Current Potholes and Hump Detection Techniques: A Literature Review

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Abstract—India recorded that over 9,300 people had been killed and nearly 25,000 were injured in road accidents as a result of potholes. This is a serious concern over increasing accidents due to potholes on roads and these are much more than deaths due to terror attacks. It is unacceptable that such a large number of deaths take place on roads due to potholes and humps. A constant detection and repair in proper time can not only result in ensuring road surface quality but can also save many lives. Many Proposals are collected from the standard journals, and it is first reviewed chronologically to find out the contributions in potholes and hump detection techniques. After reviewing, the various challenges addressed in the road maintenance is discussed. The various approaches used in the detection of potholes and humps are discussed and reviewed. The approach such as a vibration based for automatic detection of potholes and speed breakers along with their coordinates, a stereo vision system which detects potholes during driving, an internet of things based road monitoring system (IoT-RMS) is proposed to identify the potholes and humps in the road, Ultrasonic sensors are used to identify potholes and humps and also to measure their depth and height respectively, Computer vision approaches are generally based on either 2D road image analysis or 3D road surface modeling. As the research outcome, case studies are taken and reviewed.

Index Terms—pothole detection, computer vision, road surface modeling, speed breaker, road surface monitoring, stereo vision,cloud, IoT , ultrasonic Sensors, Android application.

1 Introduction

India, the second most populous Country within the earth and a quick growing economy, is understood to possess an infinite network of roads. Roads are the dominant means of transportation in India today. They carry almost 90 percent of the country's passenger traffic and 65 percent of its freight [1]. However, most of the roads in India are narrow and congested with poor surface quality and road maintenance needs don't seem to be satisfactorily met. No matter where you're in India, driving may be a breath-holding, multi-mirror involving, potentially life threatening affair.

The bad road condition is the main reason for all the truck accidents, per the survey in [3]. The weakened road system increases the upkeep cost and also the negative effects on the axle and mechanical system of the vehicles. Various factors which affect the performance of the road are 1) Heavy traffic which causes the repetition of the load 2) low-quality materials and inappropriate moisture condition at construction.

Potholes, formed due to heavy rains and movement of heavy vehicles, also become a major reason for traumatic accidents and loss of human lives. Road surfaces can be classified into different categories such as smooth roads, potholes, bumps, contraction joints, man holes, expansion joints etc [2]. The surfaces where one has to slow down his speed are potholes and bumps (also known as speed breakers).

Fig 1 represents the statistical data of Indians killed in pothole related accidents over the past four years and shows top states in pothole deaths. Following is the report by the ministry of road transport.

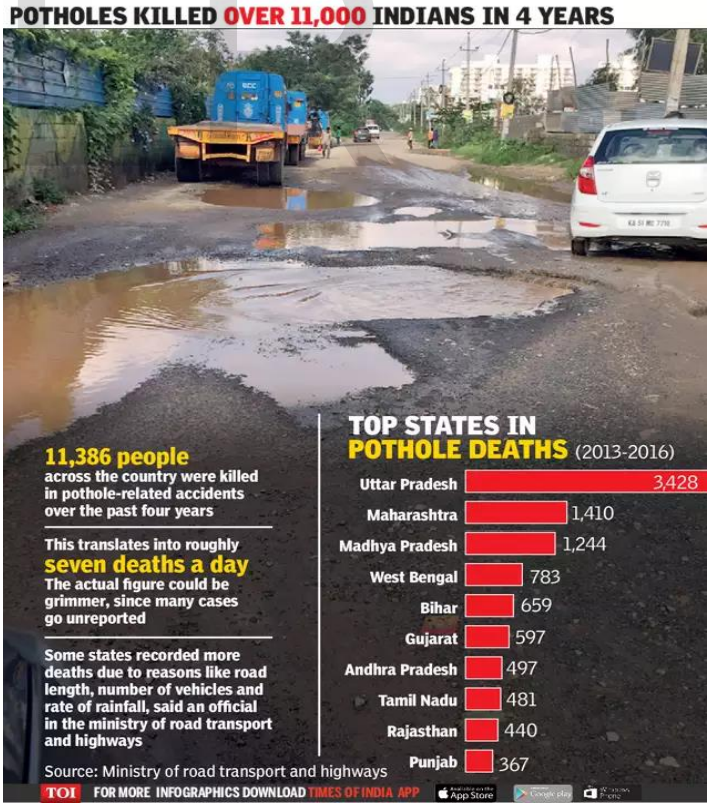

Fig 1: Statistic Report by Government representing road accident

From the above data we can see Pothole-ridden roads have taken 11,386 lives across India in the last four years, which interprets into roughly seven deaths each day. These dangerous road conditions are a distraction for all the commuters, hence detection of these potholes plays a major role in fixing them on time and can prevent many road accidents. For pothole detection many approaches are preexisting but

each of them has their own drawbacks. This paper analyses the related work and proposes an efficient solution which may prove to be a great help to the commuters.
In this paper the Related work and their analysis is presented in Section 2 followed by the conclusion in Section 3.

2 Related Work and Analysis

Pothole detection being a noteworthy subject of research, specialists are taking an effort at various pothole detection methods. a number of the pothole detection methods are referenced underneath.In this section we'll analyze each of those approaches

2.1 Road Pothole Detection System Based on Stereo and Information Sharing

Yaqi Li [5] proposed a stereo vision system which detects potholes during driving. The target is to learn drivers to react to potholes prior to. This technique contains two USB cameras taking photos simultaneously. They used parameters obtained from camera calibration with checkerboard to calculate the disparity map. 2-dimensional image points are projected to 3-dimensional world points using the disparity map. With all the 3-dimensional points, we use the bi-square weighted robust least-squares approximation for paved surface fitting. All points below the paved surface model are detected as pothole regions. the scale and depth of every pothole is obtained furthermore. The experiments we conducted show robust detection of potholes in several road and light-weight conditions.

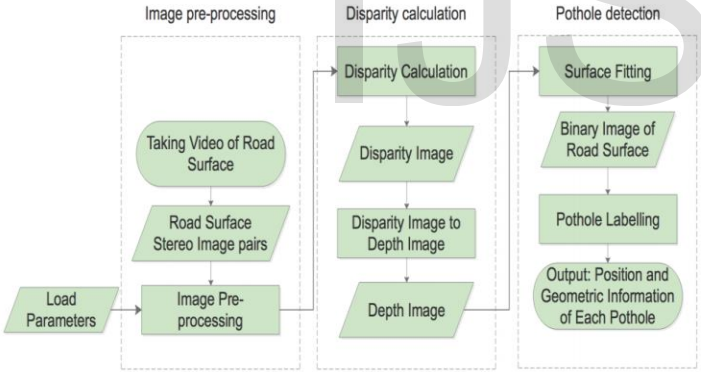

Fig 2: On-line Flowchart of the Pothole Detection System [5]

2.2 IoT Based Humps and Pothole Detection on Roads

Chellaswamy C [6] proposed an online of things based road monitoring system (IoT-RMS) method to spot the potholes and humps within the road. The pathway which is full of the pothole is greatly influenced by the scattering signal of the ultrasonic sensor. therefore the magnitude of the reflected signal decreased because of the roughness of the surface and therefore the signal amplitude is difficult to investigate. The Kirchoff"s theory basically applied for real-time analysis and it's certain limitations. to beat this difficulty, an accelerometer has been included with the ultrasonic sensor to live variation present within the signal and optimized using honey bee optimization (HBO) technique. The IoT-RMS automatically updates the status of the road with location information within the cloud. Each road vehicle can access the data from the server and estimate the speed in line with the potholes and humps present on the road. The simulation has been done and therefore the result shows that the IoT-RMS is accommodated in road vehicles to scale back accidents. this technique was implemented and tested using Arduino Uno with ESP 8266.

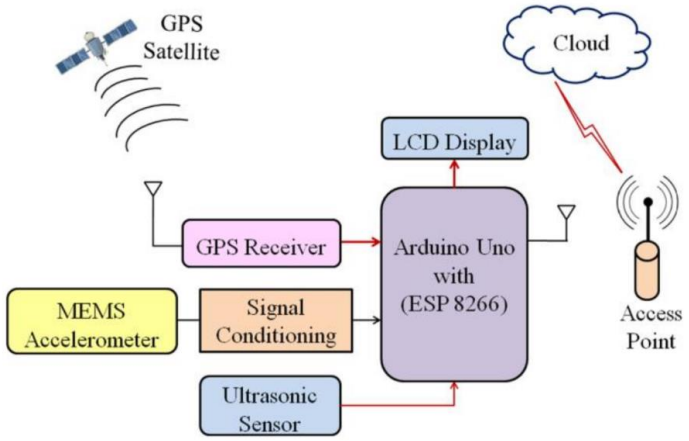

Fig 3: hump and pothole detection and information sharing system [6]

2.3 Automatic Pothole and Speed Breaker Detection using Android System

Vinay Rishiwal [4] presented a vibration based approach for automatic detection of potholes and speed breakers together with their coordinates. During this approach, a database is maintained for every road, which is formed available to the general public with the assistance of a world database or through a portal. Potholes and humps are detected together with their severity using android's built-in accelerometer. The results of the proposed approach are tested over a 4 km flat road and compared to manual inspection of pothole and speed breakers on the identical considered road. The accuracy of the proposed approach came dead set be 93.75% for detection of potholes and speed breakers.

2.4 Smart Pothole Detection System using Vehicle Mounted Sensor and Machine Learning

Ali Anaissi [7] proposed a virtual road network inspector (VRNI), which continuously monitors road conditions and provides decision support to managers and engineers. VRNI used acceleration data from vehicle-mounted sensors to assess road conditions. It proposed a novel road damage detection method based on two adaptive one-class support vector machine models, which were applied on the vertical and lateral acceleration data. Evaluated this method on data from a real deployment on school buses in Australia. Experimental results show that our method consistently detects 97.5% of the road damage with a 4% false alarm rate that relates to benign anomalies such as expansion joints.

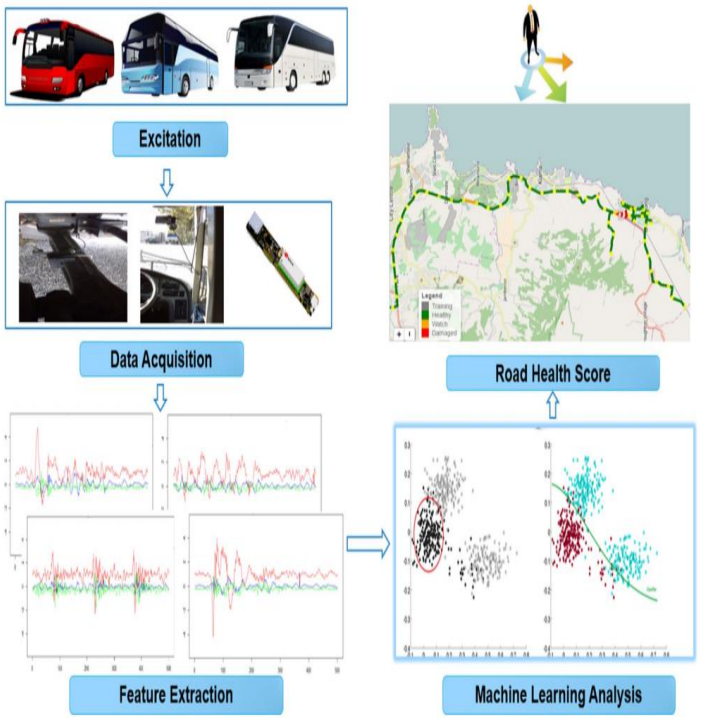

Fig 4: System overview of the virtual road network inspector[7]

2.5 Automatic Pothole Detection System

S Gayathri [8] presented a prototype which detects the pothole in the path of driving and updates it to the cloud. A voice notification alerted the driver of the potholes ahead. Website was built which will be accessible by the authorities concerned so that they can take care of the potholes detected. This system helped in the maintenance of the roads.

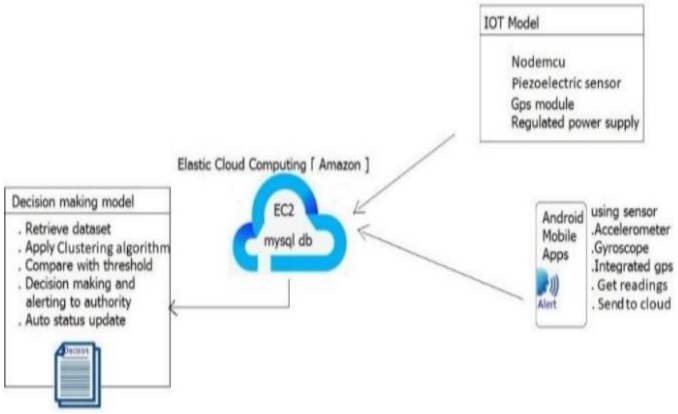

Fig 5: Block diagram of the system [8]

2.6 Design and Development of an Intelligent System for Pothole and Hump Identification on Roads

B. G. Shivaleelavathi [9] presented a simple solution to detect potholes and humps and hence avoid accidents and help drivers. Potholes were detected using Image Processing Technique and Ultrasonic Sensors were used to detect humps. Controlling device used is Raspberry Pi. The system acquires the geographical position of potholes using Wi-Fi and transmits it to authorities to take corrective measures.

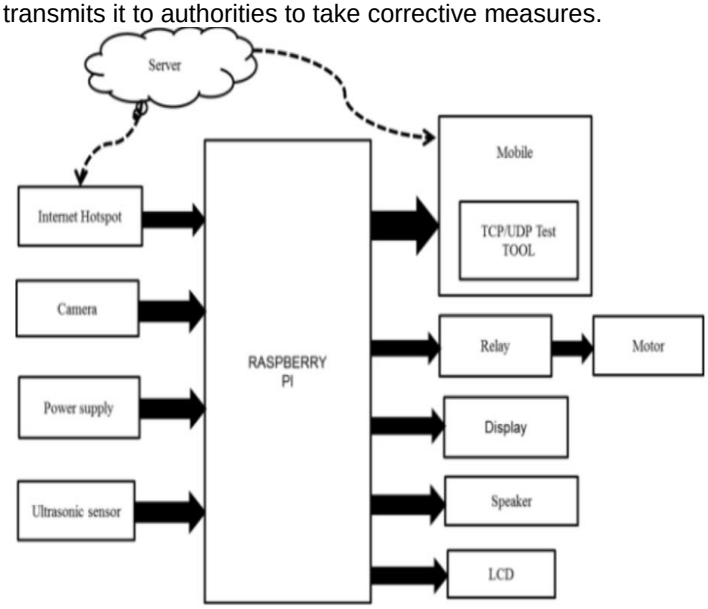

Fig 6: Block diagram of the Pothole and Hump detection System [9]

2 Conclusion

In this paper the authors explorers and give analysis on various pre existing approaches for detecting the pavement potholes. The authors also suggest the issues in the predecessors work [4, 5, 6, 7, 8, 9] and tries to give a novel approach with the assumption to eliminate the high equipment cost, high computation power and error in the data collection. Authors propose a demo of a very low cost embedded system, installed on public transports for crowd sourcing the relevant pothole data along with the location coordinate.

Although we can conclude that a simple model presented may be sufficient to estimate the road quality and avoiding traffic congestion and collisions, there are still many issues that are to be dealt with in our future works to make the approach more efficient.

In future, we envisage to improve and extend this approach to accommodate with simulation results and with information about the quality of road by detecting the vibration data we get from accelerometer sensor module.

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