad-core or above
- Operating system: Any OS of 64-bit

III. EXISTING SYSTEM

Experts have experimented with different crater detection methods as a fascinating research field. Here are some suggestions for drill detection techniques:

- Measure and visualize craters using Microsoft Kinect Sensor
- Pothole detection study based on 3D project transformation
- Pothole detection based on SVM of pavement emergency images
- Detection and sharing of road obstacles by smartphone multimedia sensor analysis
- Real-time using Android smartphone with accelerometer pothole detection
- Pothole detection algorithm using an efficient stereo vision system
- Excavation detection and warning system for autonomous vehicles
- Detection of potholes in autonomous vehicles

IV. PROPOSED SYSTEM

The main objective of this project is to develop a system that can detect gaps from video inputs. Hole detection can be done in real-time. The YOLO algorithm was used for this. The car's front camera records road video as input to the computer. The computer uses the YOLO algorithm to detect potholes in the video and alert the driver to road conditions.

Advantages over Existing System

- Fast and reliable
- Cost efficient

V. LITERATURE SURVEY

Deep Learning Based Pothole Detection and Reporting System (IEEE 2020):

Using a GPS to pinpoint the location, an accelerometer and ultrasonic sensor were put in the bottom of an automobile and driving at a speed of 25 km/h.

The control room is informed of the pothole's location by the microcontroller, which also senses it. The GPS is initialized by the microcontroller (ATmega328), which also gives us the coordinates. Comparative analysis of CNN, KNN (k-Nearest Neighbors), and Kirchhoff's Theory Method was the methodology adopted.

The Modern Pothole Detection using Deep Learning (IEEE 2020):

They Have installed a camera on the vehicle, identified the potholes, and marked their positions using an app they developed so that a vehicle without a camera could still get the information about the pothole and provide the driver with the necessary alerts.

Pothole detection and reporting using image processing using a Raspberry Pi microcontroller(IEEE 2018):

The Raspberry Pi microcomputer was used to implement the entire system, and 100% of the reports were successful.

The web server, Dropbox, and the Internet were used to store and access the reported picture of the pothole and its location. In the article "Deep Learning," YOLO Neural Network-based learning algorithm for finding potholes in a pavement surface:

For photographs of asphalt pavement, the Yolo neural network model was helpful in detecting potholes. T displays a suitable level of detection precision of the application- specific structure, Yolo v3, Yolo v3 Tiny, and Yolo v3 SPP. which have mAP values of 83.43%,79.33%, and 88.93% correspondingly, and the precision of the area measurement correspondingly, 64.45%, 53.26%, and 72.10%

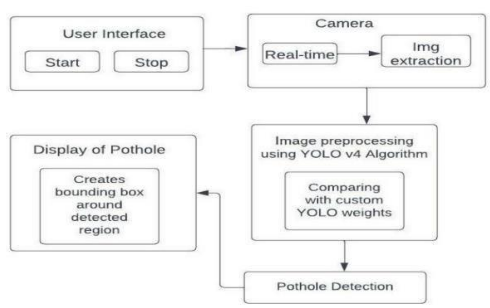
As a result, there is a good chance that it will be developed and used. The Yolo V3 Algorithm was employed.

The article written by E. N. Ukhwah et al is a YOLOv4-based pothole detection system.

The YOLOv4 algorithm used in the system this paper proposes allows it to outperform the systems discussed before. A disadvantage of YOLOv3 based on object detection is that the results are less accurate than YOLOv4. YOLOv4 provides more accurate bounding boxes thus resulting in better IoU value

VI. ANALYSIS

6.1 Methodology



System Block Diagram

The proposed system is divided into two phases. Determine and evaluate the size of the pit. The images captured by the camera are fed into the image detection system. The drilling detection unit of the proposed system is based on the YOLO family of object detectors. YOLO is short for “You Only Look Once”. As its name suggests it is based on the principle that the objects in the input image can be recognized and recognized at a glance. This technique treats object detection as a regression task.

6.2 Modules

Data Exploration Module:

By using Data exploration module we can load data into the system, which is similar to initial data analysis. In addition a source of real-time data, historic information is also essential regardless of the approach. While data driven methods rely on the network’s history to predict its evolution, model-driven methods require it in order to calibrate the parameters used in the traffic simulation.

Data Pre-processing Module:

Data Pre-processing is a method that is used to convert the raw information into a clean dataset. In other words, whenever the data is gathered from different origin it is collected in raw format which is not feasible for the analysis. Used for cleaning, formatting and organizing this increases the accuracy and efficiency of a model.

Splitting Data Into Train & Test Module:

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We split the dataset into 75% for train and 25% for test and implemented different classification algorithms (RF, KNN, and SVM)

Measuring Prediction Accuracy Module:

In order to assess the standard of the traffic prediction systems, it is essential to ascertain metrics that allow the comparison of the various methods. The following metrics are the foremost common:

Mean Relative Error: Also called Mean Absolute Percent Error (MAPE), Percentage Absolute Error (PAE), Ratio of Absolute Error and accuracy (1 − MAP E). This metric corresponds to the average absolute percentage change between forecasted and true value, relative to the true value.

Mean Absolute Error (MAE): This metric corresponds to the average absolute difference between predicted and true values, also called Mean Absolute Deviation.

Root Mean Square Error (RMSE): This metric corresponds to the square root of the mean of the square difference between observed and forecasted values.

Prediction Module:

At last, the final traffic prediction is displayed and the values are predicted to the user.

Algorithm Used (YOLO) You Only Look Once:

YOLOv4 is SOTA (state-of-the-art) model for real-time object detection. It was published in April 2020 by Alexey Bochkovsky and it is the fourth version of YOLO. It achieves SOTA performance on the COCO dataset consisting of 80 different object classes. YOLO is a single-stage detector.

- The one-step method is one of the two main modern methods used for object detection tasks where speed of completion is important.
- In the one-step detector model, the ROI (Region of Interest) is removed and classes and bounding boxes are predicted for the entire image.
- So this makes them faster than two- stage detectors.
- Another example is FCOS RetinaNet and SSD. The first version of YOLO was written in the Darknet Framework (which is a high-performance open-source framework for implementing neural networks written in C and CUDA).
- DarkNet is usually the main network.
- It divides the object detection task into a regression task followed by a classification task.
- Regression predicts the class and bounding box for the entire image in one direction and helps identify the positions of objects.
- Classification defines the class of objects.

Algorithm Overview:

The architecture consists of different parts, in general,

- The input comes first basically the set of training images we have which is fed to the network
- It is processed in a parallel cluster of GPUs. Next comes the spine and neck where feature extraction and assembly takes place.
- Neck detection and head detection together can be called object detection and finally the detection/prediction is done by the head.
- Basically, the head is responsible for identification (localization and classification).

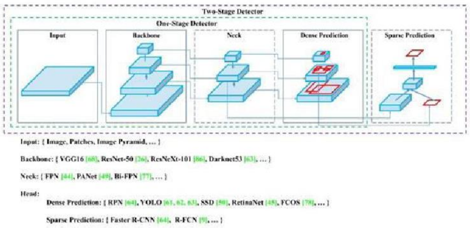
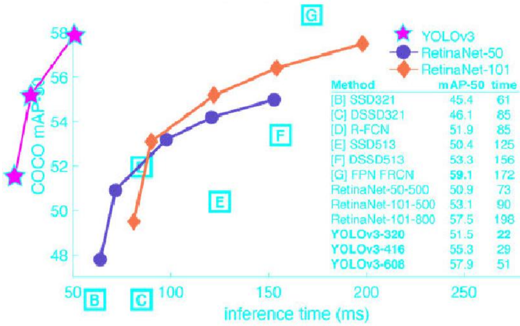
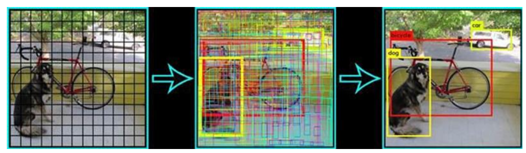
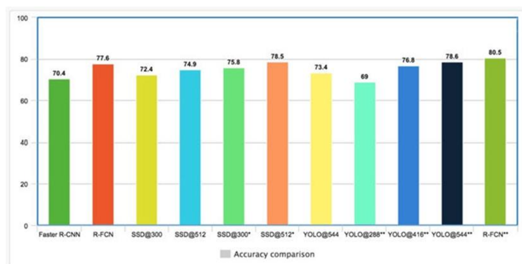
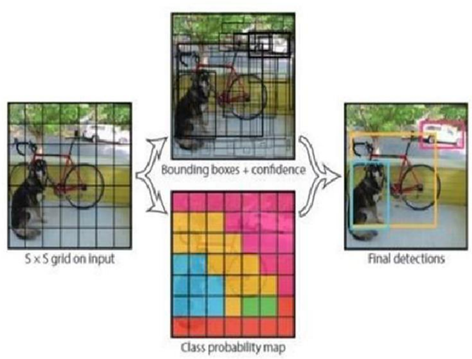


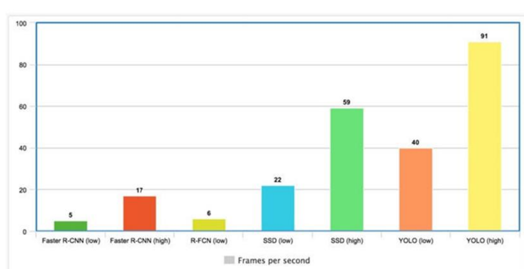
Figure 2: Object detector.











System Architecture

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. A system architecture can consist of system components and the sub-systems developed that will work together to implement the overall system. There have been efforts to formalize languages to describe system architecture, collectively these are called architecture description languages (ADLs).

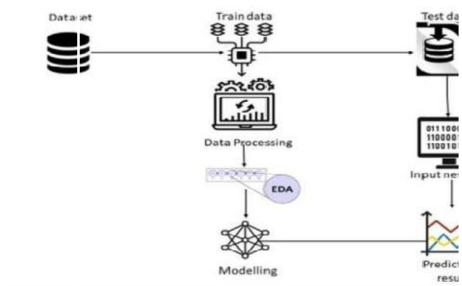


Fig 1: System Architecture of Pothole Detection.

VII. USER SCREENS

Visual studio

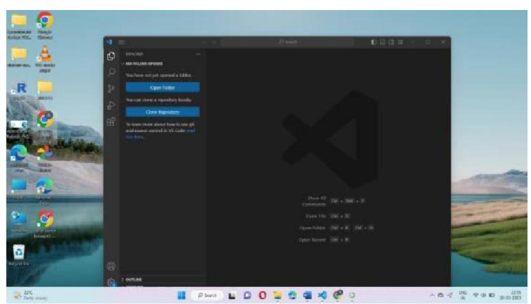


Fig 2: Connecting to visual studio

The above image shows the connection with server.

Folder in Visual Studio Code

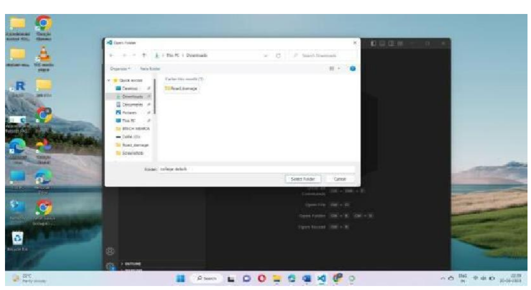


Fig 3: Folder stored in VS code

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Stored Preprocessed videos

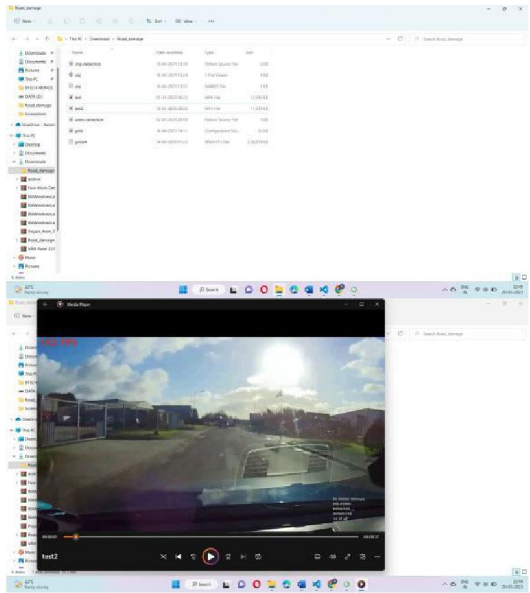

Fig4: Stored pre-processed Videos

The above image shows the preprocessed videos which are stored and these videos will be used for grey-scaling

Result Predction

Fig 5: Predicted Result

VII. CONCLUSION

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%. This work presented the state-of-the-art deep learning models (YOLO family and SSD-mobilenetv2) for real-time pothole detection leading towards the deployment on edge devices. Although, YOLOv5 showed the highest mAP@0.5 of 95% among other models but exhibits miss-classification and no detection potholes at long distances. Therefore, we concluded the YOLOv4 as the best-fit pothole detection model for accuracy and Tiny-YOLOv4 as the best-fit pothole detection model for real-time pothole detection with 90% detection accuracy and 31.76 FPS.

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VIII. FUTURE ENHANCEMENT

In the future, it may be possible to combine pothole detection systems with autonomous repair robots. This would allow for potholes to be identified and repaired without the need for human intervention, reducing the risk of accidents and improving road safety.One possible enhancement is to make the system work in real-time, allowing for immediate detection of potholes and other road hazards. This could be achieved by optimizing the machine learning algorithms or by deploying the system on edge devices that can process data in real-time.

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