American-Eurasian Journal of Scientific Research 12 (3): 172-179, 2017
ISSN 1818-6785

DOI: 10.5829/idosi.aejsr.2017.172.179

IOT Based Pothole Detection And Notification System

S. Gnanapriya, V.B. Padmashree, V. Bagyalakshmi and G.A. Pravallikha

Department of Information Technologym, Easwari Engineering, College, Chennai, India

Abstract: One of the major problems faced by developing countries is the maintenance of road condition. Road infrastructure for the society is very important because majority of road accidents takes place due to bad condition of road like potholes. Potholes are caused due to poor quality and badly maintained roads. The constant movement of the overweight vehicles like trucks is also responsible for these ill roads. These ill quality roads will cause severe damage to the vehicles in terms of tyre and most important thing is the accidents which are caused due to this. An optimal system should be developed to monitor the road condition and analyses for future work. We propose an innovative method to prevent these hazards by using the advanced sensor system. The sensors will be attached to vehicles and from vehicles the data's obtained from sensors and the location obtained by the GPS are transferred to road transport authority by IOT where officials take necessary actions. Using the data's obtained more damaged area can be prioritized and damage control can be reduced.

Key words: IOT · Sensors · Prioritization · Analysis · Road safety

INTRODUCTION

India is a fastest developing country after china. Although India is doing exceptionally well in certain field, they majorly lack in road ways. Roads are the dominant means of transportation in India today. However roads here are narrow and congested with poor quality and is not maintained properly. This road condition is a boosting factor for traffic congestion and number of road accidents. Potholes are formed due to heavy movements of vehicles and heavy rains and water logging. According to the survey of "road accidents in India 2015" road accidents increased by 2.5 per cent from 4,89,400 in 2014 to 5.01,423 in 2015. Over 11,000 people killed by potholes, speed breakers last year. To overcome this pathetic condition many technologies have been implemented and integrated with road safety.

Fig. 1: Condition of roads with potholes

(IoT) is an ever-growing network of physical objects that feature an IP address for internet connectivity. Main enabling factor of this promising paradigm is the communications solutions.The concept is basically connecting any device with an on and off switch. According to the analyst firm at Gartner there will be over 26 billion connected devices by 2020. The IOT is considered as a giant network of connected "things" (which also includes people). There are three types of relationship i)people-people, ii)people-things iii)things-thing.

Information gathering is the first step in IOT. Then the information sensed are transferred to the next level of processing. for this they either require Wi-Fi or WAN for communication. Zigbee, near field or Bluetooth can also be used.

Corresponding Author: S. Gnanapriya, Department of Information Technologym, Easwari Engineering, College, Chennai, India.

Sensor is a device used for detecting and measuring of physical property and records, indicates or otherwise response to it. in simple words they are used to detect events or changes in environment and send it to a controller. there are three types of sensors i) analog ii) digital iii) pwm. There are list of different sensors which fall under either of these types.

The **GPS** (Global Positioning System) is a "constellation" of approximately 30 well-spaced satellites that orbit the Earth. It is possible for people to pinpoint their geographic location. The accuracy is anywhere from 100 to 10 meters for most equipment. A GPS system works by receiving at least three satellite signals to calculate latitude and longitude and the movements. When GPS gets signal from four or more satellite then a 3-D position can be viewed ie latitude longitude and altitude

Data analytics refers to quantitative and qualitative. The science of measuring raw data with the purpose of drawing conclusion from that information is called data analytics. To make efficient and better decision data analytics is used in many fields like industries, companies and other organization. Data extracted analyzed accordingly (behavior, pattern and technique). Benefits of data analyses are: cost, competitive advantages and business opportunity. Data analysis application is used in marketing, finance, government, healthcare, insurance, retail and telecommunication.

Top big data tools are:

- Apache Hadoop
- Apache spark
- Apache Hive
- Nosql Database

Predictive analysis is an advanced analytics, which is used to make prediction about future events known or unknown. it. next step of analysis is prediction. Its s used to predict future events. It gives a pattern to identify risk opportunities and relationship among factors to allow assessment and make decision.

All in all, the data from the vehicle such as vibration value accelerometer value and location of the vehicle are collected and transferred to the transport authority server. The officials respond according to the data collected and using this information prediction is generated.

Relatedworks: This section describes about existing solutions for pothole detection.

FARIA KALIM [2] developed CRATER which is an opportunistic mobile crowd sensing application for estimating road conditions using an Android phone with GPS and accelerometers without any input data from the user. It sends these data's to the server.A simple in-cloud meta classifier is used to find out if a significant number data's from users passing through the same location determines the pothole or not. The decision of the meta-classifier is stored in the database and published on the website. this method was capable of detecting 90% of the potholes in the road.

Dong-Won Jang [1] proposed a new spatio-temporal saliency that detects the objects coming closer to the vehicle such as potholes using a dash-cam installed in cars. Using directional filtering the saliency of the pothole is enhanced. It only reports the presence of potholes but not pothole position for repairs.

Sudarshan S. Rode, *et al* [13], proposed a system in which, vehicles equipped with Wi-Fi collect information about the road surface and sends to Wi-Fi access point which in turn broadcasts this information to other vehicles nearby in the form of warnings.

SandeepVenkatesh, *et al* [12] proposed an intelligent system that uses laser line striper and a camera to detect and avoid potholes. A centralized database of the location of potholes is maintained. A warning message is also sent to the nearby vehicles about the occurrence of potholes using Dedicated Short Range Communication protocol.

Proposedmodel

Pothole Detection: In the proposed system, advanced sensor system is used to track and update the potholes on the road. UV sensor is used to find the difference between the pothole and speed bumps. Accelerometer is a vector quality which defines the direction in which it is occurring. The sensor will detect the unusual changes the vehicle. they are determined by three parameter xyz. Along with this a vibration sensor is used which also finds the potholes if the vehicle is vibrated more than the threshold level. The threshold level is fixed beforehand. Both these sensor values are fed to the adurino and the GPS sensor updates the coordinates where exactly the potholes are present.This data is sent into the web server through IOT for the Road transport officials to take necessary action. Using the information road condition is predicted and prioritization is done to take the necessary steps.

The hardware components used are:

- ARM 7 Development Board
- Zigbee transmitter and receiver
- GPS Module
- Vibration Sensor
- Accelerometer Sensor

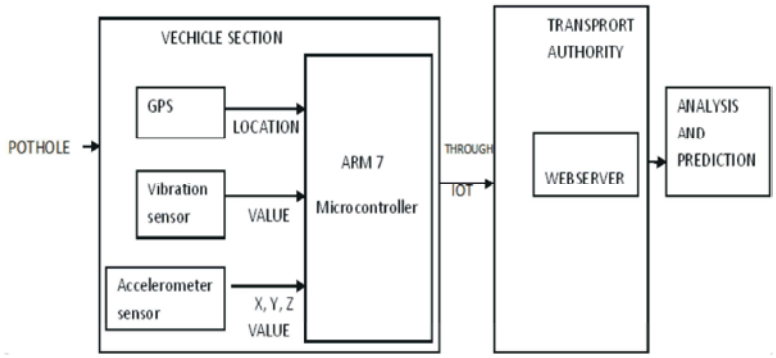


Fig. 2: Architecture diagram

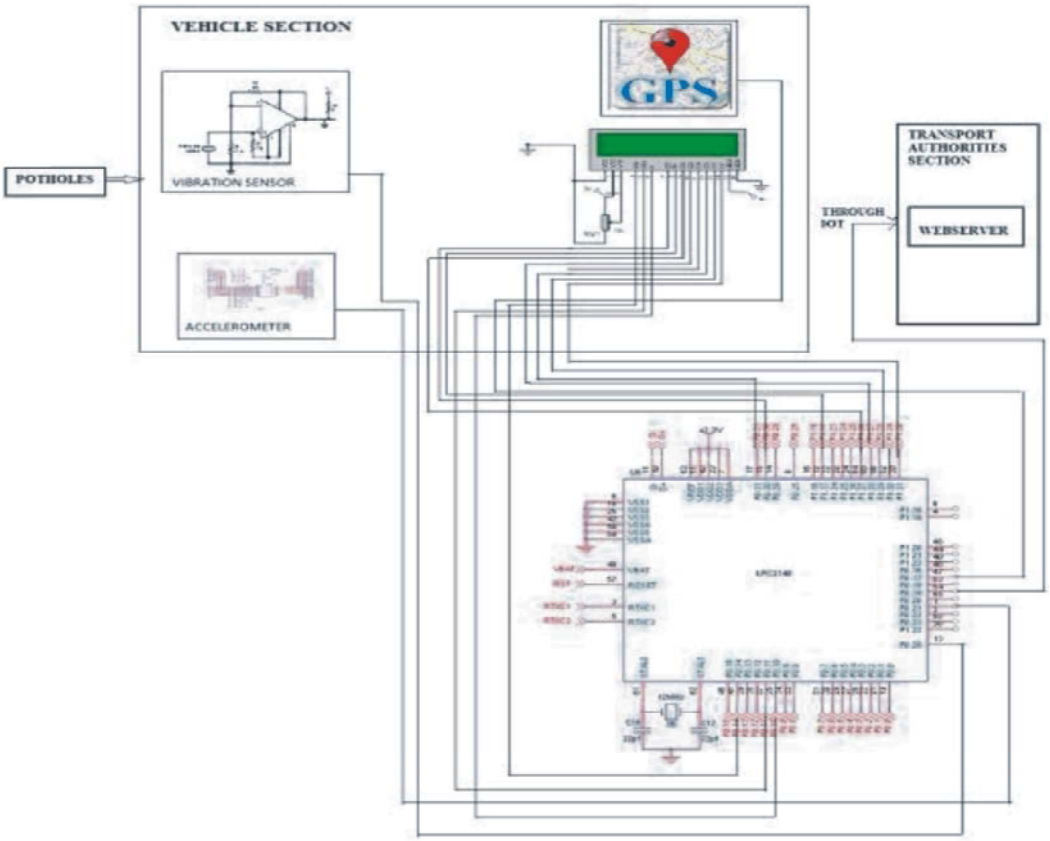


Fig. 3: Circuit diagram

From the architecture diagram fig [2] it can be seen that, all the sensors are present in a vehicle. When there is a pothole the values of vibration sensor and accelerometer sensors are considered. If the values exceeds a threshold value then it is considered as a pothole with greater depth and needs immediate pair fig [4]. The accelerometer sensor gives the movement of the direction of the vehicle. It consists of x-value,y-value and z-value. The x-value indicates the movement of the vehicle in right and left direction. The y-value indicates the forward and backward movement of the vehicle. Z-value indicates themovement of the vehicles when in passes through a pothole.If the vibration value and the z-value of the accelerometer exceeds threshold, using GPS its latitude and longitude along with other details are sent to transport authority web server which is displayed to them based on the priority in which they need to repair the road. The data is also used to predict the quality of the road.

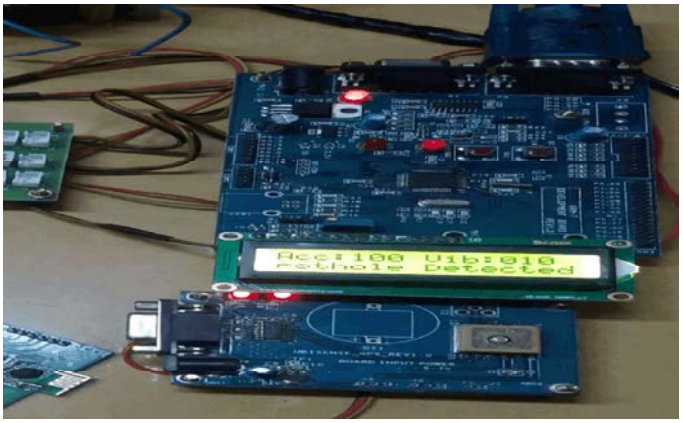
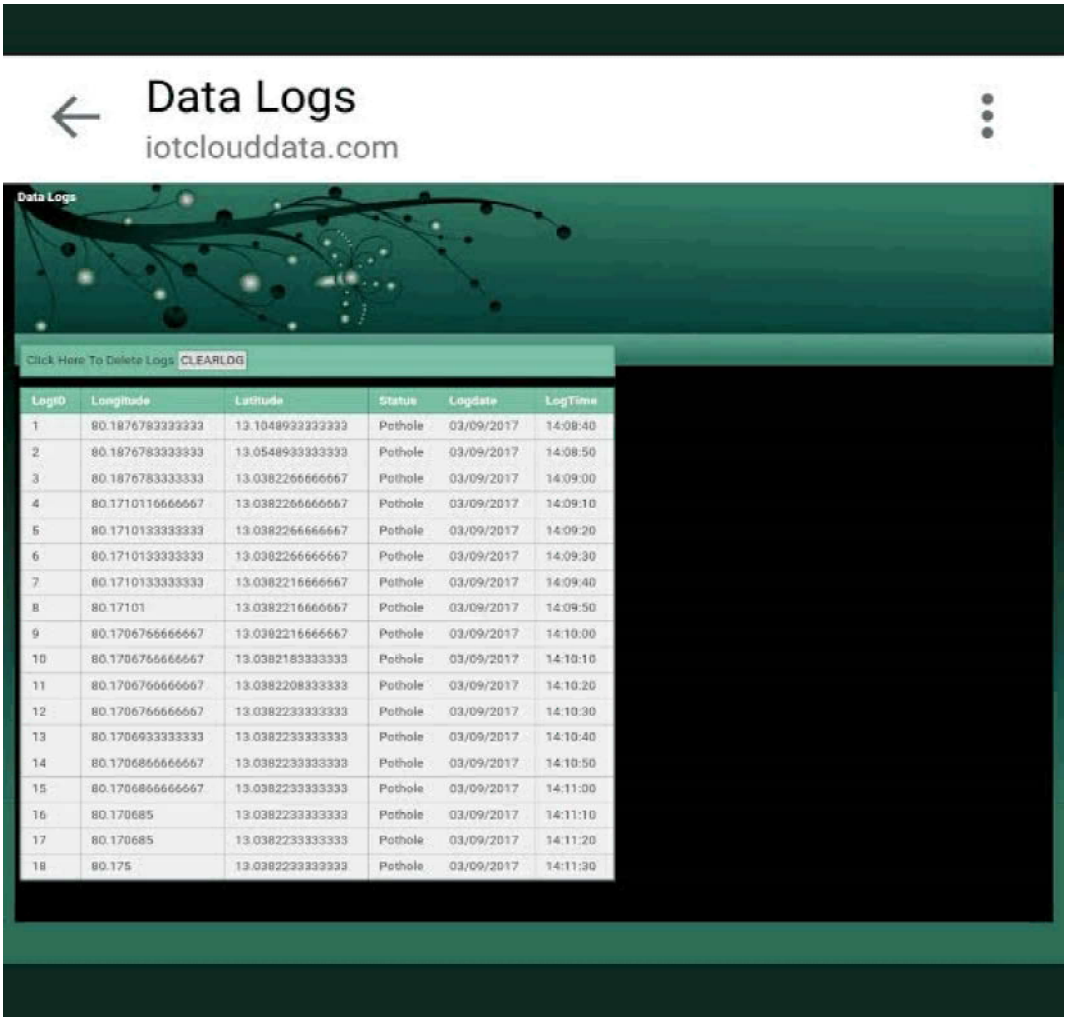


Fig. 4: Pothole detection

The necessary values are updated in the website using IOT which can be viewed anywhere.



LogID	Longitude	Latitude	Status	Logdate	LogTime
1	80.1876783333333	13.1048933333333	Pothole	03/09/2017	14:08:40
2	80.1876783333333	13.0548933333333	Pothole	03/09/2017	14:08:50
3	80.1876783333333	13.0382266666667	Pothole	03/09/2017	14:09:00
4	80.1710116666667	13.0382266666667	Pothole	03/09/2017	14:09:10
5	80.1710133333333	13.0382266666667	Pothole	03/09/2017	14:09:20
6	80.1710133333333	13.0382266666667	Pothole	03/09/2017	14:09:30
7	80.1710133333333	13.0382216666667	Pothole	03/09/2017	14:09:40
8	80.17101	13.0382216666667	Pothole	03/09/2017	14:09:50
9	80.1706766666667	13.0382216666667	Pothole	03/09/2017	14:10:00
10	80.1706766666667	13.0382183333333	Pothole	03/09/2017	14:10:10
11	80.1706766666667	13.0382208333333	Pothole	03/09/2017	14:10:20
12	80.1706766666667	13.0382233333333	Pothole	03/09/2017	14:10:30
13	80.1706933333333	13.0382233333333	Pothole	03/09/2017	14:10:40
14	80.1706866666667	13.0382233333333	Pothole	03/09/2017	14:10:50
15	80.1706866666667	13.0382233333333	Pothole	03/09/2017	14:11:00
16	80.170685	13.0382233333333	Pothole	03/09/2017	14:11:10
17	80.170685	13.0382233333333	Pothole	03/09/2017	14:11:20
18	80.175	13.0382233333333	Pothole	03/09/2017	14:11:30

Fig. 5:Website Updation

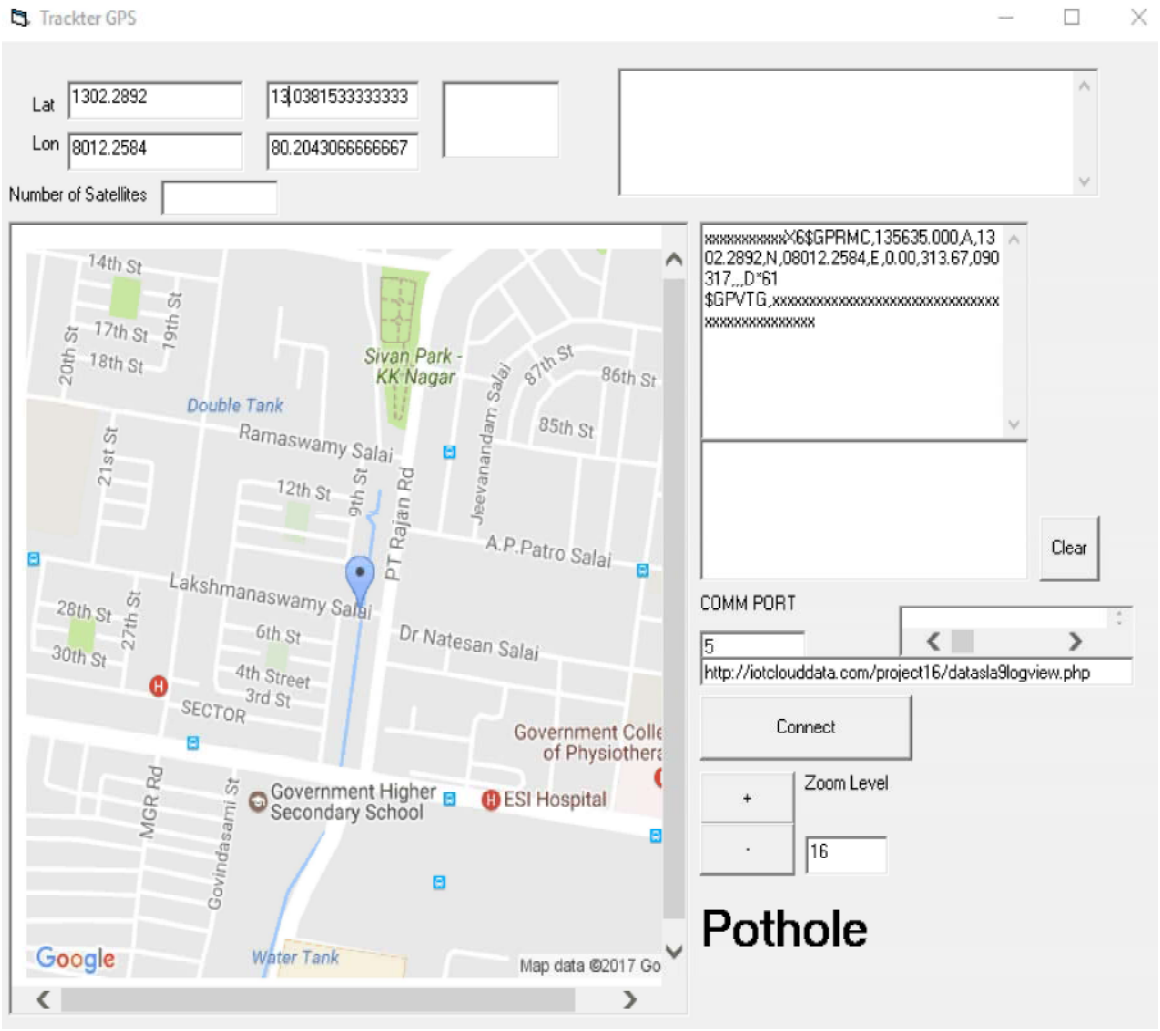


Fig. 6: Pothole location

Using VB as an interface we can view the location using google maps.

Analysis: Random forest algorithm is used for analyzing the data. It works in the following way: The algorithm is used to construct each tree.

- Let N be the number of training cases,M be the number of variables in the classifier.
- Let mbe the number of input variables used to determine the decision at a node of the tree. M should be greater than m.
- Training sets are given to this tree by choosing n times with replacement from all the N available training cases.(i.e. Take a bootstrap sample).
- Randomly choose m variables on which to base the Decision at that node for each tree. The best split based on these m variables in the training set is calculated.
- Each tree is fully grown and not pruned.(as may be done in constructing a normal tree classifier).

New sample is pushed down the tree for prediction and assigned the label of the training sample in the terminal node it ends up in. The procedure is iterated for each tree in the ensemble and the average vote of all the trees is reported as random forest prediction

ExampleSet (9999 examples, 5 special attributes, 8 regular attributes) Filter (9,999 / 9,999 examples): all

Row No.	quality	prediction(quality)	confidence(good)	confidence(medium)	confidence(bad)	vibration	x-value	y-value	z-value	latitude	longitude	time	date
1	good	medium	0.349	0.514	0.137	6	80	80	42	13.662N	81.0743E	16:02:26	Aug 18, 2016 ...
2	medium	good	0.481	0.266	0.253	5	88	79	51	12.0098N	81.5924E	11:10:39	May 9, 2015 1...
3	bad	good	0.731	0.133	0.137	8	80	76	59	12.1921N	81.8794E	06:56:54	Aug 13, 2013 ...
4	?	medium	0.143	0.703	0.153	7	90	79	41	12.5641N	80.8053E	12:37:51	Oct 1, 2014 1...
5	?	good	0.402	0.345	0.253	10	86	73	43	12.0966N	80.1204E	09:52:51	Jul 15, 2014 ...
6	?	medium	0.412	0.452	0.137	8	80	80	49	13.8539N	81.0581E	10:30:55	Jul 31, 2016 ...
7	?	good	0.447	0.199	0.353	6	87	73	53	13.2273N	80.3535E	10:29:22	May 16, 2012 ...
8	?	good	0.368	0.345	0.287	6	83	75	42	13.3911N	81.2898E	12:26:11	Apr 6, 2013 1...
9	?	medium	0.295	0.518	0.187	8	85	74	49	12.6596N	80.7064E	22:37:21	Nov 28, 2016 ...
10	?	medium	0.356	0.458	0.187	6	90	72	50	12.8822N	80.1537E	03:18:40	Jan 1, 2013 1...
11	?	good	0.445	0.402	0.153	4	84	79	59	12.6016N	81.1544E	14:00:19	Sep 18, 2015...
12	?	medium	0.349	0.447	0.203	5	80	70	42	12.9554N	80.6271E	13:39:24	Jan 19, 2017 ...
13	?	good	0.595	0.335	0.070	1	80	71	52	12.4469N	80.9971E	12:41:31	Aug 5, 2015 1...
14	?	good	0.381	0.332	0.287	7	89	76	54	13.044N	81.4026E	12:22:06	Aug 7, 2014 1...
15	?	good	0.381	0.266	0.353	5	86	72	52	12.1468N	80.3637E	21:33:06	Jul 20, 2012 ...
16	?	good	0.731	0.082	0.187	2	80	75	56	12.4809N	80.3418E	08:35:59	Aug 13, 2013 ...

Fig. 7: Predicting Road Quality

The random forest algorithm considers random samples of our input dataset with replacement. Each sample will have different set of attributes.it constructs a tree for each of the samples. The label that is obtained from majority of the trees for the training data is considered.

We have classified the road condition as good medium and bad. 'Good' indicates that the road is in good condition.' Medium indicates that the road is about to get damaged and 'Bad' indicates that the road condition requires immediate action.

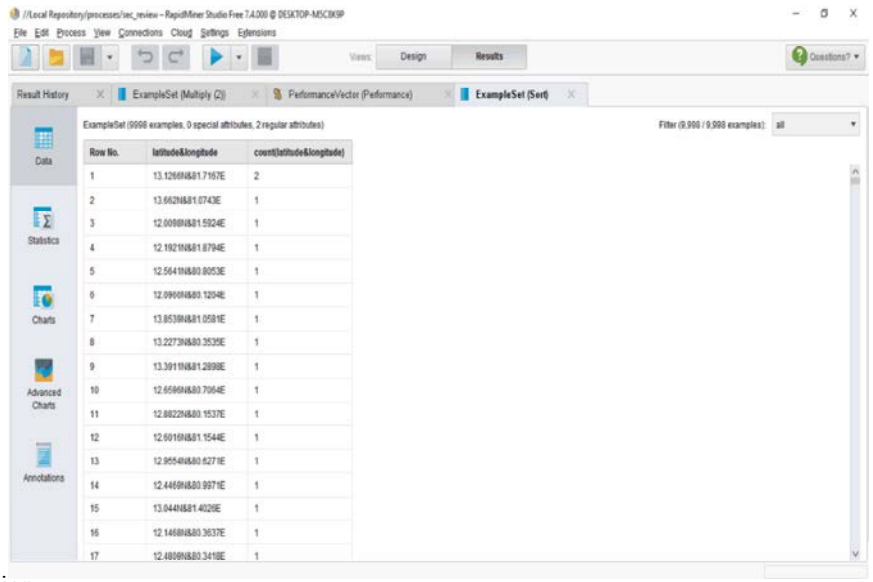


Fig. 8: Prioritization

The location is displayed based on certain priority. The prioritization is done considering the frequency of occurrence.

The most frequently occurred location is given first priority and so on. The performance obtained by using the random forest algorithm can be seen in Fig. 6.

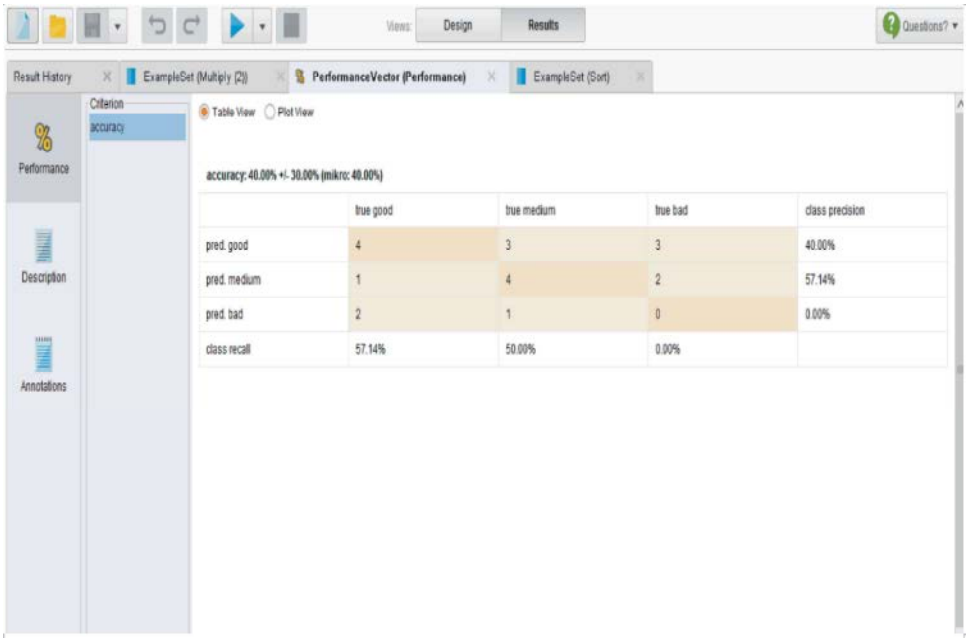


Fig. 9: Performance of prediction.

CONCLUSION

This paper serves as a tool in monitoring issues related to road conditions by using sensor IOT (Internet of Things) and incorporating data analytics for future work. As with traditionally where human workers personally check for road condition can be avoided and make it easier and automatic while a vehicle passes through a pothole. This paper features vibration data, location data and other data from which pothole conditions can be determined. Identifying the potholes with the help of sensors would be useful enough for road management to operate and implement at low cost. Once transport authority receives the dataprioritization is done and the most affected area is recovered first and also notifies the location of the roads which are in verge of severe damage. Ultimately to recover bad road condition as soon as possible.

REREERENCES

1. Dong-Won Jang and Rae-Hong Park, 2016. Pothole detection using spatio-temporal saliency, IET Intelligent Transport Systems, 10(9): 605-612.
2. Faria Kalim, Jaehoon (Paul) Jeong and Muhammad U. Ilyas, 2016. CRATER: A Crowd Sensing Application to Estimate Road Conditions", IEEE Access, Volume: 4,page(s)**:** 8317 - 8326,08 September 2016.
3. Moazzam, I., K. Kamal, S. Mathavan, S. Usman and M. Rahman, 2013. Metrology and Visualization of Potholes using the Microsoft Kinect Sensor, Proceedings of IEEE Conference on Intelligent Transport System, pp: 1284-1291.
4. Jog, G.M., C. Koch, M. Golparvar-Frard and I. Brilakis, 2012. Pothole properties measurement through visual 2D recognition and 3D reconstruction. Proceedings of ASCE International Conference on Computing in Civil Engineering, Clearwater Beach, FL, USA, pp: 553-560.
5. Jin Lin and Yayu Liu, 2010. Potholes Detection Based on SVM in the Pavement Distress Image, Proceedings of Distributed Computing and Applications to Business Engineering and Science, pp: 544-547.
6. Kim, T. and S.K. Ryu, 2014. Review and analysis of pothole detection methods, J. Emerging Trends Comput. Inf. Sci., 5(8): 603-608.
7. Koch, C., G. M. Jog and I. Brilakis, 2013. Pothole detection with image processing and spectral clustering, Journal of Computing in Civil Engineering, 27(4): 370-378.
8. Kongyang Chen, Mingming Lu, Xiaopeng Fan, Mingming Wei and Jinwu Wu, 2011. Road Condition Monitoring Using On-board Three-axis Accelerometer and GPS Sensor, Proceedings Communications and Networking in China, pp: 1032-1037.

9. Li, Q., M. Yao, X. Yao, *et al*., 2009. A real-time 3D scanning system for pavement rutting and pothole detections. Proc. Viedeometrics, Range Imaging and Applications X, San Diego, CA, USA, August 2009, pp: 74470B–74470B-9.
10. Prachi More, SudhishSurendran, SayaliMahajan and Saurabh Kumar Dubey, 2014. Potholes and pitfalls spotter, IMPACT:IJRET, 4: 69-74.
11. Sachin Bharadwaj, Sundra Murthy and Golla Varaprasad, 2013. Detection of potholes in autonomous vehicle, IET Intelligent Transport Systems, 8(6): 543-549.
12. Sandeep Venkatesh, E. Abhiram, S. Rajarajeswari, K.M. Sunil Kumar and Shreyas Balakuntala, 2014. An Intelligent System to Detect, Avoid and Maintain Potholes: A Graph Theoretic Approach, Proceedings of IEEE International Conference on Mobile Computing and Ubiquitous Networking, pp: 80.
13. Sudarshan S. Rode, Shonil Vijay, Prakhar Goyal, Purushottam Kulkarni and Kavi Arya, 2009. Pothole Detection and Warning System, Proceedings of IEEE International Conference on Electronic Computer Technology, pp: 286-290.
14. Yu, X. and E. Salari, 2014. Pavement Pothole Detection severity Measurement using laser Imaging, Proceedings of IEEE International Conference on Electro or Information Technology, pp: 1-5.
15. Zhang, Z., X. Ai, C.K. Chan, *et al*, 2014. An efficient algorithm for pothole detection using stereo vision, Proceedings of IEEE International Conference on Acoustics, Speech and Signal Processing, Florence, Italy, pp: 564-568.