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RESEARCH ARTICLE OPEN ACCESS

Pothole Detector Using IOT

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ABSTRACT

One of the common problems in progressing countries is the maintenance of roads. Potholes are the main cause of accidents other than over speeding. In this paper it is proposed to identify a pothole and save its exact location along with vehicle's information for predicting vehicle's condition i.e. (if something is wrong with it or not) and will predict its maintenance time accordingly all this will be saved on the cloud. All this information will be displayed on the map and can be accessed by the common people as well as government authorities so that the potholes can be repaired as soon as possible. And with the help of machine learning, the device will be able to predict the condition of the vehicle.

Keywords **-** Elasticsearch, Kibana, Map, Pothole, Raspberry pi

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I. INTRODUCTION

In India more than 2,000 people lost their lives in 2019 due to road accidents caused by potholes and more than 4,000 people were injured in over 4,800 road accidents, according to the latest data given by the government in Parliament [8]. Potholes also cause damage to the vehicle's suspension, wheels/rims, tires, and exhaust pipe [7]. To overcome this issue the project aims at identifying the potholes using an ultrasonic sensor which will collect the data about distance and displacement along with an ODB2 sensor which will collect data about the car all this data will be sent to the raspberry pi which will process the data and send it to the cloud which will be stored on Elasticsearch all the data and will be displayed on the map in real-time using Kibana it will display all the damaged roads, show heatmap on that location.

II. LITERATURE SURVEY

IoT Based Humps and Pothole Detection on Roads and Information Sharing

The proposed system is implemented using Arduino uno, Ultrasonic sensor and Accelerometer. This system uses the honey bee optimization algorithm (HBO). All sensed data is gathered to perform Pre-processing operation and then given to the honey bee optimization algorithm to monitor the surface of pavement. The Kirchhoff's theory is applied for Realtime analysis and it has certain restrictions. To overcome this difficulty the system uses accelerometer included with ultrasonic sensor to sense, detect and measure the variation present in the signal and optimized using HBO technique. Arduino Uno is used in internet of things based on road monitoring system (IOT-RSM) for the flexibility of instructions while coding. The IOT-RSM is used to update the status of the road with location information in cloud. [3]

Pothole Detection System using Artificial Intelligence

This paper describes a conceptual design of pothole detection using AI. The idea behind this system is to detect and notify the potholes possibly without the human intervention. This system is implemented using AI-enabled camera and the object detection API that will help to detect the potholes. The dataset is collected by cloning TensorFlow object detection repository from GitHub. The API is the open-source framework built on TensorFlow, making it easy to construct, train, and deploy objection detection models. The location of the vehicle is tracked using GPS and camera captures the image of the road continuously through Open CV, and the captured images then are compared with the trained data set of potholes. If the image matches with the dataset, then it sends an email to the municipal authorities along with the image and the location of the pothole. But the

system lacks to provide the real-time pothole updates in google map. [5]

Detection of Potholes and Speed Breaker on Road

This paper provides the system consist of four units i.e. Microcontroller unit, mobile application unit, communication unit, cloud unit. Microcontroller unit collects all the information about the potholes, humps and speed breaker along with its geographical location. Communication unit provides internet connectivity and also collects co-ordinates of the pothole and distributes the data to the other units. Cloud unit receive all the data which are sent from the microcontroller unit. Lastly, mobile application unit uses the data and gives information to the driver.[4]

A Modern Pothole Detection technique using Deep Learning

This project is implemented using Deep Learning, Transfer Learning, Faster Region-based Convolutional Neural Network(F-RCNN), Tensor flow API, Accelerometer, and Inception-V2. Deep Learning is used to detect potholes early using image and video which can reduce the chances of an accident. TensorFlow's object detection API is used for processing the captured images to get the high accuracy of the potholes. Transfer Learning and Inception-V2 help to save time and improve performance.

III. EXISTING SYSTEM

In developing countries, the pavement pothole is often detected manually by inspectors of the municipal corporation during periodic field surveys. Although this conventional method can help to acquire an accurate evaluation of potholes, it also features low productivity in both data collection and data processing. The reason is that one pavement inspector can only inspect less than 10 km per day. With a large number of road sections needed to be inspected routinely, the automation of the pothole detection becomes a pressing need for transportation agencies. The simplest method might be to collect photos of road damage and hazards taken by the participants and to upload them to a central server. However, this requires strong participation and interaction from the users as well as manual image analysis. We believe that an automated approach for detecting potholes with little or no human interaction is more promising. This would ensure more comprehensive survey data with fewer errors caused by human factors than generated by the mere enthusiasm of participants. Moreover, the productive pavement surveying process significantly leads to economic gain. It is because, if the rehabilitation process is performed timely, pavement restoration cost can be saved by up to 80%.[5]

- Drawbacks of Existing system:

1. No map access to potholes data
2. No centralized storage of data
3. It requires more workforce.
4. Manual inspection in large cities will be complicated.
5. It is more time consuming.

- Advancement in the system:

1. Universal access of pothole data through web browser
2. Vehicle maintenance prediction

IV. OBJECTIVES

- Avoidance of accidents by showing real-time potholes prone routes.
- Accurate location of potholes.
- Mark routes with pothole density (similar to traffic density in Google map).
- Provide vehicle maintenance information to the user.

V. PROPOSED SYSTEM ARCHITECTURE

In this IOT based platform-based project, Raspberry pi is used. Here the raspberry pi takes 3 inputs – OBD2 connecter which will provide vehicles diagnostic data, GPS will provide location co-ordinates and the Ultrasonic sensor will provide reflected pulse signal. Which will be constantly fetched and converted into a JSON format that data will be sent to the cloud via the internet if there is no internet connectivity data will be stored on local storage using Logstash as the internet connectivity resumes the data will be sent. In the cloud, there will be Elasticsearch which will receive that data which is in JSON format and it will be stored on scheme free database in different documents in 1st document it will store pothole data and its corresponding location, and in the 2nd document it will store OBD2 data after which machine learning algorithm i.e. CNN (Convolutional Neural Network), will be executed to calculated vehicle condition and its maintenance period using time series forecasting. There will be a customize Kibana dashboard to which all the data will be passed to it which will show a map that will be accessible to everyone and for vehicle details there will be separate user access through personalized login.

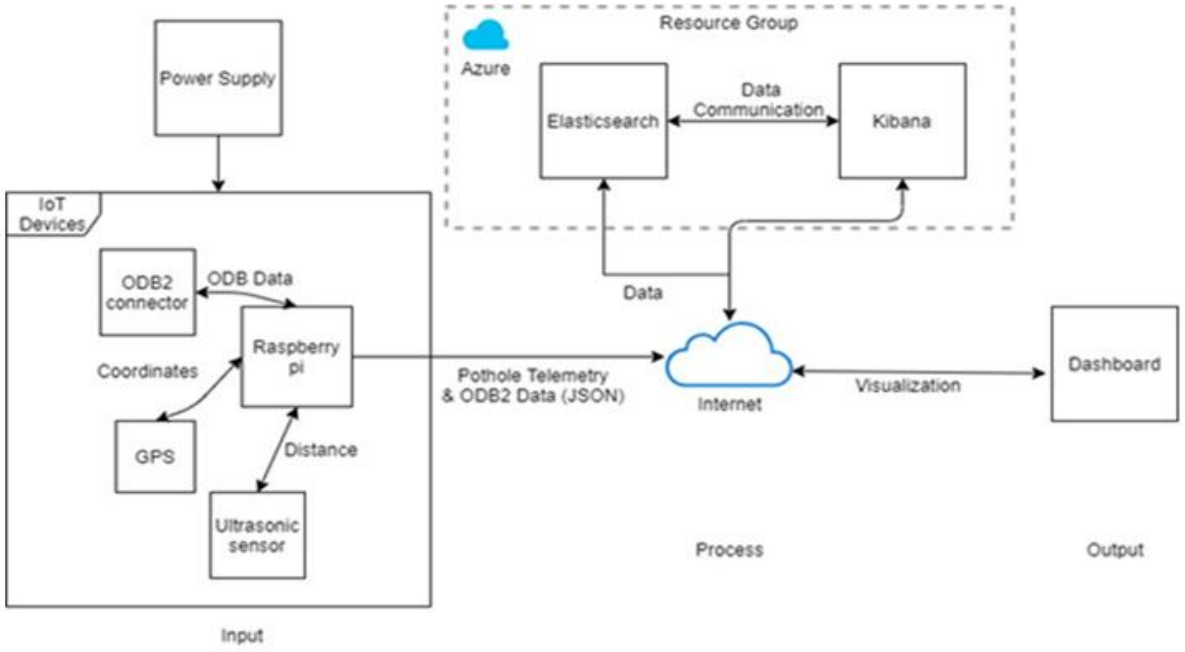

Figure 1: Block Diagram

VI. COMPONENTS USED IN THE PROPOSED SYSTEM

1. Raspberry Pi Zero-W: Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. Early on, the Raspberry Pi project leaned towards the promotion of teaching basic computer science in schools and in developing countries The Raspberry Pi Zero W is still the Pi you know and love, but at a largely reduced size of only 65mm long by 30mm wide and at a very economical price.

2. Ultra-Sonic Sensor: is an active ultrasonic sensor and contains a transmitter and a receiver. It is used to measure distance at which, objects are placed in front of it. The ultrasonic sensor transmits high frequency sound waves and waits for the reflected wave to hit the receiver. The distance is calculated based on the time taken by the ultrasonic pulse to travel a particular distance. There are different types of ultrasonic sensors with different transmission ranges and angles of detection. The HC-SR04 sensor work at frequency of 40 KHZ and can measure distances of the objects in the range 2 to 400 cm with a 15° angle of detection. [2]

3. GPS Module: Global Positioning System (GPS) is a satellite navigation system and is used to capture geographic location and time, irrespective of the weather conditions. It is maintained by the U.S. Government and is freely available to anyone who has a GPS receiver. It obtains the GPS information from satellites in National Marine Electronics Association (NMEA) format. The NMEA has defined a standard format for the GPS information. This is followed by all the satellites. The standard defines various codes such as Fig. 3. Architecture of the proposed system. GLL-Latitude/Longitude data, GSV–Detailed satellite data and RMC-Minimum Recommended Data [9]. GSM SIM 900: Global Standards for Mobile Communication (GSM) is a set of standards for Second Generation (2G) cellular networks. The GSM SIM 900 module uses any network provider's SIM to communicate over the telecommunication network. This modem can be used to send and receive text messages and to make and receive voice calls. GSM SIM 900 is a quad-band GSM modem that functions at 850, 900, 1800 and 1900 MHz frequencies. This modem also supports features like transferring voice data, integrated support for GPRS and TCP/IP stack.[2]

4. Elasticsearch: Elasticsearch is a search engine based on the Lucene library. It provides a distributed, multitenant-capable full-text search engine with an HTTP web interface and schema-free JSON documents. Elasticsearch is developed in Java. Following an open-core business model, parts of the software are licensed under various open-source licenses (mostly the Apache License).[10]

5. Kibana: Kibana is an open-source data visualization dashboard for Elasticsearch. It provides visualization capabilities on top of the content indexed on an Elasticsearch cluster. Users can create bar, line and scatter plots, or pie charts and maps on top of large volumes of data.[11]

VII. MATHEMATICAL MODEL

S= {I, O, F, Success, Failure}
S=System, I = Input, O = Output, Success = Success case, Failure = Failure Case.
I = {I1, I2, I3} I1=ultrasonic sensor, I2=GPS sensor, I3=OBD2.
O = {O1, O2} O1=Heatmap, O2=vehicle details and maintenance
F = {F1, F2} F1= Elasticsearch data nodes. F2= CNN (Convolutional Neural Network).
Success Case = System will show right location of potholes on map and vehicle's maintenance prediction.
Failure Case = System will show wrong locations of potholes on map and wrong vehicle's maintenance prediction.

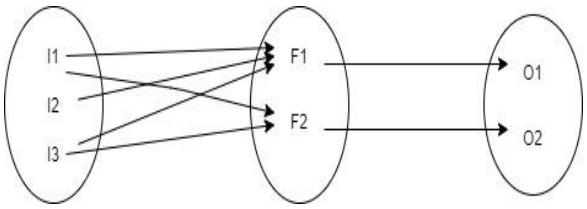

Figure 1: Venn Diagram

VIII. CONCLUSION

This application demonstrates how we can make a big difference in road maintenance by collecting the data of potholes and provide it accurately on the map to the government and people so it can be accessed easily which will boost the road maintenance work and provide people with maintenance and other details of their car so they will know if something is wrong with their vehicle.

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