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DESIGN AND DEVELOPMENT OF POTHOLE DETECTION USING IoT

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Abstract— ***One of the major issues faced by developing countries like India is maintaining the road conditions. Potholes are caused due to badly maintained roads. This will cause severe vehicle damage that leads to unexpected accidents. Here we propose the design of a 'Pothole detection System' which assists the driver in avoiding pot-holes on the roads, by giving him prior warnings. The sensor is attached to the vehicle. The data obtained from the sensor and the locations obtained by GPS are transferred to the server. Data from the server is accessed by the mobile application and is notified to the user. This will help minimize major road accidents. This designed work is more economical and precise.***

Keywords— Pothole, Wi-Fi access, buzzer, sensor, mobile node, access point.

I. INTRODUCTION

An increase in the world's population has caused an increasing load on the infrastructure. Roads have been flooded with vehicular traffic. It has become increasingly difficult to manage this traffic. This is the prime motivation behind making a vehicle intelligent enough to aid drivers in various aspects. One of the increasing problems the roads are facing is worsened road conditions. Because of many reasons like rains, oil spills, road accidents, or inevitable wear and tear make the road difficult to drive upon. Unexpected hurdles on-road may cause more accidents. Also because of the bad road conditions, the fuel consumption of the vehicle increases; causing wastage of precious fuel. Because of these reasons, it is very important to get the information about such bad road conditions, collect this information and distribute it to other vehicles, which in turn can warn the driver. But there are various challenges involved in this. First of all, there are various methods to get information about the road conditions. Then this information must be collected and distributed to all the vehicles that might need this information. Lastly the information must be conveyed in the manner which can be understood and used by the driver. In this project we try to design and build such a system. In this system the access point collects the information about the potholes in the vicinity of a wireless access point and distributes it to other vehicles using a wireless broadcast. Here 'vicinity' is a user-defined term. Ideally, the vicinity is every route till the next access point.

II. LITERATURE REVIEW

[1] Byeong-ho-Kang and Su-il-choi proposes the concept of sensing potholes by using 2d lidar method. It is a sensing method which uses light pulses to ascertain the surface of earth. The major drawback in this method is, it is highly affected by heavy rain, fog, etc. Also does not work well at huge reflections .The operating cost for this approach is comparatively high.2021

[2] Amila Akagic, Emir Buza and Samir Omanovic used the RGB image processing techniquehusly,complex figuring devices that consolidate programming and equipment to process the pothole pictures are required in this technique. It is also consumes more time when compared to other methods. Also the accuracy rate is low in this approach. Moreover it needs prior knowledge of the images i.e., a large quantity of training sets have to be given. 2021

[3] Kana Azhary, Feerd Murtaza, Muhammad Herboon mohammed and Hafed Adman Habit stated an approach of finding and localizing the potholes based on computer vision in asphalt pavement images. Histograms from the input images are classified using naïve bayes classifier using normalized graph cutsegmentation scheme. This experimentation showed 90% accuracy on localizing the potholes from the pothole images.2019

[4] Yaqi Li Christos Papachristou proposed a stereo based system that helps to detect the potholes. Following is the workflow for the same: The system contains two USB cameras taking photo simultaneously of the road. After collecting all the required data. We use parameters obtained from camera calibration with checkerboard to calculate the disparity map. By making the use of 2-dimensional image points that can be projected to 3-dimensional world points using the disparity map.2019

[5] Artis Mednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs, Leo Selavo" has proposed "Real time pothole detection using android with accelerometer" which uses primary data of the accelerometer sensors were collected using LynxNet collar device on an urban road with various potholes. The working of device is based on Tmote Mini sensor node with Texas Instruments microcontroller MSP430F1611 and Analog Devices 3 Axis accelerometer ADXL335.2018

[6] Bhoraskar R., Vankadhara N., Raman B. & Kulkarni, P. has proposed "Traffic and Road Condition Estimation using Smartphone Sensors" which uses accelerometer for detection of potholes with magnetometer and gps is implemented. However, this project does not have a real time access to the location where the detection was triggered.2018

[7] G. Strazdins, A. Mednis, G.Kanonirs, R. Zviedris, and L. Selavo has proposed "Sensor Networks with Android Smartphones for Road Surface Monitoring" uses hardware components and is attached to the vehicles and uses clustering algorithm for data analysis.2018

[8] Kim and Ryu proposes Convolutional Neural Networks (CNNs) have the ability to learn the art of extracting relevant features from an Image. We have created a dataset of 1500 images datasets of pothole. The dataset is annotated and trained using YOLO (You Only Look Once). The new dataset is trained on YOLOv3, YOLOv2, YOLOv3-tiny, and the results are compared. The results are evaluated based on the mAP, precision and recall. The model is tested on different pothole images and it detects with a reasonable accuracy. 2018

[9] K. T. Chang, J. R. Chang, and J. K. Liu describes a low-cost method that employs a smartphone and an OBD-II module to detect and locate potholes on roads. It utilizes vision data, sensor data and OBD data to create and validate triggers caused by potholes. The image-triggered and data-triggered methods proposed recognize potholes on roads and create a trigger through image/video processing and data processing respectively. The results obtained from each method is cross validated by the other method that help in evaluating ride quality based on road conditions.2017

[10] H. Lokeshwor, L. K. Das, and S. Goelproposed the 3d laser method to detect potholes and obstacles. The 3D laser checking is one of the outstandingly flexible and productive advances for precisely catching extensive arrangements of 3D facilitates. This method uses laser pulses to detect the irregularities in road surfaces. It is applicable to 2d and 3d surfaces. The disadvantage is that it requires post-processing to produce a usable output i.e., the output requires manipulation.2017

III. EXISTING SYSTEM

There are various challenges involved in this project.

• Client device must be able to sense the pothole. It will be an added advantage if it can characterize the pothole telling how severe it is.

• Placement of access points is an important factor. It should be in such a way that the data should be distributed to maximum vehicles.

• Communication between access point and client device can have many problems which should be resolved. Some of the problems that communication can face are interference, Low throughput due to large no of client devices, end to end reliability.

• Data representation should be in such a way that the client device should be able to locate and warn the driver about the potholes which it has information about.

In this report we explain the system that has to be built. Chapter 2 explains the overall systems and what are the subsystems involved, different choices for the subsystem. Chapter 3 explains the challenges involved in implementing the selected subsystems. Chapter 4 explains experimental setup, some of the experiments that are performed and some which need to be performed. And finally, Chapter 5 gives the summary of the report and Future work.

IV. PROPOSED SYSTEM

Pothole detection system is a system that aims at warning the driver about the uneven roads and potholes in its path. We study the different ways in which the goal of the system can be achieved. We justify the methods we have

chosen in tprojectects. And then we give details about the working of the different subsystems. The problem statement can be given as follows. This system consists of two components one is the mobile node and the other is the access point. Access points are responsible for storing the information about potholes in its vicinity, taking the feedback from vehicles, updating the information in the repository and broadcasting the information to other vehicles. Whereas Mobile node which is the small device placed in vehicle is responsible for sensing those potholes which it did not have previous information about, locating and warning the driver about the potholes which it has information about, and giving the data about newly sensed pothole to access point. The whole scenario works as follows. While deploying the access point we feed in some initial data about potholes to it. Then it keeps on broadcasting the data. Vehicle equipped with the client device catches that data. Now the device has the information about the locations of potholes. The device is responsible for warning the driver about occurrences of pothole. But new potholes may always be formed because of environment or fatigue. So client device also acts as a sensor and finds out the occurrence of newly formed potholes on the road. If it finds out any new potholes it gives data of new pothole to Access point in terms of the feedback. Access points updates this information to its data store and then adds it to the information broadcast.

Components Used:

1) Ultra Sonic Sensor:

As the name indicates, ultrasonic sensor measure distance by using ultrasonic wave. The sensor head emit an ultrasonic wave and receives the wave reflected bank from the target. Ultrasonic sensor measures the distance to the target by measuring the time bet the emission and reception.

Figure 1: Ultra Sonic Sensor

2) Node MCU

NODE MCU: Fig 3.1 Node MCU is an open-source LUA based firmware developed for the ESP8266 Wi-Fi chip. By exploring functionality with the ESP8266 chip, Node MCU firmware comes with the ESP8266 Development board/kit i.e. Node MCU Development board. Since Node MCU is an open-source platform, its hardware design is open for edit/modify/build.

Node MCU Dev Kit/board consist of ESP8266 wifi enabled chip. The **ESP8266** is a low-cost WIFI chip developed by Expressive Systems with TCP/IP protocol. For more information about ESP8266, you can refer to the ESP 8366 WIFI module.

There is Version2 (V2) available for Node MCU Dev Kit i.e. **Node MCU Development Board v1.0 (Version2)**, which usually comes in black colored PCB. Fig 2 Node attached

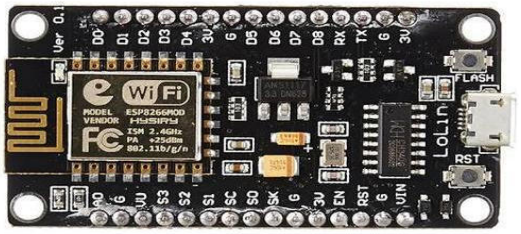

Figure 2: GSM Module

3) GPS Sensor

GPS sensors are receivers with antennas that use a satellite-basednavigation system with a network of 24 satellites in orbit around the earth to provide position, velocity, and timing information. Fig 3.3 GPS Sensor attached.

Figure 3: GPS Sensor

Client device must be able to sense the pothole. It will be an added advantage if it can characterize the pothole telling how severe it is.

Communication between access point and client device can have many problems which should be resolved. Some of the problems that communication can face are interference, Low throughput due to large no of client devices, end to end reliability.

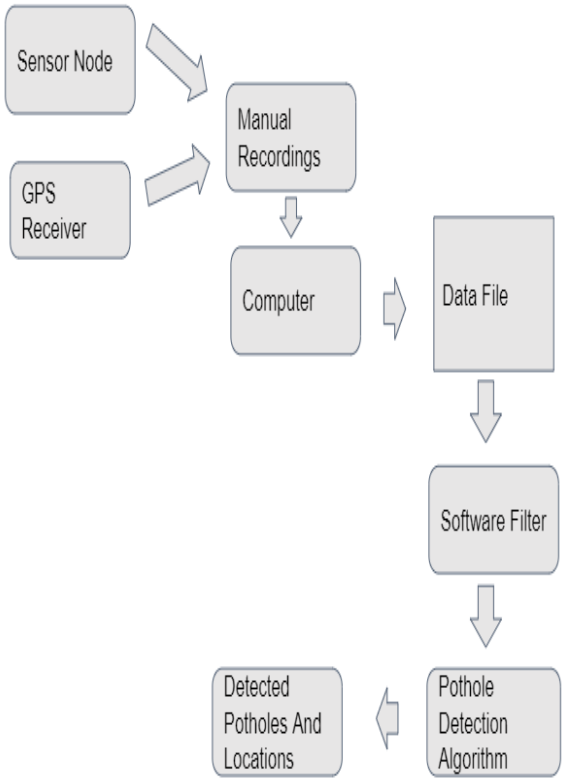

Figure 4: Block Diagram of Proposed Design

V. RESULT AND DISCUSSION

The proposed algorithm is implemented on Arduino using ultrasonic sensor. The sensor is attached under the vehicle body so that it has a direct view of the road. The working of our proposed system will be tested in simulated environment which is essentially a demo model consisting of artificial potholes. The test will be divided into two parts: First is the detection of potholes and this information will be recorded and uploaded to the database. Second is the alert sent to the driver based on the detected potholes and their locations as stored in the database. After implementing proposed Pothole Detection and Mapping System which overcomes two major problems that concerned the people the most and which leads to frequent accidents and damage of vehicles that is automatic detection of the potholes with their intensity and mapping it on map. The proposed work is more economical as it uses a low-cost ultrasonic sensor and a GPS module. This model also works when potholes are filled with water and corresponding information about the potholes is shown in the android app. This work provides best solution for the above problems as the location of the pothole can be seen in the app along with its intensity, it brings to the notice of the government officials as a result, and they can maintain the roads properly.

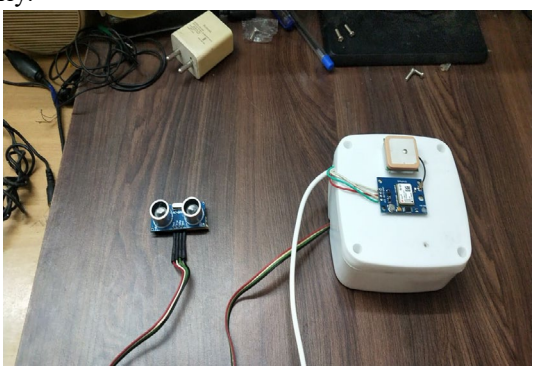

Figure 5: Photography Diagram

IMPLEMENTATION DIAGRAM:

In the Fig 6 Implementation Diagram represent the application shows the Data of Latitude and Longitude. It shows Ultrasonic sensor data in Centimetre units. Based on the latitude and longitude it visualizes in Map.

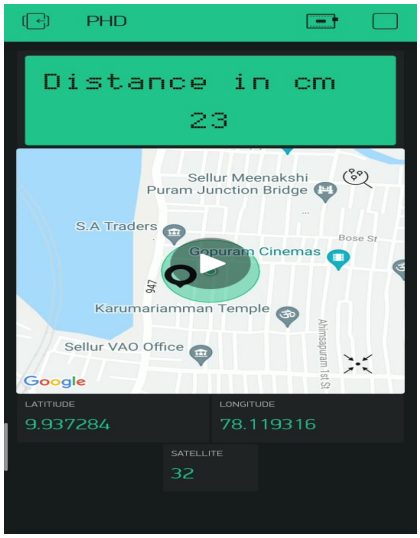

Figure 6: Implementation Diagram

Fig 8 Diagram represents the application shows the Data of Latitude and Longitude. It shows Ultrasonic sensor data in Centimeter units. Based on the latitude and longitude it visualizes in Map.

VI. CONCLUSION

The automatic detection of the potholes and humps is achievable with inexpensive and accurate system using ultrasonic sensor and GPS module. The pothole detection system here uses PIC microcontroller for processing of data. In this project report we described about ultrasonic sensor, Wi-Fi technology, GPS receiver and implementation of pothole detection system, also benefits of the system. We have achieved our target of detecting the pothole and creating the database of the detected pothole. This system is also capable to work in rainy season when potholes are filled with muddy water as alerts are generated using the information already collected in the database. The project presents the model for the detection of dry and water- filled pothole. The model works well for detecting pothole and giving warning. The ultrasonic sensor with the help of micro controller calculates the depth of the pothole and using other modules calculates the distance. It gives warning to the driver about the presence of pothole. The experimental results shows that the algorithm works for the detection and warning the driver regarding pothole. It detects the discontinuity and warns by displaying proximity and depth of the pothole on LCD We used ultrasonic sensor for sensing the depth of the pothole and GPS receiver for recording its location in the terms of latitude and longitude. We used Wi-Fi module for sending the data to the server through creation of hotspot on mobile. The database of the recorded potholes could be observed over the server or the serial monitor. The model proposed overcomes two major problems that concern the people the most and which leads to frequent accidents; the automatic detection of the potholes and their depth. The proposed work is more economical as it uses a low-cost ultrasonic sensor and a GPS module. This model also works when potholes are filled with water and corresponding information about the potholes is shown in the google map API which is integrated in android app. This part is implemented as an android application that is installed on the vehicles driver's smart mobile phone to provide alerts real time about the presence of potholes also pedestrian users can use this app and upload images of potholes they encountered. The application continuously runs in the background of phone application to provides the current geographic location of the vehicle through GPS and then accesses the locations of potholes which is stored in the server database also with the upload pothole option the user can upload a image of pothole and once its approved by admin then it will be processed by deep learning framework As shown in figure 8.A and 8.B and maps all the potholes records their dimensions and classifies them accordingly and update result that is pothole severity in the server database. The social benefits of proposed system are as given below:

It helps the common people and government by localizing potholes with its severity. It removes the need for citizens to submit social complaints to their government regarding road condition. It also removes the need for manual collection and analysis of data.It does not require any expensive dedicated hardware for data acquisition, installation and maintenance. Information is continuously updating to get real information to take future decisions. This may lead to further improvement in road conditions by government which allows traffic to move faster and smoother. It improves health of public and vehicles.

VI. Future Scope

In future we can use this system widely for safety and maintenance of roads.We can use sensor network deployed over a public transport system to monitor environmental pollution and road surface condition.Our next and immediate step is to use the Accelerometer on real vehicles and measure their response And we plan to come up with values for the related parameters.This prototype can be implemented in the real life world with various other applications other than the sole purpose of the project such as car tracking via GPS, anti-theft management, humps detection and vehicular communication.

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