Pothole detection using image processing

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Abstract - The presence of potholes on the roads is one of the major causes of road accidents as well as wear and tear and gash of vehicles. lately, with an increase in vehicular business and pollution, the roads are getting filled with potholes in nearly every megacity in the country. This is a major problem in numerous advanced countries also. Detecting potholes manually is a labour-ferocious and time-consuming task. To break this problem, colourful ways have been enforced ranging from manual reporting to authorities to the use of vibration-grounded detectors to 3D reconstruction using laser imaging. But all these ways have some downsides similar to the threat while discovery, high setup cost, or no provision for night vision. thus, In the proposed system our main end is to descry the potholes and warn the person driving about the pothole at a distance. This system might give more accurate results and helps in avoiding accidents.

I. INTRODUCTION

Over the last two decades, there has been a tremendous increase in the vehicle population. This has increased the number of roads. India has grown extensively, as further and further people graduate by the nanosecond and further and further of us gain employment by the hour, we're all bound to commute and spend utmost of our time travelling. Different reports and checks are of the opinion that last time, 10,727 people were killed in crashes caused by potholes, speed combers and roads under the form or being constructed. Though losses under these orders had come down hard from 2014, the number of people killed due to potholes rose to 3,416 from 3,049 in the former times. putatively, the crucial reason for road accidents happens to be defective roads and the unexpected circumstance of potholes. The safety of drivers should be prioritized, and a smooth commute should be assured for everyone. Current approaches to pothole discovery involve homemade examination or counting on reports from the public. These styles are time-consuming and frequently affect detainments in repairing potholes. To address these issues, we propose a pothole discovery system that utilizes computer vision and machine literacy ways to decry potholes in real-time.


Fig 1 Images of damaged road

II. LITERATURE SURVEY

[1] "Pit free: Pot-holes detection on Indian Roads using Mobile Sensors", Gaurav Singal, Anurag Goswami, Suneet Gupta, Tejalal Choudhary "978-1-5386-6678-4/18/$31.00 c 2018 IEEE

With an objective to detect pot-holes via mobile sensors, the data was collected through an Android App. To achieve this objective, an Android app is used to collect data. This app was developed for different functionalities to start and stop the data collection and save the data on the Android Device. The data is saved in the 'CSV' file. The readings are captured across the X-axis, Y-axis and Z-axis of the accelerometer sensor. Based on the direction, the gravitational force acceleration on either of these three axes is captured. GPS readings of Latitude and Longitude are also taken into consideration. The location of the potholes can be identified with the help of an accelerometer sensor used in the Android App on a mobile phone which helps in capturing the dataset during the travel and provides the sensor with the 3D motion of the device in X, Y, and Z -direction. Prediction of potholes on the road can be done by the changes in the readings.

[2] "Path hole Detection System: Using Wireless Sensor Network" Ashish Gaikwad, Yashwant Belhekar, Mandar Dangre, Ankit Chaudhary International Engineering Research Journal (IERJ), Volume 2 Issue 12 Page 4643-4646, 2018 ISSN 2395-1621

Here we proposed the design of a 'Pothole Detection System' which assists the driver in Avoiding pot-holes on the roads, by giving him prior warnings. Warnings can be like a buzzer if the driver is approaching a pothole, or the driver may be warned in advance regarding what road has how many potholes. This system is divided into three subsystems: the sensing, server and the user sub-unit. In the sensing sub-unit, potholes and humps are detected using an ultrasonic sensor, where the GPS receiver stores the data in the database. This is called the server sub-unit. The drivers are alerted regarding potholes and humps by a hardware module which is set up by the user sub-unit.

[3] Identifying and Reporting of Potholes and Humps using IoT, Smita Saitwadekar, Dr Payelsaha2International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 06 Issue: 02 | Feb 2019

The model proposed in this paper serves two important purposes; automatic detection of potholes and humps and also alerting vehicle drivers to evade potential accidents. The proposed approach is an economic solution for the detection of deadly potholes and uneven humps, as it uses low-cost ultrasonic sensors. The web application used in this system is an additional advantage as it provides timely alerts about potholes and humps. This application also registers pothole complaints with the date and location and also it registers one complaint only once. There are 3 modules in this system which include (1) Microcontroller module the (2) the server module and the (3) the application module. Here, Arduino is used as a Microcontroller module which collects information about potholes and their geographical locations by Global Positioning System (GPS) and this collected information is sent to the server. The server module receives information from the microcontroller module and then processes and stores it in the database. The web application module provides timely alerts to the drivers using the information stored in the server database.

[4] Road Condition Detection Using Smartphone Sensors: A Survey Authors: Gunjan Chugh, Divya Bansal and Sanjeev Sofa, Department of Electrical Engineering, National Taiwan Normal University, Taiwan 2 Industrial Economics and Knowledge Center, Industry Technology Research Institute, Taiwan978-1-4799-8745-0/15/$31.00©2015 IEEE

In this system, RCDD (Road Condition Detection Device) has an Arduino-based sensing module and an Android smartphone which is a user interface. A low-cost sensing module is designed which is placed on the vehicles. Arduino Uno R3 acts as the computational core of this sensing module. The input and output of this core are the accelerometers and Bluetooth module. The evaluated result with raw data which is obtained by the Arduino-based sensing module is sent to the smartphone through Bluetooth. The three functions of the Android APP are: 1) Bluetooth communication, 2) Google Maps inquiry and display, and 3) driving patterns display.

[5] Pothole Detection System using Machine Learning on Android (IJETAE 2012) Aniket Kulkarni, Nitish Mhalgi, Sagar Gurnani, Dr Nupur Giri (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 7, July 2014)

In this system, the changes in the acceleration are monitored by the potholes sensor plug-in to detect potholes. The device accelerometer built-in function is used to gather the accelerations of the X, Y & Z-axis. The location coordinates are collected using a GPS chip, which includes the Display module, which consists of appropriate buttons to carry out the task. The algorithm takes in the training set and displays the pothole scenario in the particular area. The Android application launches pothole detection when the user starts his/her journey. While the user is driving, an application which has the algorithm plug-in running detects potholes. The application monitors the changes in acceleration. To the event log the application adds geographic coordinates, current times and different statistics of the potholes. After the user finishes his/her journey he/she can tap Stop and they are presented in the event log.

III. IMPLEMENTATION

ALGORITHM FOR POTHOLE DETECTION:
INPUT: Live video feed from a camera.
OUTPUT: Warnings of pothole if detected.

ALGORITHM:
STEP – 1: Start
STEP – 2: Define confidence_threshold
STEP – 3: Load YOLOv7 Model (custom-trained)
STEP – 4: Get a frame
STEP – 5: Pass the frame through the model loaded in STEP – 3.
STEP – 6: For each detected pothole in the frame, repeat,

a. If the confidence of the detected pothole is greater than or equal to the defined confidence_threshold in STEP-2, then,
   i. Count the pothole as a real pothole and show a warning

b. Else, go to STEP - 4

STEP – 7: Stop.

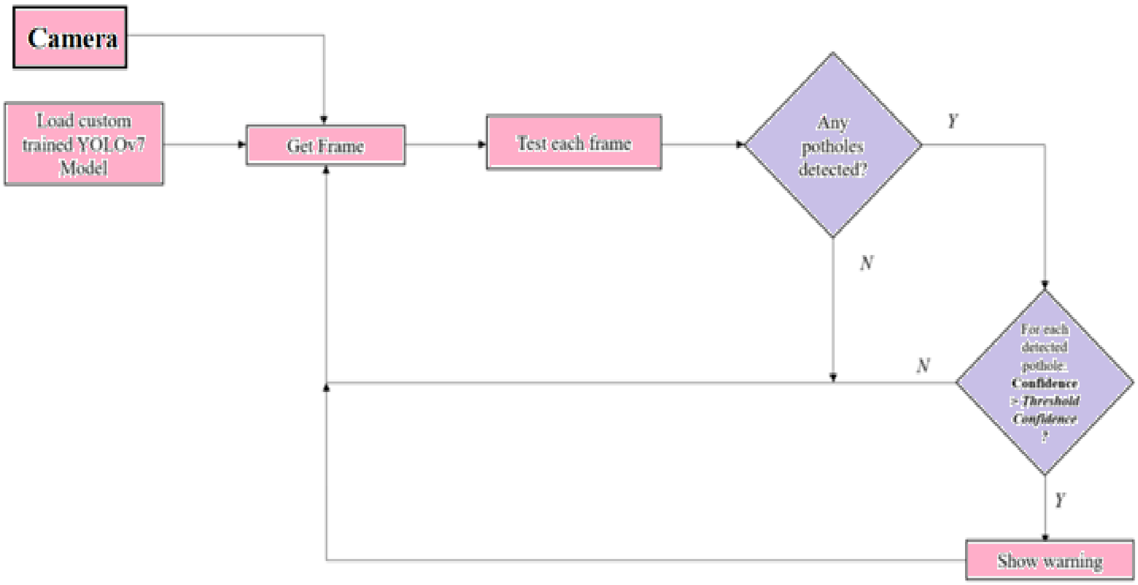

Fig 2: Flow diagram of Pothole Detection System

DATASET

We used the dataset compiled at the Electrical and Electronic Department, Stelllenbosch University, 2015, provided in [2] and [3]. This is the same dataset used for the solution proposed in [7]. It consists of images taken from a video of a car dash camera. The image resolution is 3680 x 2760 pixels. An example of the image from this dataset is shown in Fig. 1.

Fig 3: Some images from the custom dataset

Each image in this dataset is labelled with 5 rudiments per discovery object class, box centre (x, y), range, and height. For illustration, one entry would be 0,0.59,0.79,0.26, and0.39. Then, 0 is the class marker for potholes. The class marker is followed by the centre coordinates (x, y) of the bounding box 0.59 and 0.79, as fragments of the range and height of the image. Eventually, the range and height of the bounding box are0.26 and0.39 independently, also as fragments of the range and height of the image.

DATA PREPROCESSING

The pre-processing of images from the dataset comported of cropping and resizing. The images were cropped for two reasons. The first reason is that potholes aren't present in the bottom or top areas. These areas cover the sky and the vehicle's dashboard. The alternate reason is that cropping images increases the size of potholes relative to the image size. Cropping at the bottom was performed as follows. Among all images, the pothole that was closest to the bottom was linked. All image's bottom was cropped so that this pothole was 100 pixels from the new bottom. An analogous process was performed to crop the top of the images. As a result, the new perpendicular size of the images was reduced to 37% of the original height. The left and right areas of all images were also cropped reducing the vertical size of images to 37% of their original value to maintain a constant aspect rate. It needs to be noted that cropping the images horizontally did remove some potholes labelled near the left and right borders, but the number of these potholes is lower in comparison to the total number of potholes in the dataset. Images were also resized to 640 x 640 for training to fulfil the input conditions of the models. The markers of potholes were also acclimated consequently. For each training batch, we pass training data through a data haul with data addition. The data haul makes a variety of accruals, similar to scaling, colour space adaptations, vertical flipping, and mosaic image generation, which combines four images into four penstocks of a new image with arbitrary rates. There were 7779 images in the stoked dataset, and the dataset was aimlessly resolved into training, confirmation, and testing sets with a 70:20:10 rate.

MODEL ARCHITECTURE:

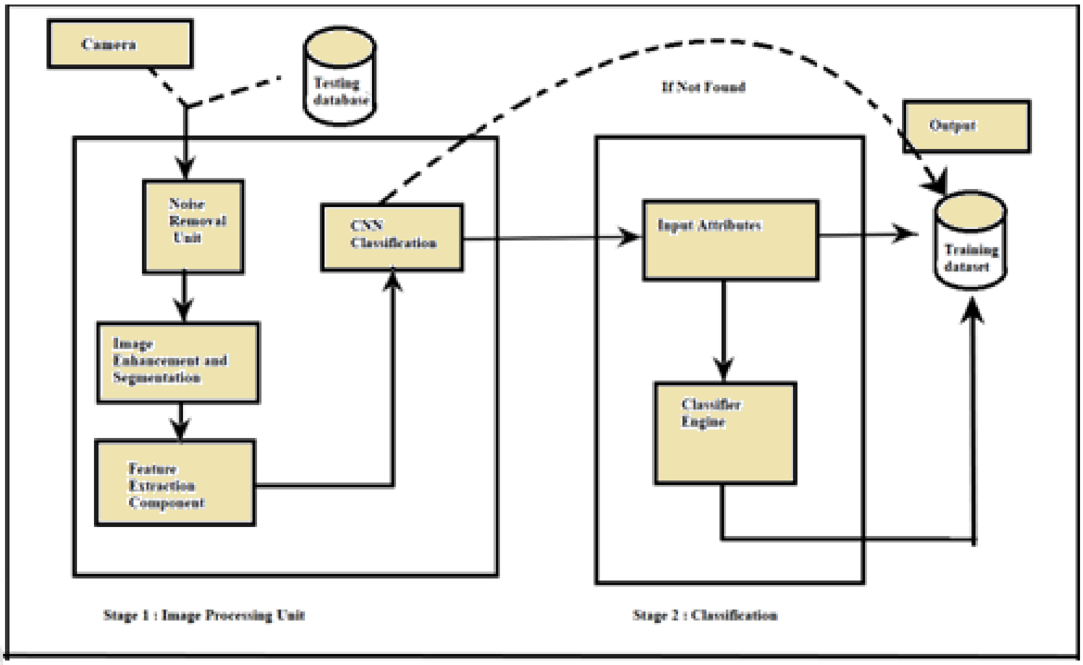

Fig 4: Architecture diagram of an image processing unit and classification unit.

The framework can be comprehensively sorted into the following significant stages:

1. **Acquisition of image:** Images are attained by a camera or any tackle source. Whatever the source may be, it's veritably important that the image of the data is transparent and conservative. An inconceivable picture is demanded for this.

2. **Pre-Processing of image:** The affected part needs to be extracted without any noises and blurriness from the images, so here need to apply some pre-processing techniques like Filtering, Histogram equalization, Image enhancement, noise removal etc. Most of the pre-processing for images is done with the help of Python software. The preprocessing of images aims at selectively removing the redundancy present in scanned images without affecting the details which that play a role in the diagnostic process. Each image is pre-processed to improve its quality. The Preprocessing techniques applied here are as follows:
   a) The histogram equalization method was used to enhance the contrast of the image.

   b) Median filtering is required to remove the effect of poor contrast due to Glare, noise and effects caused by poor lighting conditions during image capture. A low-frequency image was generated by replacing the pixel value with a median pixel value.

3. **Data storage aspect to preserve information images for testing and training:** If controlled learning will occur, as is the case here, it is important to prepare data sets. The sampled database is the images collected during the photo procurement process. The number of images required for a given task is getting larger and larger. Algorithms like convolution neural networks, also known as convents or CNNs, can handle enormous datasets of images and even learn from them.

4. **Classifier to classify the type of road potholes:** The classifier used here is the last layer of the system which gives the true probability of each experience. The project involves two major parts Image preparation unit and a Grouping unit. The object processing system enhances the image by removing the clatter and noisy bits. The road and the image will then be isolated into different segments to isolate the Road from running the mill after the image features are evacuated to check whether or not the Road is contaminated.

5. **Noise reduction unit:** Noise is always present in digital images during image accession, rendering, transmission, and recycling way. Filtering image data is a standard process used in nearly every image processing system. Filters are used for this purpose. They remove noise from images by conserving the details of the same

6. **Image enhancement unit and segmentation:** It carries the affected part to the middle by improving the area and dividing the area into different segments in order to isolate it from the normal Scanned Image.

7. **Feature Extraction Components:** One of the notable developments in any gathering-centred issues is highlighting extraction. Looks are the cornerstone for both purposes of planning and screening. This feature contains noteworthy image information that will be used to identify the potholes.

8. **Identification units for potholes:** The results strongly suggest that a road has potholes.

9. **Input Attributes:** Attributes All noteworthy attributes, asymmetry, edge, concealment, distance, progression, etc. that have been expelled from the image are now handed as fidelity to Part II.

IV. CONCLUSIONS

Pothole detection using image processing projects is a promising approach for detecting potholes on road surfaces. The project utilizes image processing techniques such as feature extraction and classification to identify regions of the image that may contain potholes, and post-processing techniques to refine the results. The project has the potential to improve road safety and reduce vehicle damage by detecting potholes early.

V. REFERENCES

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