International Journal of Computer Trends and Technology
ISSN: 2231 – 2803 / https://doi.org/10.14445/22312803/IJCTT-V69I10P105

Volume 69 Issue 10, 33-38, October 2021

Original Article

Hardware Design and Experimental Study for Road Conditions & Smart Detecting System Based on IMU and Ultrasonic Sensor

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Received Date: 10 September 2021
Revised Date: 12 October 2021
Accepted Date: 25 October 2021

Abstract - *This research paper is focused on analyzing and design of an easily detachable and user-friendly system that is specialized to detect potholes, main holes, and close-range obstacles. The system is composed of two subsystems, and The First Part is the "Sensing System" that detects potholes or main holes from a distance in order to warn the car driver before reaching any of them. The Second Part is the "Cloud unit," which collects the location of both potholes or main holes detected to be represented on a map. By this technology, we can maintain the driver's safety, and also it helps the governmental authorities that are responsible for road maintenance to have access to a renewable web server so as to have a better knowledge of the road state occasionally. The main components of the system are Arduino Uno, an IMU sensor which split inside it into an Accelerometer and gyroscope, an Ultrasonic sensor, LCD. According to the ultrasonic sensor, it will be used to detect the pot-hole or main–hole and then determine the result of scanning if there is a pot-hole or main-hole or the rood is clear then this information is sent to the Arduino to be shown next on LCD Screen, On the other hand, when the car is passed on the pot or main hole, the IMU sensor will play its role for sensing the tilting of the vehicle, and if the tilting exceeded a certain threshold then this Indicates the presence of either pothole or main hole. It works to confirm the information that came from the Ultrasonic sensor. According to the real-time road conditions evaluation, the abnormal road condition can be detected and saved in the traffic center. The experimental results show that our proposed system is an efficient system with higher accuracy and performance.*

Keywords *- Road conditions, Ultrasonic sensing, remote sensing, Arduino, IMU, LCD.*

I. INTRODUCTION

The Concept of the main system is that the Ultrasonic Sensor detects the targets that are located in front of the car, determining if there is an obstacle the car will impact with it or not; if the ultra-sonic read the obstacle, then it reports the type of obstacle (pothole or main-hole) and shows it on the LCD Module device that will be front of the driver whom purpose to warn him to avoid the impact that will be caused by the obstacle before reaching it. The significance of the project is to make the driver avoid the obstacle before the impact, and it also reduces the dangers of occurring an accident and also it protects the entire structure of the car from damage or being wasted by the time

System contents like [1-6] are the Arduino controller that manages the tasks of Components and the harmony of the entire system and the ultrasonic that radiates ultrasound waves. And the IMU consists of a gyroscope system and an accelerometer system to know the position of the car before and after and in the impact or neither. The LCD previews the state of the road if it is either clear or there is a pot-hole or even a main-hole.

II. THE PROPOSED SYSTEM

The Arduino is the brain of the main system described in figure 1, as it takes the readings of the ultrasonic sensor to know if there is a pot-hole or main-hole and if it detected a pothole or main hole, it previews it on the LCD module to warn the driver that there is an obstacle in front of him. Then when the impact happens (an acceptable impact according to the worn of the ultrasonic sensor), the IMU will work on measuring the tilting that can decide that it is really a pothole or manhole (confirming the data that came from the Ultrasonic) and all of this scenario happen in the IMU by using two systems which are Gyroscope system and Accelerometer system. Figures 2,3,4,5 describe the components of our system. We have in the schematic diagram about 7 components, and they are ultrasonic sensor, whiteboard, Arduino, LCD, wires, IMU, and potentiometer.

The ultrasonic sensor generally is used as an object detector, and it detects objects (main holes & potholes) by calculating the time taken of propagating ultrasound waves which are generated from the trigger and then reflected the echo and then by applying a certain algorithm it coverts time into the distance, 5 DC volts is applied for the sensor and the trigger pin is connected with a digital port from Arduino as well as the echo pin is connected with digital port too.

LCD is used as a user interface for the driver and used in alarming, it is composed of 4 pins for transferring strings from Arduino to LCD screen, enable pin works as a switch for switching on the LCD screen, Read/write pin will be active low to do write operations on the screen, Pin (3) in the LCD is connected to the potentiometer for controlling the contrast of the LCD screen, pin (2) & pin (15) are set, on the other hand, pin (16) and pin (1) is grounded. Copper Wires and whiteboards are used for connecting the components with each other for either transmitting data or electricity.

IMU is an abbreviation to "inertial measurement unit," and it's composed of Accelerometer and gyroscope, and both of them work together to act as smart title sensing units. Accelerometer mainly measures linear acceleration in (m/s^2), the basic principle of the accelerometer is to measure the force acting on the proof mass while Gyroscope measuring the angular rate of the sensor rotation with respect to an initial reference system and its unit is degree per second (DBS), both sensor work for detecting a pothole, manhole, tunnels, bridges, and even in the care ideal case.

IMU is used as a tilt sensing unit for confirming the presence of either potholes or main holes, and it is biased by 3.3 volts, SCL (Serial Clock Pin) is connected to its corresponding pin in Arduino, SDA (Serial Data Pin) is connected to its corresponding pin in Arduino.

Arduino is considered our control unit in our design, as it regulates the tasks between all surrounding modules; we utilized Arduino Uno for providing power supply to other modules in this design, Data transfer between Arduino and the other components, also for making use of digital-based ports in case we have digital components such as an ultrasonic sensor. The potentiometer simply varies the applied voltage to pin (3) in the LCD (Liquid Crystal Display) screen, which in turn varies the LCD screen's contrast. The screen is an electronic display module and finds a wide range of applications. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. This LCD has two registers, namely, Command and Data. The schematic diagram of the main system to be implemented is shown in figure 6.

As shown in figure 7, the Software implementation flow chart shows the steps done for simulation of the main system.

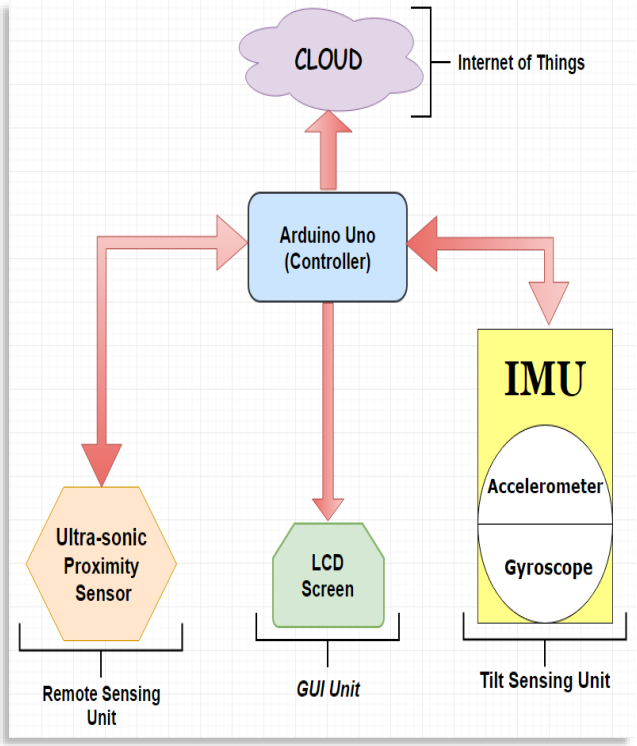


Fig. 1 Block diagram describing the hardware implementation

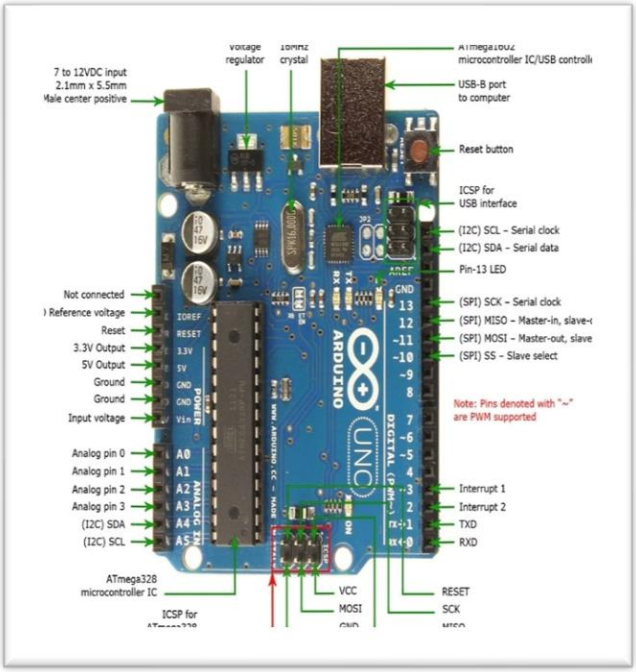


Fig. 2 Arduino schematic diagram

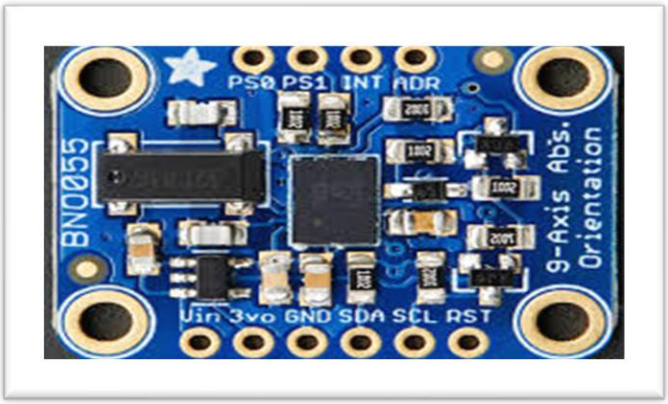


Fig. 3 IMU schematic diagram

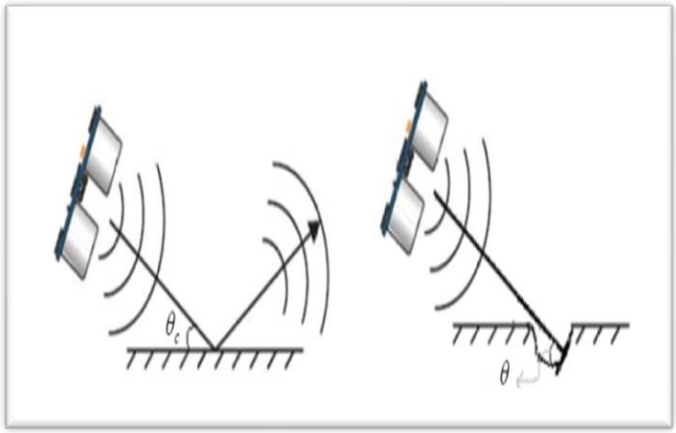


Fig. 4 Ultrasonic Sensor module diagram for distance measurement

Fig. 5 LCD screen shape

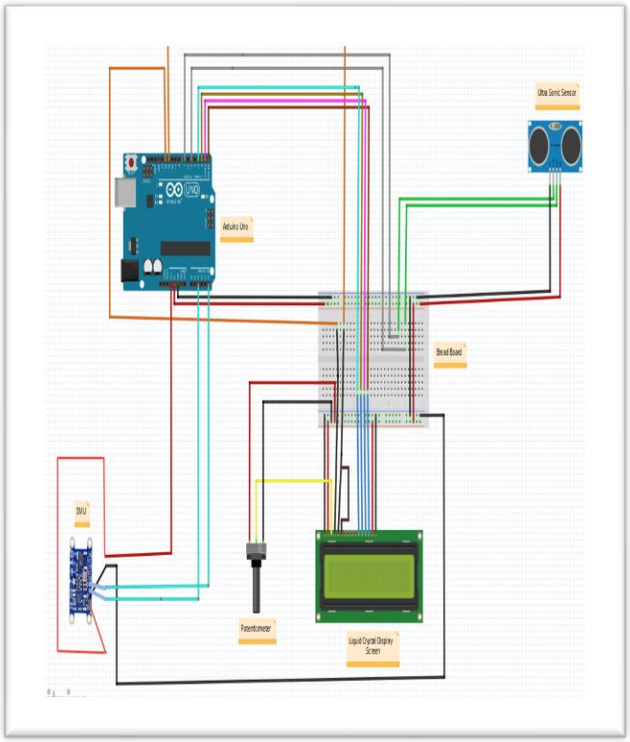


Fig. 6 Schematic diagram of the main system to be implemented

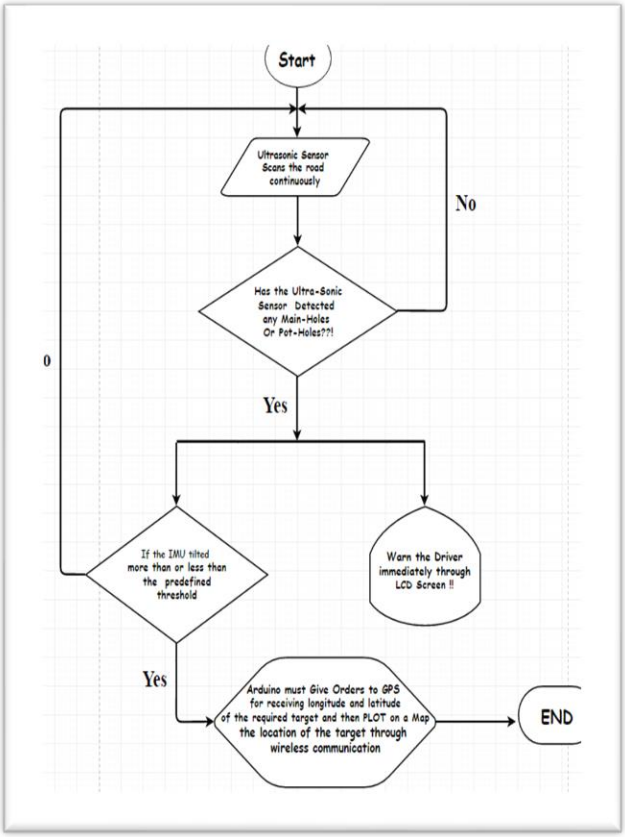


Fig. 7 Flow chart for the work of the main system

III. RESULTS

The simulation results are done for three cases. The first case, figure 8, shows in the case of the clear road the output of the ultrasonic, we can notify that there is nothing detecting as green (by using processing). The output of the IMU that's lay on the threshold from 83 to 96, as shown in figure 9, this threshold means that there is no tilting happen. *& Italic)*

Fig. 8 The output of the ultrasonic in case of clear road

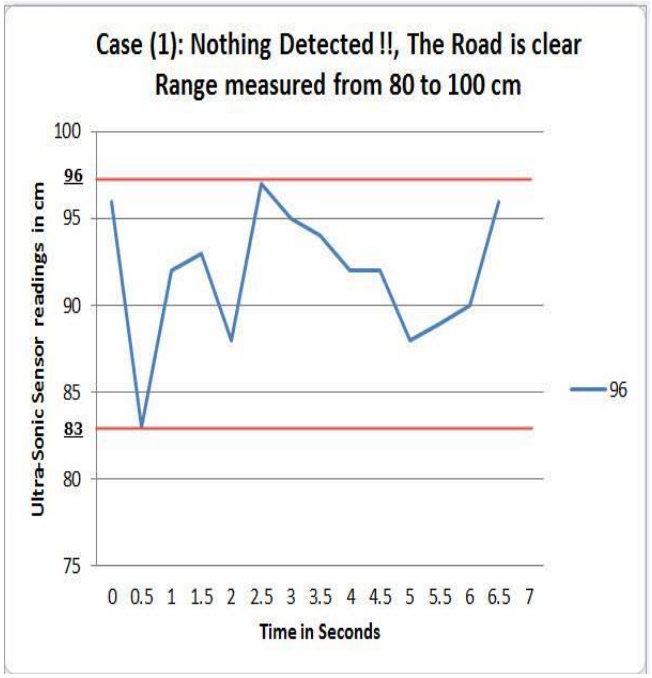


Fig. 9 The output of the IMU in case of clear road

In the second case, as shown in the previous figure, there is no obstacle in front of the prototype simulator device. In addition, it seems clear on the ultrasonic sensor readings. In the Case of pot-hole, as shown in figure 10, there is a pothole detected on the output of the ultrasonic. In figure 11, the output of IMU gives a reading of the pothole according to the threshold between 32 and 36cm. As shown, there is a pot-hole in front of the prototype simulator device, as also shown on the ultrasonic read.

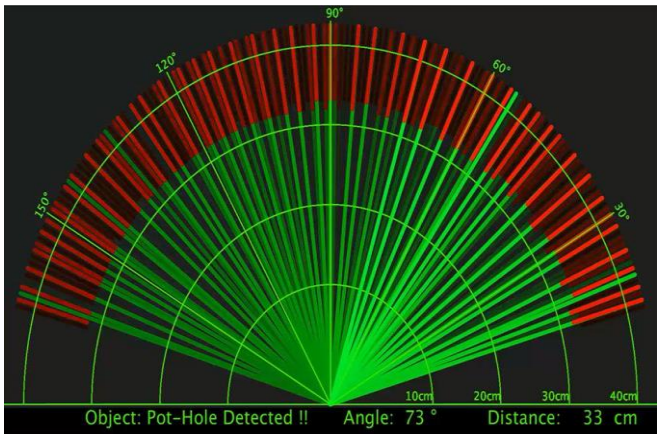


Fig. 10 The output of the ultrasonic in the case of pot-hole

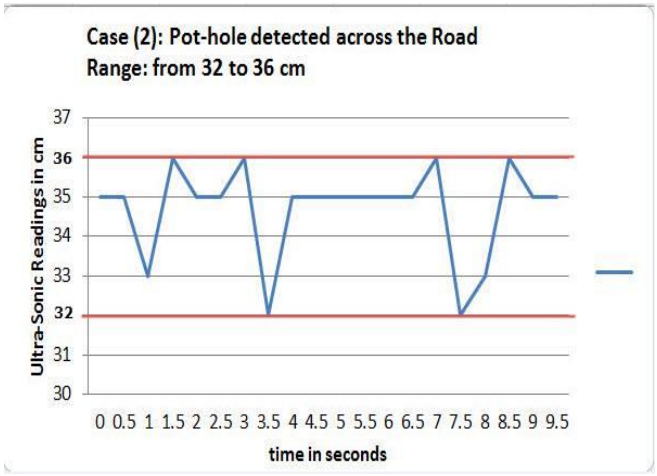
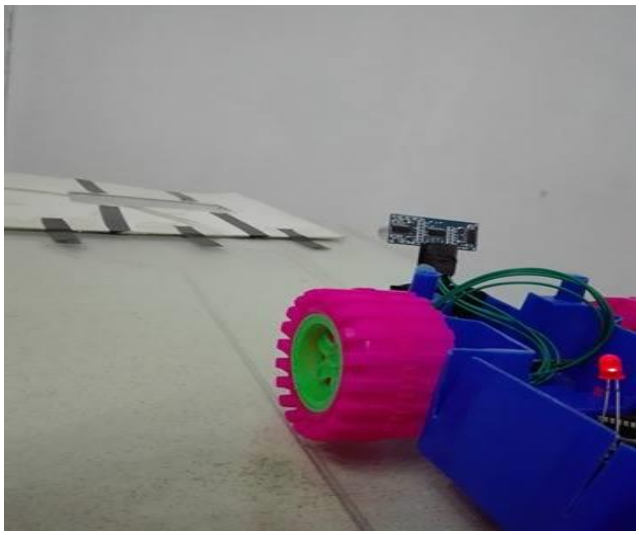
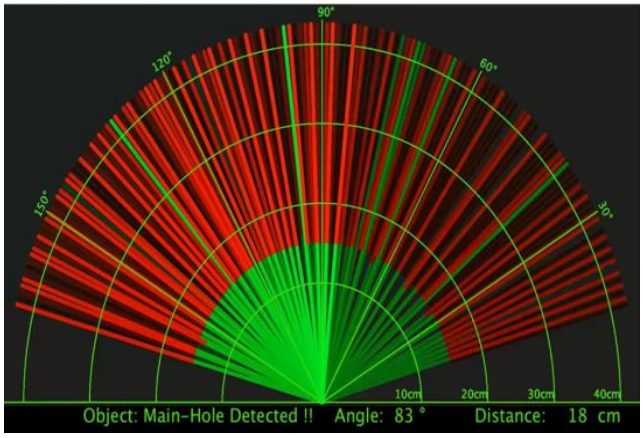


Fig. 11 The output of the IMU in the case of pot-hole





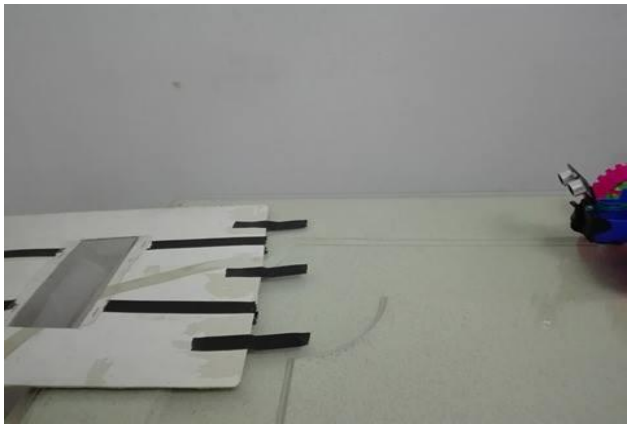


Fig. 12 The implemented system in case of a pot-hole

In the third case, in case there is a manhole, figure 13 shows the output of the ultrasonic is reading a manhole according to the reading distance that previews on the output. The output of the IMU is detecting a manhole according to the threshold between 15 and 20cm. As shown, there is a manhole front of the prototype simulator device, as also shown on the ultrasonic read.

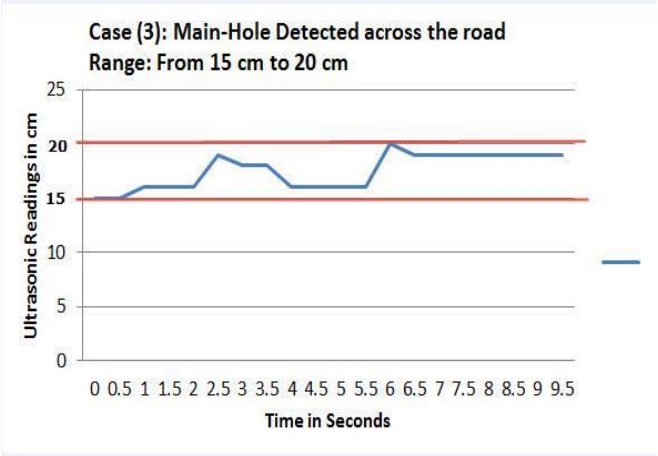


Fig. 13 The output of the ultrasonic in the case of a manhole

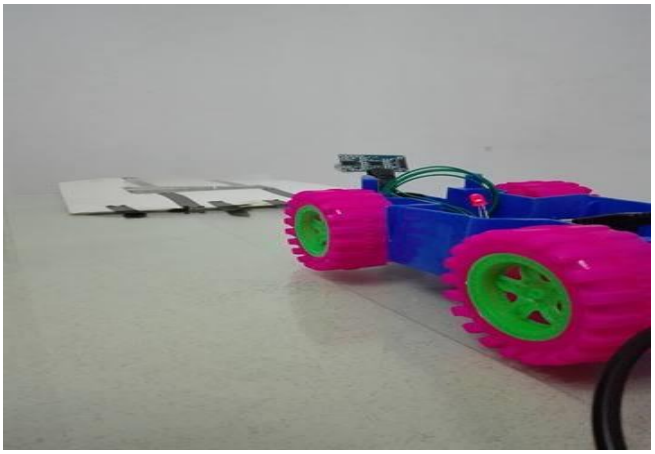


Fig. 14 The output of the IMU in the case of a man-hole

Fig. 15 The implemented system in case of a manhole

IV. CONCLUSION

The experimental results shows that the real-time road conditions evaluation are efficients with higher performance by detecting the road conitions in case of traffic. Vehicle drivers can obtain nearby road data from other vehicles via active alarm signals to direct their driving behaviors to enhance driving safety, performance, and efficiency. Road status can be improved, and people will be convenient.

V. FUTURE WORK

- Adding a cloud system that can share the result of our project with another car by the internet
- Making a website that includes a map pinned on it the location of the obstacle detected by all cars that use this project
- Using a GPS Receiver Module to include the longitude and latitude of the obstacle on the map and to let the driver know his position on the map and the distance between his location and the nearest obstacle
- Android application that can be available on all mobile systems (android – ios – windows)

REFERENCES

[1] Ravi Bhoraskar, Nagamanoj Vankadhara, Bhaskaran Raman, Purushottam Kulkarni, Wolverine: Traffic and Road Condition Estimation using Smartphone Sensors, Indian Institute of Technology, Bombay

[2] Jakob Eriksson, Lewis Girod, Bret Hull, Ryan Newton, Samuel Madden, Hari Balakrishnan, The Pothole Patrol: Using a Mobile Sensor Network for Road Surface Monitoring MobiSys, June 1720, 2008, Breckenridge, Colorado, USA. Copyright 2008MIT Computer Science and Artificial Intelligence Laboratory

[3] Gunjan Chugh, Divya Bansal, and Sanjeev Sofa, Road Condition Detection Using Smartphone Sensors: A Survey, Department of Computer Science and Engineering PEC University of Technology, Chandigarh, India ISSN 0974-2174, 7(6) (2014)

[4]

[5] Aniket Kulkarni,NitishMhalgi,Sagar Gurnani,Dr. NupurGiri, Pothole Detection System using Machine Learning on Android,2015, V.E.S. Institute of Technology, Mumbai-74

[6] Syuan-Yi Chen1, Annie Shih2 and Chun-Yi Hsiao, Road condition Detection Device Using Arduino Sensing Module and Android Smartphone, International Conference on Consumer Electronics-Taiwan (ICCE-TW) (2015).

[7] Artis Mednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs, Leo Selavo, Real-Time Pothole Detection using Android Smartphones with Accelerometers, Digital Signal Processing Laboratory Institute of Electronics and Computer Science R& D Center for Smart Sensors and Networked Embedded Systems, (2009).