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Fast pothole detection with the YOLO algorithm

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ABSTRACT

Roads play a very important role in our daily life for the transit of goods and passengers. So, we have to be very careful about all the activities which may lead to the damages of roads to avoid the major or minor road accidents. One of the main causes of these accidentare due to the potholes created on the roads. These potholes caused by the augmentation and dwindle of ground water after the water has plunge into the ground under the footway. To avoid such incidents a real time-based road damage identification system is required.Our project proposal is how a real-time based pothole detection system can be developed to avoid such accidents in future.

Keywords:- *Accident, Potholes, YOLO Algorithm*

1. OBJECTIVE

Objective of the program is to make the roads safe and smoother to drive.

2. INTRODUCTION

Transportation through roads is one of the most cost friendly and preferable mode of transportation, both for goods as well as passengers.It is also crucial for economic development and maintain social integrity of our country. Road Transport has secured a dominant role inIndia's transportation sector with a share of 4.5% in India's GDP in 2005-06. The Road Transportation Sector is capable of about 87%passenger traffic and 64% goods traffic movement in our country. With the rising of road transportation road accidents are also raisingday after days. An accident can occur due to multiple reasons such as direct collision of vehicles or damaged road conditions. In our country 67% of road accidents happened due to feeble road conditions. Big or medium sized potholes are found in the cent percent of the roads and highways in India. These potholes lead to fatal road accidents and may cause loss of lives also. Government has taken schedule checking activity of the roads and pothole repairing measures to curb this type of incident. But there is lack of research work found on internet related to real time pothole detection and send the caution message to the approaching driver to alert them. In this paperwork we will discuss about a real-time pothole detection system and demonstrate how it works to send the alert message to the approaching driver for safe driving of their vehicles.

3. PROCEDURE

In the process of pothole detection using YOLO (You Only Look Once) algorithm we will install the camera (which was previously connected with pothole detection system circuit's Raspberry Pi) in front of a car. Now the car will move from its starting point to its destination slowly and the camera will click images of the road at every instant and the system will simultaneously process every imageand detect whether there is any pothole or not.

Now for simplicity the system's algorithm will take P to represent presence of pothole in the images. If the system finds any pothole inany image it will equal P with 1 (P=1) for the image and if there is no pothole in the image then P=0. If P=0 the system will store

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nothingand start processing the next image and if P=1 the system will notify the user, collect the data of the pothole using YOLO algorithm. The YOLO algorithm will draw a rectangle around the pothole and will collect the length, breadth and the coordinates for x and y at thecenter of the rectangle. The rectangle's length, breadth and coordinates will help to know the actual length and breadth and area of the pothole. Now the system will collect the GPS location of the pothole and check whether the location of new image of pothole match with any previously taken pothole image or not. If yes then the system will send an alert message to the user about the same pothole andif not, then also the system will send an alert message to the user about detection of new pothole along with uploading all the data and picture of the pothole at the Bylnk. After processing and finding potholes from image the system will automatically start looking for thenew pothole in the upcoming road and the process will go on until the user stop the car and turn off the system, after turning off the system the camera will stop clicking pictures and the whole system will be switched off.

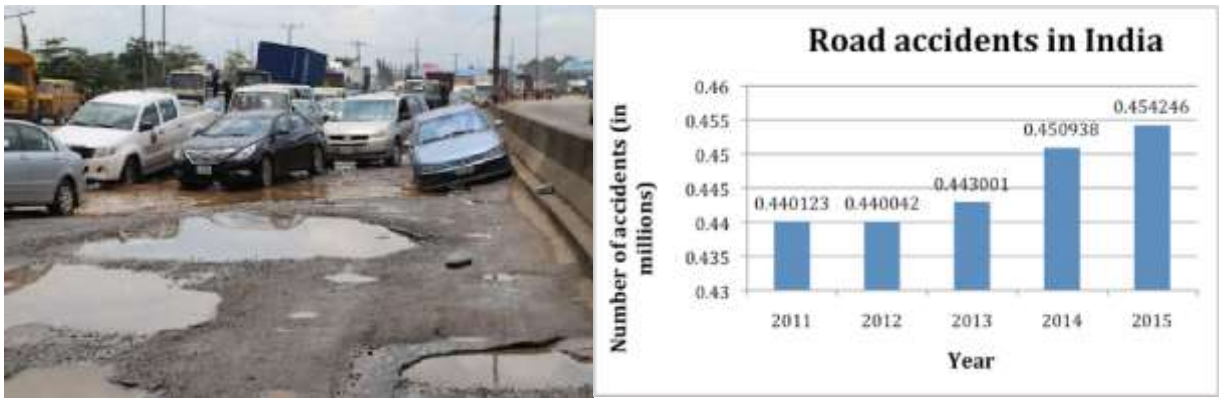
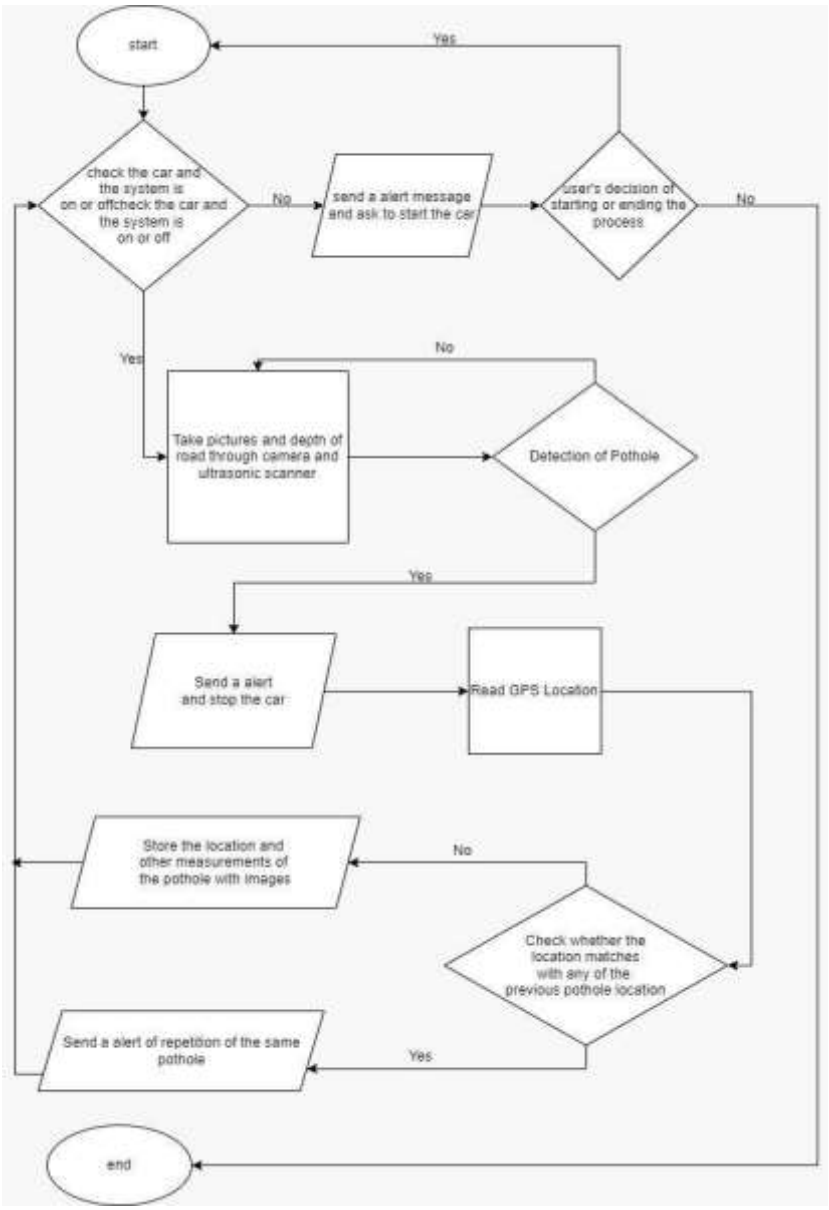


Figure 1: Potholes and accident statistics due to potholes

4. FLOW-CHART



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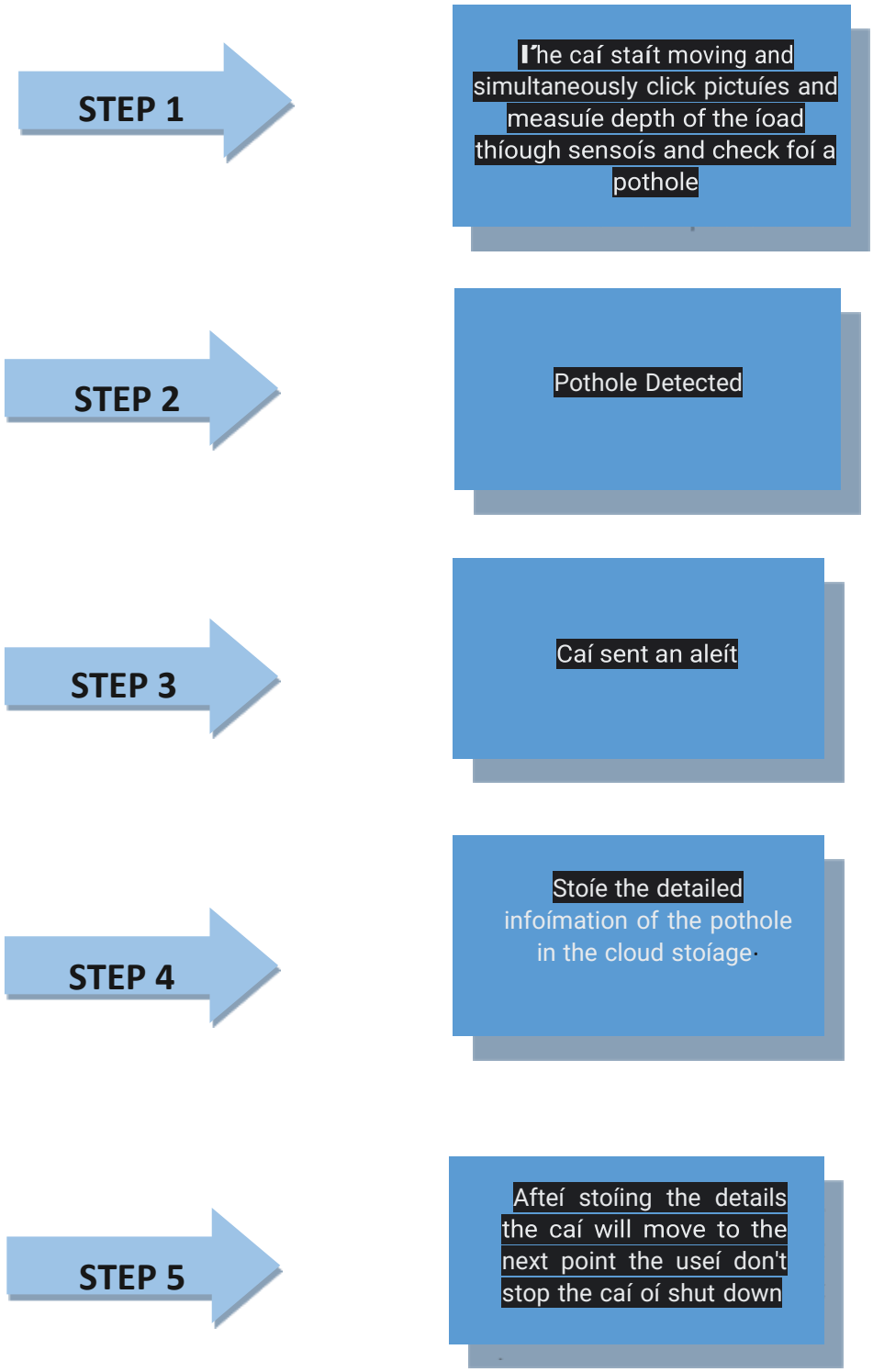
5. YOLO Algorithm



6. MATERIALS REQUIRED

1. Hardware Required:

Raspberry Pi 4 Model B: We are using Raspberry Pi 4 Model B for our project, which is the latest product in the popular Raspberry Pi range of computers. It offers ground-breaking increases in processor speed, multimedia performance, memory, and connectivity. Thisproduct's key features include a high-performance 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 4GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0,Gigabit Ethernet, USB 3.0, and PoE capability (via a separate PoE HAT add-on).

Figure 2: Raspberry Pi 4 Model B

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Specification:
Processor:
Connectivity:

- Broadcom BCM2711
- Quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz

- 2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac wireless LAN,
- Bluetooth 5.0,
- BLE Gigabit Ethernet 2 × USB 3.0 ports
- 2 × USB 2.0 ports.

SD card support:

- Micro SD card slot for loading operating system and data storage

Input power:

- 5V DC via USB-C connector (minimum 3A1)
- 5V DC via GPIO header (minimum 3A1)
- Power over Ethernet (PoE)–enabled (requires separate PoE HAT)

HC-sr04 ultrasonic sensor: We will use HC-SR04 ultrasonic distance sensor for our project. It will provide us the facility of 2cm to 400cm of non-contact measurement functionality with maximum 3mm of ranging accuracy. Each HC-SR04 module have a n ultrasonictransmitter a receiver and a control circuit.

There are only four pins in the sensor There are only four pins that you need to worry about on the HC-SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground).

This sensor is very easy to set up and use for your project of pothole detection system. This sensor has additional control circuitry that can prevent inconsistent "bouncy" data depending on the application.

Features:

- Operating Voltage: 5V DC
- Operating Current: 15mA
- Measure Angle: 15°
- Ranging Distance: 2cm – 4m

Figure 3: HC-SR04 ultrasonic distance sensor

Camera: We are going to use OV7670 camera module as it is cheap and we only need to take the photos of the potholes to send it to the administrators.

Figure 4: OV7670 Camera

GPS Module: We are using NEO-6M for our project. NEO-6M is a well-performing GPS module, and it has an inbuilt 25x25x4mm ceramic antenna. This antenna is capable of powerful satellite search capability. It also has on-board memory chip. This GPS module includes a rechargeable battery; this battery backup is useful in an emergency. When the supply is cut down accidentally, the battery backup feature can save the data in the module. This module works with power supply 5V, and the default baud rate is 9600 bps.

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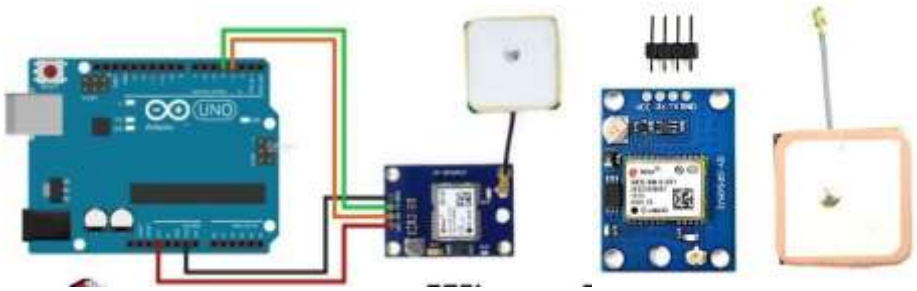

Figure 5: GPS Module

Wi-Fi Module: We are using ESP8266 Wi-Fi module for our project. ESP8266 Wi-Fi module is low-cost standalone wireless transceiver that can be used for end-point IoT developments.

Figure 6: ESP8266 Wi-Fi module

2. Software Required:

YOLO Lite Algorithm: We are using Yolo Lite for detecting the potholes. This is a real-time object detection model developed to runon portable devices such as a laptop or cellphone lacking a Graphics Processing Unit (GPU). The model was first trained on the PASCALVOC dataset then on the COCO dataset, achieving a mAP of 33.81% and 12.26% respectively. YOLO-LITE runs at about 21 FPS on anon-GPU computer and 10 FPS after implemented onto a website with only 7 layers and 482 million FLOPS. This speed is 3.8x faster than the fastest state of art model, SSD MobileNet Vi. Based on the original object detection algorithm YOLOV2, YOLO- LITE was designed to create a smaller, faster, and more efficient model increasing the accessibility of real-time object detection to a variety of devices.

Figure 7: Potholes detected by yolo algorithm

Blynk Software: We are using Blynk software to instantly track the location and send the data to the specific cloud server or Govt. Server or local IOT administrator via mail. In this software, we have bot controlling buttons and GPS Latitude and Longitude value andMail Icon for sending mail of the pothole location detected and a map of the live location of the BOT. This is achieved when Authorization characters are mailed to the required users using Blynk software. The required Authorization characters code, when usedin the program, allows users mentioned in the Blynk software to receive live locations of potholes, humps or any other hurdles along the way. The required data is received in a short delay of just 6seconds to 9seconds.

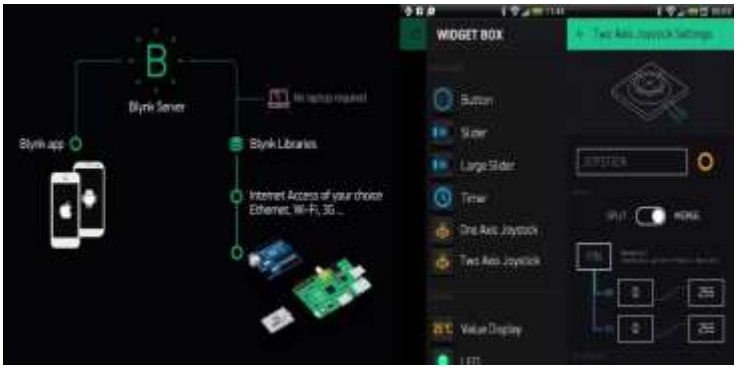

Figure 8: Working principal of Blynk software

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Figure 9: Location tracking in Blynk software (GUI)

7. ADVANTAGES AND FUTURE SCOPE

- The proposed system uses sensors which are economically less costly and can be implemented on a large scale.
- This project will create a mass collection of information on potholes, humps, for which density map can be created to for effectiveand quick analysis of poorly constructed roads, which further can help Government bodies like BMC or can help commuters in avoiding a particularly bad patch of poor road with the help of density maps of potholes on the servers
- As the sensors are cost-efficient, they have their limitations like less range, less accuracy, less direct analysis like image process techniques. Implementation of cameras or laser technology can boost the accuracy of the data collection.
- We also can develop an alarm system which can detect potholes from a distance and warn the diver to decrease the vehicle speed.

8. CONCLUSION

In this paperwork we have discussed about the potholes; its size and shape and how fatal these are to violate traffic safety. We have also discussed our approach to detect potholes in real-time and alert the approaching driver to prevent road accidents.

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