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Machine Learning Approach for Predicting Bumps on Roads

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Abstract: Now a days, the number of accidents increased due to the increase of number of vehicles. The driver must be known about the road condition for his safety. There are some expensive methods to install a dedicated hardware on the vehicle. So we have designed a method based on smart phone using Accelerometer and GPS sensors to identify the road condition. The system that is designed is called Bumps Detection System. The potholes are detected by using the accelerometer and the location of potholes are plotted on the map by using the GPS sensor. So we implemented an Android application by extracting the API of Google Map to locate the potholes in the roads by using a smart phone device held by the driver. The condition of the road and the number of potholes will be informed to the driver in advance in the map by a warning mark. While designing the system, some threshold values that are experimentally derived. A machine learning approach is used to find those threshold values. By using these information, the system is trained. To build the system on the trained data, K-means algorithm is applied. For better prediction, the Random Forest Classifier is applied on the test data. In this application we also include voice based command in both English as well as in our regional language (Malayalam) to notify the driver about the condition of the road.

Keywords: Accelerometer, Google Map, GPS, K-means Clustering, Random Forest Classifier

I. INTRODUCTION

We designed a system by focusing to reach the destination as soon as possible. There are so many instances on the road to effect out travel. Something like speed bumps, potholes, lane change. These instances are not indicated on the Google map while we are travelling in an unknown route by using Google map. So the driver is unaware of the road condition and chance for fall on the potholes and bumps. In our device, one is an expensive method which is to enter the data manually about the road conditions. Now days, the growth in the smartphones are extraordinary. Now a normal smartphone has some sensors like accelerometer, GPS, magnetometer and cameras. By using these sensors like accelerometer and GPS, we can find the condition of the roads. By using the application on the smartphone, the driver can be get informed about the road condition and potholes. The voice assistance is also provided in both English and our regional language (Malayalam). The accelerometer is used to find the potholes and bumps in the road. In a normal condition the X and Y-axis remain zero and when the bumps, the z-axis increases and during the potholes, the z-axis decreases. There is a threshold value which is experimentally derived and when the z axis is increased more than this value, the bumps are detected and when decreased than this, then potholes are detected. By using GPS, the location is stored in the database and spotted in the map.

II. LITERATURE SURVEY

Shortest Route at Dynamic Location with Node Combination using Dijkstra Algorithm is explained in this paper[1]. In our daily life, we have to travel a lot. The number of vehicles are also increased day by day. It also increases the traffic in the roads and the roads become congested. In any emergency condition, we have to reach the destination as soon as possible, so we have to find the shortest path from our location to the destination. In this paper[1], they focus on finding the shortest path from a location to the destination by using the Dijkstra algorithm. The Dijkstra algorithm checks the every path from the location to nearest vertex or junction. Then it replace the longest route by the shortest distances and at last it founds the shortest path to reach the destination from the location. The GPS is used to find the location of the user and then the distance is founded from that location. The API of Google map is used here to show the shortest path and another method called node combination is used here. In this method, the distance from a common point to an another point through different ways are combined together and a common path is plotted and then also combine another paths together and find the shortest path.

Travel Time Prediction: Comparison of Machine Learning Algorithms is described in this paper[2]. In our daily life the time is very important. This paper[2] is based on the method to find the travelling time by using the location of the user and the destination to reach. By using this paper the user can reduce the transportation cost and delays during travelling.

The Google map API is used here to indicate the map. The Nearest neighbour is the one of the method used here. In this method, the time taken for covering a fixed distance is founded and by using that, the time required to reach the destination is found. An another method used here is Windowed nearest neighbour, using this method, the travel time is found by finding the distance covered by the user in a fixed time. Google Maps API has been used to collect travel time data for a link that had not available or accessible travel time data. Then, several machine learning models were applied to predict travel time for short horizons.

Real Time Pothole Detection using Android Smartphones with Accelerometers is described in this paper[3]. There are so many distractions can be caused during our transportation like dangerous road surface. In the case of an unknown route, the driver will be unaware of the road condition and there is a chance for accidents due to the bad condition of road. To avoid that an application has been designed which indicates the potholes on the road by using an accelerometer and a smartphone. The application in the smartphone indicates the potholes on the road and the accelerometer is used to identify the potholes in the roads. A threshold value is determined experimentally. During travelling, the change in the z-axis is noted and then if the change is greater than the threshold value, then a pothole is identified and then it is located in the map by using the GPS. The smartphone sensors are also used here for finding the pothole.

Nericell: Rich Monitoring of Road and Traffic Conditions using Mobile Smartphones is explained in this paper[4]. In this paper the real time traffic conditions are monitored by using the GPS and Google map API. The GPS is used to track the whole person in the road and it is the same technique that used by Google to identify the traffic of each road and in Google map, the traffic areas are denoted by tracking each person and check the number of users are in the road and by a ratio that between the area of the road and number of person on the road to check the road is congested or not. The Google map API is used to maintain a user friendly interface like Google map. This paper provides the user a information about the traffic condition of the road that he want to go. The user can monitor the traffic condition of the road. By using the accelerometer in the smartphone, the movement is also tracked also the location. So, the number of users in a particular location increases, then the traffic is shown high and when it comes low, then it shows a low traffic.

A Google-Map-Based Arterial Traffic Information System is explained in this paper[5]. It is introducing a web based mapping technologies for a traffic information system. Few of such systems only focus in arterials or urban streets. This paper explains about the Real time Google map based arterial traffic information system for urban streets in a particular city or town. By using this method, we can reduce the transportation cost, reduce traffic, and delays. It also helps to reduce the congested roads and indicates the traffic on the application installed in the smartphone. The user has to update the details about the road that they used and they has to send a feedback. Then their feedback will be active for a few minutes and the other users can get informed about the road condition from other users. There is a database to store the data that collected from the users and the other users can access the same data for a fixed time and it must be updated. When somebody has done a feedback, their location is traced and marked in the Google map as their feedback. An html webpage is used to enter the feedback by the users. It is not much practical and so many other methods has been implemented now.

In [6] today there are lot of accidents occurring because of increase in number of vehicles. There are various situations of road that may can cause accidents that user may not aware of these while travelling. One of the solution for this is manually identify such situations and stored on central server. But this method is expensive so a smartphone based method that uses an accelerometer and GPS sensors used to analyse different road conditions. Accelerometer is used for pothole detection and GPS for plotting location of potholes on Google Map. So, drivers may get information in early about number of potholes on road. During designing the system we have assuming some experimentally derived values. To explain these values we uses Machine learning approach. In order to develop a model, K means clustering algorithm is applied on the data to be trained. The external and internal sensors of smart phone can be used for collecting data about various road conditions. This data obtained is called Training data. By using this data can able to make future or better prediction of road conditions. Smart phone has the ability for sensing. This method based on smart phone is useful because it eliminates the need of placing sensors in vehicle or different junctions. One of the advantage is scalability.

In [7] , presents a system which can automatically detect and alert the dangerous vehicle manoeuvres typically related to drunk driving. In this system the typical driving pattern are extracted from the real driving tests. A programmed mobile phone placed inside the vehicle which contains the orientation sensor and accelerometer. The device can read the vehicle acceleration and compare with the drunk driving patterns. When the evidence of drunk driving is present the mobile phone will alert the driver and call the police before any accident will happen. In this approach utilize the mobile phones as the main platform to detect drunk driving and alert the driver or police about the dangerous driving situation. So that the system can function effectively because the mobile phone are highly portable and all the necessary components for this system are already integrated into it. They design an algorithm for detecting the drunk driving using mobile phone are developed.

In [8] , As the present road condition getting worse day by day, Vehicle manufactures use advanced driver-assistance systems to increase the safety. New smart phones provides a variety of sensors that helps as safety measures to the drivers on road. An android based smart phone provide three-axis accelerometer to detect the behaviour of the driver and conditions of the road for the safety purpose. Conditions are analysed on the basis of data collected and determine how to operate a vehicle efficiently and safely. While traveling our main aim is to reach the destination quickly and more safely. In current society it is much more difficult to reach the destination as soon as possible through these worse condition of road. Due to these bad condition of road accident rate are increasing day by day. In current world, production and usage of smart phones are high and they are embedded with accelerometer, GPS, cameras. Sensor network scope has expanded into many application domains such as intelligent transport system which can provide users with previously unheard of new functionalities. Additionally, older vehicles could have only passive safety features since manufacturers have only recently started to introduce effective driver assistance. Since sensors ultimately add to a vehicle's cost initially and can't be upgraded affordably. In this article, we use an Android-based smart phone's three-axis accelerometer to monitor and evaluate different vehicle activities and local road conditions potentially dangerous to rider, surrounding people, and automobile safety.

In [9], when we move on to the road we people are unaware of the road condition. In smart phones there will be inbuilt sensors to provide safety to the drivers on road. While travelling the three axis accelerometer and GPS system in the smart phone helps to assist the driver. In this paper they studied and reviewed the safety measures with Advanced Driver Assistance System (ADAS). Various road conditions are analyse and record using three axis accelerometer in the android based smart phone. Which also used to alert the drivers. Road condition is mapped using GPS coordinates. The system will also contain a micro controller unit. By using GSM module the device send a message to the concerned person when an accident occurs. The main reason for sudden vehicle fall and hazardous road condition such as potholes, bumps, etc... So we need a method which automatically detecting the bumps or potholes, here we are using a smart phone which is connected with number of sensors such as GPS, Microphones and Cameras. In this paper we are analysing Bump detection methods, Road mapping, accident monitoring, etc... This work will give safety to the driver inside the vehicle. Accident is captured using a camera placed in the vehicle. Which is helpful to understand the reason for collision.

In [10], on the available vehicle data, this paper introduces a method for identifying the type of road and the congestion levels of the road. For increasing the power management of the vehicle here we can use these information. For this purpose we use different machine learning algorithms. This machine learning algorithm is used to identify the road type and congestion levels. And a neural learning algorithms is also used for this same purpose. For learning about different power control parameters here we will use different kind of machine learning algorithms. For developing the vehicle model a PSAT software is used here. UMD_IPC is used as the vehicle power controller. This UMD_IPC contains a neural network which is used for the road type and congestion levels. For extracting some useful features from the vehicle speed segment this paper uses the feature extraction algorithm.

In this paper[11] an efficient 3D point –cloud point with their elevations were captured during scanning and extraction. The experimental result of this system will indicate security and coverage of distress. Basic component of this system is 3D laser scanner, it also known LIDAR. It is an auto scanning total station. Point coordinate is obtained by using this laser scanner. Laser ranger, control and data processing component and optical scanning components are the basic parts of the system. Here we use clustering. Various kind segmentation method are used such as edge based, point based and region based.

In this paper [12] , a pothole detection algorithm is proposed. It uses motion and intensity of features to distinguish potholes accurately from similar object. The invented algorithm consist of two steps of segmentation and decision and is much simpler than the previous method. Result shows the out forms of proposed algorithm. Segmentation using the motion step is the primary procedure of the new proposed algorithm. It include optical flow, regression, high-pass filtering, standard deviation and binarization.

In this paper[13], the motion-based algorithm is showed the best detection experience. However, the previous algorithm were not suitable for a smartphone because complexity is too high. Here we use pothole detector, pothole client and pothole server. In this study, we tested our system on two different roads were 20 and 24 pothole images are collected in national roads. A smartphone is a suitable device for pothole detection because it has video camera, network system and GPS. The experimental result shows that our system has high detection accuracy.

In this paper [14], precisely detecting potholes is a task in determining the proper condition of roads. In this method it uses 2D images for the pothole detection. This method consist of three steps a) segmentation b) Region extraction and c) Final decision. First it extracts the darker region for pothole detection, next the candidate region is extracted based on

the different features such as size of the pothole and compactness. Next region of the pothole is extracted and the same steps are repeated on the basis of these features. The 2D images are collected with the help of a vehicle. With the current method, it is very difficult to find stains and patches which looks more similar to a pothole. It can precisely detect a pothole with features like standard deviation.

In this paper [15], Pothole is a type of surface problem that is due to the presence of water in the soil structure. Many researches tried to find a maintenance system. Recently image based detection methods have been studied using with the help of camera by collecting the image. Algorithms are used to extract the pothole background thresholding is used here .Threshold method gives accurate detection of potholes on roads. Performance of it compared to other pothole detection algorithm it is high.

This paper [16] describes the implementation on Texas Instruments C6678 Digital Signal Processor (DSP) of an earlier suggested detection system for potholes. The system uses variance maps as data, accompanied by surface fitting and linked part marking (CCL) for identification of potholes. Matrix measurement optimizations in the device algorithm is rendered DSP compliant .Potholes in roads were one of the biggest problems for drivers worldwide and this has begun to worsen in recent years .The solution to locating the pothole was to consider the differences between the aircraft equipped and the real plane, provided a diagram of inequalities .Disparity maps (u, v, disparity value) created by stereo-vision input devices must be translated to Euclidean domain (x, y, z) before surface fitting is implemented .Ultimately, multicore processing in the hardware platform, with the aid of Open MP further decreases processing time .That's not part of this article. Optimizations can still be performed in linear assembly or assembly to reduce the computing period more.

A well-preserved road network is a must for economic development and human well-being in any country. Sadly, these road networks do not operate in most developing countries .While the lack of funds is primarily attributable to the inability to build new road networks and to maintain existing ones, the lack of a proper inspection and reporting system is a major contributing factor to the worsening state of road networks in third world countries. They suggest a sensor network based on public transit for tracking the state of the road surface. We are currently building such a network called BusNet to monitor environmental pollution[17] and that system can be extended to monitor road surface conditions by adding sensor boards for acceleration to the system .A strong, well-maintained road network leads to a country's economic prosperity and the well-being of its people .BusNet's importance isn't restricted to developing countries. Although it also addresses this, it was not suggested as a remedy to the lack of communication networks. Through replacing them with few traveling sensors, the BusNet reduces the cost of installing a large number of sensors .It also addresses the control, repair, and security issues associated with a network of sensors spread over a broad landscape. These are common problems and the BusNet is very important for developing countries with good connectivity infrastructures .The road surface monitoring system that utilizes the BusNet is of greater importance for developing countries, though.

Access to timely and accurate information on road conditions, notably regarding hazardous potholes, is of great importance to the public and the government .In fact, a P3-enabled smartphone will deliberately acquire the information about the host vehicle's suspension system without human intervention and adopts a one-degree vibration pattern (DOF) to infer the depth and duration of the pothole while the vehicle reaches the pothole[18] .Poor road conditions, particularly dangerous potholes, are of great concern to pedestrians, insurance companies and the government, which are seriously threatening driving safety and causing enormous loss .Ultimately, to predict more precise pothole profiles, we will further research more complex displacement methods, other than the one-DOF type.

In this paper [19], spoiled pavement like potholes are rising due to the climate change such as heavy rains and snow in Korea, and thus complaints and lawsuits of accidents related to potholes are growing. As one type of pavement distresses, potholes are important clues representing structural defects of the asphalt road, and exactly detecting these potholes is one of the important tasks for find out proper strategies of asphalt-surfaced pavement maintenance and rehabilitation. The pothole detection method s which have developed and suggest a potential direction of developing a pothole detection method to exactly and efficiently detect potholes. The existing method of pothole detection which can be divided into vibration based methods, 3D reconstruction-based methods and vision based methods. Although the vision- based methods are cost-effective compared to 3D laser scanner methods ,it may be difficult to accurately detect a pothole by these methods due to distorted signal generated by noise since they detect to pothole through analysis of the collected image and video data. Thus, there is need to develop a pothole detection method using various features in 2D images which improve the existing pothole detection method and can accurately detect a pothole.

Tracking and avoiding obstacles presents an interesting problem when driving an autonomous vehicle, as this requires combining the vision and the motion systems. The problem becomes much more serious in an unstructured world, since the challenges must be clearly identified for any decisive action to be taken. Pothole avoidance can be considered

similar to other avoidance of hazards except that the potholes are depressions rather than surface extrusions. Because potholes typically differ significantly visually from a background surface, a non-contact approach to vision was adopted. Wide potholes shall be found greater than 2 feet in diameter. External cues are recorded by the vision systems of the vehicle and correctly pre-processed. When assess whether a pothole is within the field of view, a histogram is used to determine a brightness threshold. The primary benefit of the approach is that it is easily interfaced with the current core logic system. Can detect and avoid any two-dimensional form, the solution can also be easily extended. Humans have sophisticated vision systems through which a large amount of information can be received and interpreted very quickly. We also have extremely adept systems for making decisions based on these visual input and also the means to perform appropriate actions. A truly autonomous robot must sense its environment accurately and react appropriately. This issue attains greater importance in an outdoor, variable environment. A new obstacle was introduced in the navigation course at this year's competition-simulated potholes. These are white circles of 2 feet in diameter, randomly placed across the course. The aim of this paper is to explain our model for those potholes being found.

III. CONCLUSION

This paper is all about discussing many of the proposed systems as a method for predicting the bumps and potholes on the roads using machine learning method. Now a days everyone has to travel a lot in a day. So by using this method, we can identify the condition of the unknown road. The accelerometer and GPS sensors are used here to find the potholes and to locate the pothole. The change in z-axis of accelerometer is detected and the potholes and speed bumps are classifies by using k-means clustering algorithm and random forest algorithm. Also included a voice assistance in English and our regional language (Malayalam). So the application installed in the smartphone can notify the user about the condition of the road through voice commands and also indicates the potholes and bumps in the map included in the application.

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