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# Road quality analyser

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## ABSTRACT

***The condition index (cracking index) is one regular metric used by many countries to measure their road quality and justify the budget spent every year on the road repair. These decisions are dependent on the evaluation criteria that are subjective but not representative. In this paper, we confer about our initial approaches to solve the problem of data asymmetry in decision-making about the road quality. The proposed work explains the process of determining road-defects using data collected by the Road Quality Analyser (RQA). A web-based interactive user interface to host a large amount of data collected by the device RQA towards digitizing the process of road quality inspection. This approach of combining data and device for the assessment of road, which enables the government to make accurate decisions on road repairs and it will lead to an anticipative response which will result in significant cost saving.***

***Keywords***— *Quality, Raspbthe erry Pi, PMTK commands, Google Fusion Table*

## 1. INTRODUCTION

Maintenance of the road quality is the most visible indication of a government's performance. In an age of autonomous vehicles, cities and municipalities need a digitized way to assure that their roads are of good quality. Our project involves several cycles to develop a low-cost device which automates road surface inspections by the data collected by it and develop a web-based public facing interactive user interface. Here we explain a process which can be used to identify defects on the road using the data collected by the device. It's a device which hosts a large quantity of data for digitizing the process of road inspection. Existing methods used for surveying roads are as follows - Citizens reporting potholes via smartphones. Heavy military grade equipment which gives an accurate analysis of road quality but only for a small sample of the road. PCthe I am a measure e of road distress index, which will be calculated from the visual assessment of a sample of road networks. We contend that regardless of their training and expertise, these visual assessments are subject to error and inconsistencies. IRI involves using laser technologies to inspect the quality of the roads with high precision. Unfortunately, for most of the cities, the International Roughness Index is not a feasible option for citywide road quality identification due to its high cost. Many cities are being challenged to think about their city transportation system and prepare for a driverless future. We believe that the same form of thinking should be applied to the maintenance, repair, and response of the core piece of city infrastructure i.e. roads. So there is a need for a low-cost process which enables the government to measure the entire road using a data gathering technique that is actionable, scalable, verifiable and repeatable to allow for complete measurement of road quality. This will allow the government to make targeted decisions about road resurfacing.

## 2. LITERATURE SURVEY

Pothole Detection using Machine Learning concept on Android [1] was published where we understood the concept of use of Accelerometer for the detection of pothole and GPS for plotting locations of potholes on Map. Using a machine learning approach, from this paper we understood that we can identify the potholes from the data collected by the accelerometer. Real-Time Potholes Detection using the accelerometer in Smartphones [2] was published, this paper describes potholes detection algorithms using accelerometer data for deployment on the device with constrained hardware/software resources and evaluation of road on real-time data acquired using different smart-phones based on Android OS. This algorithm tests resulted in an optimal condition for each selected algorithm and the performance analysis in terms of different irregularity classes of roadshows very high positive rates. Intelligent Pothole Detection System [3] was published which gives a description of pothole detection system based on image processing concepts developed to analyze and process the data captured by the camera fixed on a car that gives high accuracy and efficiency compared to the existing methods of pothole detection. An algorithm for the detection of pothole using stereo vision [4] was published in this paper they have described a pothole detection system based on stereo vision. Using the disparity map is created by an efficient algorithm which calculates the disparity then the potholes can be detected by calculating their distance from the fitted quadratic road surface.

## 3. THEORY

The digitizing road surface inspection process is not a unique idea by itself. Many attempts for digitizing road surface inspection has been done. However, there are a few attempts which account for scalability. Our project involves the development of a low-cost device, collection, and storage of data to automate the street surface inspections and to provide a

 

web-based public facing interactive visualization tools. Here we provide an advancement in the private sector in delivering a comprehensive approach that will not only benefits government but also address the systemic issues in citywide road quality maintenance. In this paper, we provide a survey of our project RQA, how we designed, assembled and implemented it to how the data gets collected, stored and analyzed in a robust manner.

**3.1 Raspberry Pi:** The Raspberry Pi is on the board debit card sized computer which can be used to perform many tasks which the regular computers do, like gaming, word and spreadsheets processing, it can also play HD video and for some computation. It was introduced by the Raspberry Pi foundation from the United Kingdom. It's been available for the public since 2012 with an idea of making low-cost microcomputer for educational institutes and students. The main reason for designing the raspberry pi board is to encourage experimentation, learning, and innovation for students at school level. The raspberry pi board is portable and a low-cost device.

**3.2 Ultrasonic sensor**: It is a device that uses ultrasonic waves to measure the distance from the target object to the sensor. Ultrasonic waves are mechanical waves and they travel as a sequence of rarefactions and compressions in the direction of wave propagation through the propagating medium. HC-SR04 emits a 40000 Hz ultrasound which travels through the medium along the direction of propagation and this ultrasonic wave (ultrasound) will bounce back if there is an object or obstacle in its path. Considering the speed of the ultrasonic sound wave and signal roundtrip time we can calculate the accurate distance between the sensor and the object.

**3.3 Pi Camera:** The Pi Camera Module is a custom designed add-on for the Raspberry Pi. It is attached to the Raspberry Pi board via CSI camera port on the upper surface of the board. The CSI bus has a high data transfer rate, and it exclusively transfers pixel data. Raspberry Pi Camera can be interfaced to the raspberry pi board by the CSI connector on the Raspberry Pi board. It delivers a crystal clear image with 5 Megapixels resolution or 1080p High Definition video recorded at 30fps with latest v1.3.

**3.4 Accelerometer:** ADXL345 accelerometer is a low power 3axis accelerometer. Its minimum full-scale range for the measurement of the acceleration is ±3 g. For tilt applications, it can also measure static acceleration in gravity as well as the dynamic acceleration which results due to motion, vibration or shock. Using the capacitors CX, CY, CZ capacitors user can select the bandwidth of the accelerometer.

**3.5 GPS Receiver (PA6ECAM011728):** PA6ECAM011728 utilizes the new gen MediaTek GPS Chipset MT3339 that has the industry's highest sensitivity level (-165dBm) and quick Time-to-First-Fix (TTFF) with low power consumption and precise signal processing which results in an ultra-precise positioning in high velocity. This module is a revised version for Patch on Top GPS Module with extra embedded functionality built for the I/O of an external antenna and has a short circuit protection circuit and automated antenna switching function.

## 4. PROPOSED SYSTEM

### 4.1 Device

Road Quality Analyser (RQA) consists of a Raspberry Pi 3 B computer, an accelerometer, GPS, ultrasonic sensor and a camera. It's a low-cost device which is well-suited for digitizing the road quality inspection process. In terms of implementation, RQA is mounted to the back of a vehicle with its camera and ultrasonic sensor facing downwards to the road, while the accelerometer and GPS are kept inside the vehicle in a horizontal plane with the raspberry pi computer.

### 4.2 Data collection and storage

RQA collects location, imagery and accelerometer data from GPS, camera, and accelerometer. The data collection rate or frequency of the GPS is set to 5 Hz and is done passively. The only constraint is to maintain speed the survey vehicle below 35 mph to capture a high-quality image and to stay within the local speed limits.

The ultrasonic sensor is the main sensing element in RQA. When the device is turned on it calculates the signal round trip time (SRTT) on normal road surface and then during the survey the unevenness in the road i.e. potholes will affect the signal round trip time, any changes in SRTT will make the device to trigger an interrupt to collect the data from camera, GPS, and accelerometer at that instance. And this data will be stored in an external storage device connected to the raspberry pi board in.CSV file format.

Which consist of the following data fields- Timestamp, location, Accelerometer data in x, y, z-direction and the image taken by the camera. Which can be used to plugin to superior computers than raspberry pi for the purpose of analysis and to provide a visualization tool.

### 4.3 Proposed block diagram

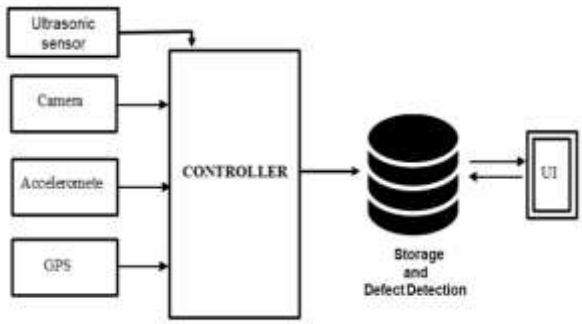


**Fig. 1: Block diagram of the proposed system**

## 5. METHODOLOGY

Interface GPS module with the raspberry pi, did some modification to the GPS module in order to get only RMC sentence & to set the update rate as 5hz by using following $PMTK commands.

– To get only RMC sentence
  $PMTK314,0,1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0*29

– To set update rate to 5Hz
  $PMTK220,200*2C

Interface picamera v1.3 with raspberry pi3 and install the picamera library package. Interface ADXL345 with raspberry pi3 and installed the ADXL345 library package. Interface HC-SR04 Sensor with raspberry pi3.Developed a program which fetches data from GPS module, camera and accelerometer when the roundtrip time calculated by the ultrasonic sensor is above the given threshold and make a database of pictures taken which are tagged with the timestamp, longitude, latitude, speed, and accelerometer data which are fetched at the time of taking the snap.

 

## 6. SCHEMATICS

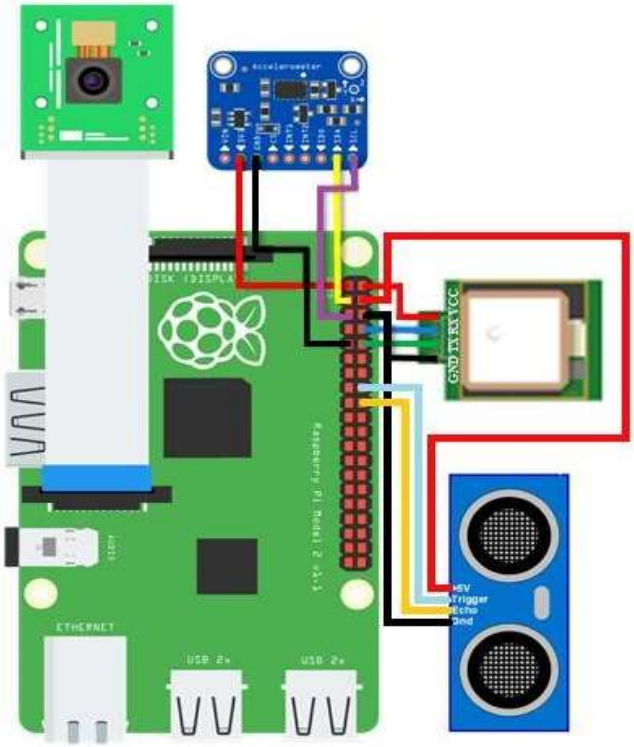

**Fig. 2: Schematics of the proposed design** II.

## 7. FLOW CHART

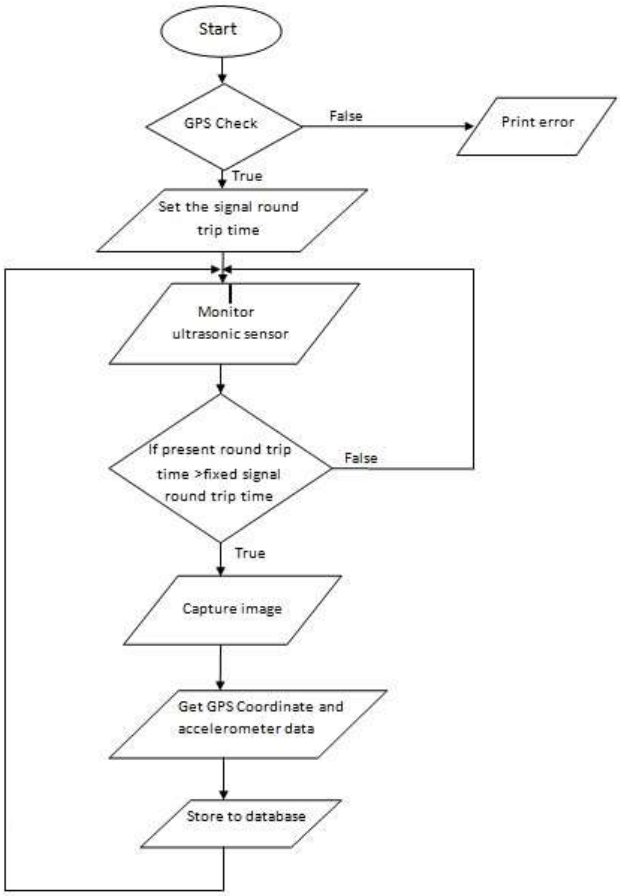


**Fig. 3: Flow chart of the proposed design**

## 8. RESULTS AND DISCUSSION

The device fetches data from camera, GPS module and accelerometer when ultrasonic sensor detects unevenness or pothole on the road and make a database of image and tag it with the corresponding GPS coordinates, timestamp, speed, and accelerometer data in X, Y, Z direction. We used Google fusion table API to render the GUI for public interaction.

### 8.1 Database created by device

| Timestamp | Latitude | Longitude | Speed | X | Y | Z | image |
|---|---|---|---|---|---|---|---|
| 1522569747 | 12.64223 | 12.64223 | 8 | 1 | 1 | 2 | https://lh3. |
| 1522569781 | 12.64226 | 77.43918 | 8 | 1.1 | 1.8 | 1.9 | https://lh4. |
| 1522569790 | 12.64227 | 77.43915 | 7 | 0 | 0 | 1.2 | https://lh3. |
| 1522569799 | 12.64226 | 77.43907 | 6 | 1.6 | 2 | 1.8 | https://lh4. |
| 1522569809 | 12.64228 | 77.43899 | 8 | 0 | 0 | 1.3 | https://lh4. |
| 1522569823 | 12.64227 | 77.43895 | 8 | 0 | 0 | 1.5 | https://lh4. |
| 1522569834 | 12.64227 | 77.43873 | 6 | 1.1 | 1 | 1.2 | https://lh4. |
| 1522569854 | 12.64226 | 77.43825 | 6 | 0 | 0 | 1.4 | https://lh6. |
| 1522569872 | 12.64226 | 77.43812 | 9 | 0 | 0 | 1 | https://lh3. |
| 1522569879 | 12.64225 | 77.43808 | 6 | 0 | 0 | 1.3 | https://lh4. |
| 1522569886 | 12.64225 | 77.43808 | 6 | 0 | 0 | 1.8 | https://lh5. |

**Fig. 4: Database**

### 8.2 Pictures of pothole

**Fig. 5: Pictures of pothole captured by the device**

### 8.3 User interface

**Fig. 6: RQA web-based data view interface**

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