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Pothole Detection and Notification Using Smartphone for Self-driving Vehicles, Drivers and Road Authorities

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Abstract: World is developing rapidly, roads without pothole is challenge for the every country. Different countries have different strategy to develop roads. But bad roads lays many problems like accidents, slowdown the transport system, harm to vehicle and humans. Condition of roads indirectly effects on growth of the country. Hence there is need for such system that can detect potholes, notify the correct information of pothole to driver and driverless car and also notify to respective central service in order to repair the pothole. The proposed system is to detect the potholes using smartphones using inbuilt sensor (accelerator and gravity sensor).This system collect pothole information using step counting algorithm and send it to the central server, server processes data using simple machine learning algorithm and classify the potholes into different category .System will process data from thousands of smart phone and i.e. system takes experience of every smart phone and learn from it. Due to inheritance of experience system is much more accurate. This system is easy to implement with no any extra sensor, cost effective and gives accurate results.

Keywords: potholes, smartphone sensors, Autonomous vehicle, android application.

I. INTRODUCTION

Every country is trying for best roads for their future. Now a days every road network is gigantic, giving it a thought about the condition of the roads. It is extremely essential that the roads are well built and strong for the future of nation. Information about potholes should be reported by government, every autonomous machine on road and driver of the manually operating vehicle in order to protect from accidents. According to Global Road Safety Report, 2015 released by the World Health Organization (WHO), only in India accounts for more than 200,000 deaths because of road accidents. These accidents can be due to overspeeding, drunk and driving, jumping traffic signals and also due to humps, speed-breakers and potholes. Hence it is important to collect information regarding these poor road conditions and distribute the same to other vehicles that in turn help reduce accidents caused due to potholes and humps [3]. Pothole detection using dedicated sensor to each vehicle are very costly to apply it on every vehicle. Roadmaps of potholes remains unclear. Many system confuse with speed breaker and pothole as well as detecting pothole in rainy season is much complex because pothole filled with water and mud so dedicated sensor fail at many times. Many times road regarded authorities are not known to pothole or newly generated pothole in order to repair it because they are not getting real time information hence there is need to provide real time information about potholes on roads. For self-driving vehicles it's very necessary to get all pothole related information in before vehicle at certain position so self-driving vehicle get appropriate decisions while traveling in order to reach destination at predicted time and efficiency. Hence there need for such dynamic system to overcome mentioned issue.

In this paper we have solved many issues in simple, effective and less cost prone module using existing smartphone sensors. Every smart phone has accelerator and gravity sensor which calculates position of mobile device. Acceleration and gravity sensor records each and every positions of phone. User walking and running also calculated by those sensor using algorithm of Step Counting Using Smartphone-Based Accelerometer [2]. Our system calculates user step while he is in vehicle hence step/movement in vehicle means vehicle is under some violence. All violence or steps are updated to server with their GPS co-ordinates .Server takes input data from number of such smartphones. Server perform machine learning algorithms and classify pothole in different category as well as recognize speedbreakers on the road. Server forwards learned experience to the other devices like smartphone, automated vehicle and respective authority of roads so other devices can use it and avoid potholes. This system much accurate than manually attached sensor to each automated vehicle due to server processed thousands of clusters (data received) per day of real time. We show that we are able to identify potholes and other severe road surface anomalies from accelerometer data of smartphone. Via careful selection of training data and signal features, we evaluate our system after clustering to further reduce spurious detections, manual inspection of reported potholes shows that over 90% contain road anomalies in need of repair. [9].

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II. LITERATURE SURVEY

1. Youquan et al. [1] have developed a model which employs optical imaging principle of 3-dimensional projection transformation to obtain pictorial information of pothole's cross-section in pothole detection. Multiple digital image processing technologies, including: binarization, image processing, thinning, three dimensional reconstruction, error analysis and compensation are conducted in the series of image analysis and processing. [1]
2. Moazzam et al. [5] have developed a model in which a low cost Kinect sensor is used. Kinect gives the direct depth measurements, thereby reducing computing costs. Meshes are generated for better visualization of potholes. Area of pothole is analysed with respect to depth. The approximate volume of pothole is calculated using trapezoidal rule on area-depth curves through pavement image analysis. In addition pothole's area, length, and width are estimated. The paper also proposes methodology to characterize pothole.[5]
3. Samyak Kathane, et al. [6] have proposed a model which is Real time pothole detection and vehicle accident detection and reporting system and Antitheft. In this system the wireless access point collects the information about potholes, it distributes this information to BMC using wireless broadcast. This system is used for the accident detection too. Antitheft in car can help to save million of dollars. Sensor boards that we used for collecting the environmental data also has an accelerometer that can measure both the vertical and the horizontal acceleration. for example, when a bus goes over the pothole there would be significant change in vertical component of the acceleration and for humps there would be a horizontal component. [6]

III. SYSTEM ARCHITECTURE

The following figure gives the information of our system architecture.

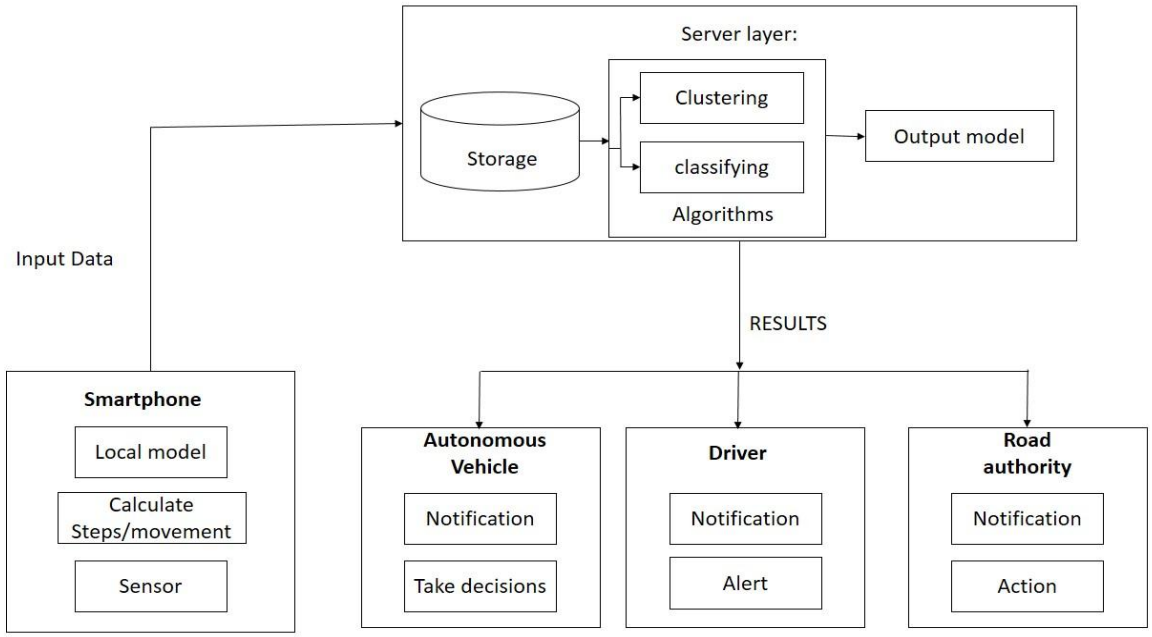

Figure: 1 System Architecture

This system work as follows

Smart phone has acceleration and gravity sensor which can able to detect movement of device. This sensor records various frequency and creates report. We are using a novel step counting algorithm based on the acceleration and the gravity sensors is proposed to enhance the estimation performance regardless of the position of a smart-phone and the motions of a pedestrian likewise walking or running. The effectiveness of the proposed scheme is demonstrated with experiments and the performance of the proposed scheme is compared with those of the conventional schemes. According to the results, the performance of the proposed scheme is enhanced compared to the conventional schemes no matter what the pedestrian is walking or running although the phone is in different places like trouser pocket, shirt pocket and hands. Therefore, it is worth to note that the proposed scheme is a concise and effective way to count the steps on real time. [4]When user device record any step or movement. Device generate sample report on it of x, y and z axis of device. Where x, y and z are the acceleration data of the x-, y- and z-axis. However, the acceleration sensor does not always keep on a steady state while the user is walking or running, thus noise tends to be increased as the moving speed of the user is increased. [4]

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When user moves speed less than 25kmph then he is walking or running but user move more than 25kmph he is mostly in some vehicle. So this system takes input data while user in vehicle only. Device records GPS co-ordinates for potholes location. When vehicle pass from any pothole, frequency of smartphone is violated and on that frequency change, pothole depth is analysed and smartphone application generate local model of that pothole .Smartphone compute all frequencies and there GPS co-ordinates. This information recorded by one smartphone is further forward to The server on the sever layer. Server take data from many smartphones and classify pothole frequencies into different categories using simple machine learning algorithms. For each pothole at a particular GPS location server takes input frequency from thousands of smartphones and calculate average of their frequencies hence here server justify accurate depth of the pothole. Using a simple machine-learning approach, we show that we are able to identify potholes and other severe road surface anomalies from accelerometer data. Via careful selection of training data and signal features, we have been able to build a detector that misidentifies good road segments as having potholes less than 0.2% of the time. [9]

There is one issue while dealing with acceleration and gravity sensor frequencies .On a time of speedbreaker, local module of smartphone consider it is as pothole which is wrongly classified which lays misguide for Autonomous vehicle, vehicle driver and road authorities. So we have solved this issue at server layer by considering thousands of input data form various smartphones. If steps or movements are same for almost every vehicle at particular point then there is possibility of speedBreaker because all vehicle must have to by speedbreaker .But in case of pothole some vehicle bypass pothole and some go through the pothole. Hence by computing and analysing this data server can easily recognize the speedBreakers. Server creates new roadmap model on basis of pothole and broadcast this information to self-driving vehicles, smartphones of drivers and road authorities. Self-driving vehicle receives the data from server and do further procedure on it. Server also gives notifications to self-driving vehicle of speedbreaker and all pothole related data. Hence self-driving vehicle can take decision before he starts travelling or predict the futuristic path while it travels. Persons who is driving car i.e. Driver, receives data from server and gives notifications to the drivers. This notification method is very useful while driver driving car at night in order to avoid pothole. It is very hard to recognize pothole by naked eyes at time of night traveling hence notification and prior message by smartphone can saves driver life by protecting it by pothole accidents.

Road authorities receives this data on basis on pothole depth and they process further in order to repair pothole. By using this data road authorities can easily analyse road healthiness without any physical survey of pothole. Hence time and cost of analysing roads are reduced using this system. At pothole some vehicle go through pothole some give side to pothole in particular geographic location. By analysing thousands of smartphones, system predict about pothole, its length and its location by using frequency and GPS data. This classified data trained and tested over many example and using that final model is developed. Final model is model roadmap of potholes. Which is further broadcasted to autonomous vehicles, drivers and road authorities.

IV. IMPLIMENTATION

Purposed system is based on client server architecture ,where mobile application collect data and send it on server and server process data and give responses to the clients who request for data.

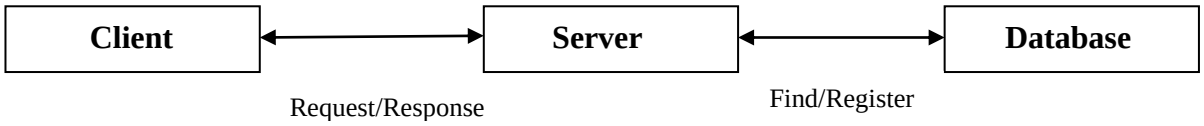

Figure 2: Basic structure of client server architecture

Here client is autonomous vehicle, phones of drivers and road authorities, server is central processing machine on cloud. Database is data regard to pothole. A mobile application which is capable to measure acceleration and gravity data installed on mobile. Smartphone collect all readings of sensor with respective there geographic location while user is traveling and provide to the server. Server is computer machine which can capable to perform machine learning algorithms on real time .Server collect information of smartphones .By using machine learning algorithm server classify and cluster this data into different categories. Clustering of this potholes by location is calculated on server using following method. The pothole events reported by the detector are likely to include some false positives. To improve accuracy, we require possible events to be corroborated to be considered valid, meaning that a cluster of at least k events happen in the same location (with a small margin of error), while moving in the same direction. This spatial corroboration helps filter out misclassified events that are unrelated to spatial location (and hence are definitely

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not potholes), such as vibrations from within the vehicle—as it is unlikely that such events would happen multiple times in the exact same location.[9]

Server generate roadmap report of the pothole and broadcasted it for the clients. For receive this pothole roadmap, smartphone user have to install mobile application to mobile hence application notify them with prior tones and messages when there is pothole. For self-driving or autonomous vehicle, they fetch roadmap of pothole from server with preinstalled program on the autonomous vehicle. For the road authorities required to brows roadmap of pothole from server.

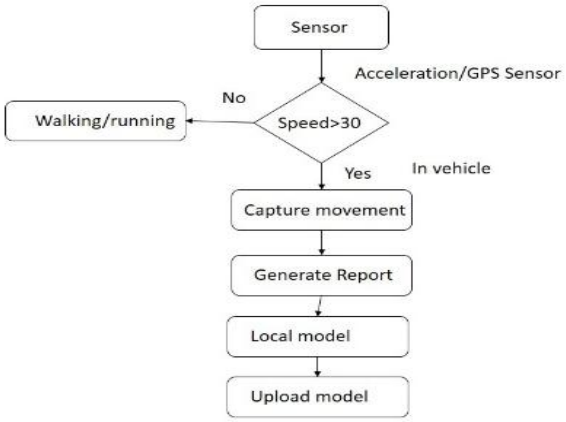

Fig 3. Smartphone Layer process

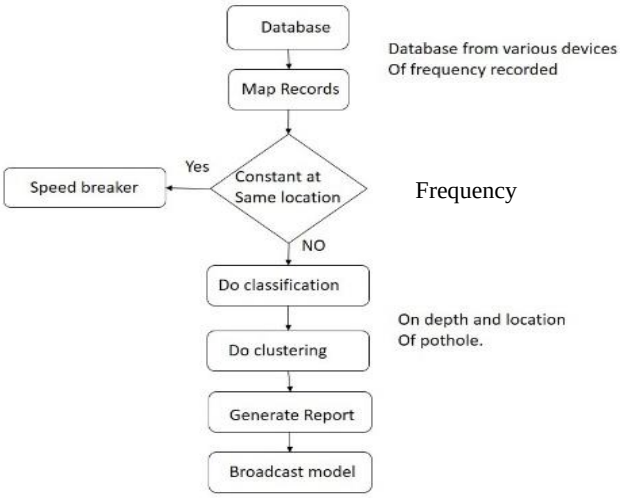

Fig 4. Server Layer Process

V. FUTURE WORK

This proposed system work with detecting potholes using step counting algorithm of mobile. This project can be further extended using images to detect and recognize object on the roads like dividers, signals on the road. Step Count Algorithm adapted to Indoor Localization can be used in autonomous robot to detect best path towards destination. This system can be extend with interface for existing sensors of the autonomous vehicles.

VI. CONCLUSION

In this paper, we have introduced Automatic detection of potholes and humps and alerting autonomous vehicle, vehicle drivers and road authorities to avoid potential accidents. The given system approach is an economic solution for detection of dreadful potholes and uneven humps, as it uses only existing mobile sensors which is very low cost. The application used in this system as it provides timely alerts about potholes and humps. System uses machine learning algorithm which gives accurate detection of potholes, it is also capable to recognize speed breaker .Due to client server

approach experience of one vehicle is inherited among others. This system is also capable to works in rainy season when potholes are filled with muddy water as alerts are generated using the information collect in the database. We feel that the solution provided in this system can gives effective solution for autonomous vehicle for reach destination save many people and ailing patients who suffer from accidents.

VII. REFERENCES

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