CS-684-2016 Final Report

Road i/o

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1. Introduction

"One accurate measurement is worth a thousand expert opinions" Grace Hopper.

In a developing country like India, the problem of poor road quality profoundly affects urban transportation efficiency. We aim to address this challenge by creating 'Road i/o' - a road quality measuring, monitoring and mapping solution which will afford urban commuters the knowledge of road quality by location in order to plan their journey for a better travel experience. Moreover, the huge database of information accumulated on the road quality map could be provided to civic authorities to make them aware of a precise need for improvement in infrastructure.

2. Problem Statement

To design and build a device that collects data about road quality parameters such as uniformity, presence and size of craters, water logging etc. and analyses this data to obtain a road quality map of the city.

3. Requirements

3.1 Functional Requirements

1. Hardware: Sensors, GPS module, SD card, Microcontroller (details in Section 3.3)
2. Software: CCS, Android Studio, Eagle
3. Power source: Battery
4. Printed circuit board, soldering apparatus

3.2 Non-Functional Requirements

1. PVC container to encase the device
2. Drills, tape, insulation and other instruments and materials for prototyping
3. Clamps, screws and bolts to mount on a vehicle
4. Cycle to mount the device for testing.

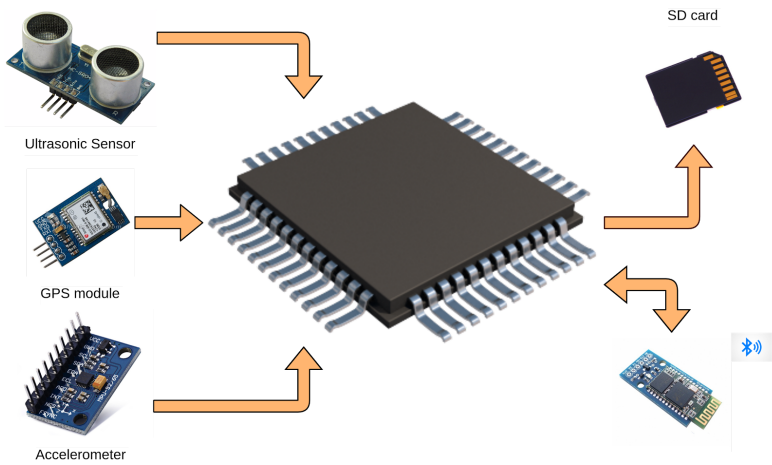
3.3 Hardware Requirements

- Ultrasonic Distance Sensor
- Accelerometer
- GPS Module
- SD Card
- TIVA C Series microcontroller TM4C123GH6PM
- 9V Battery

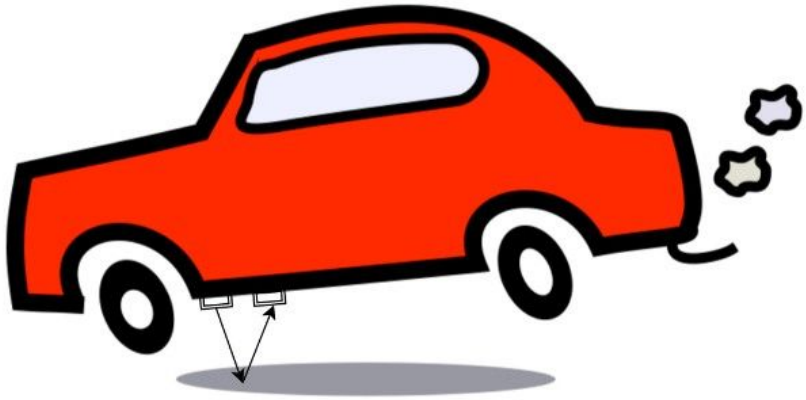
3.4 Software Requirements

- TI Code Composer Studio
- Eagle 6.5.0
- Android Studio

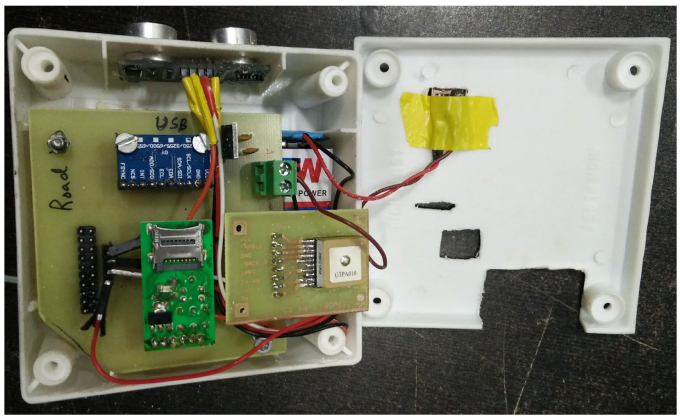
4. System Design

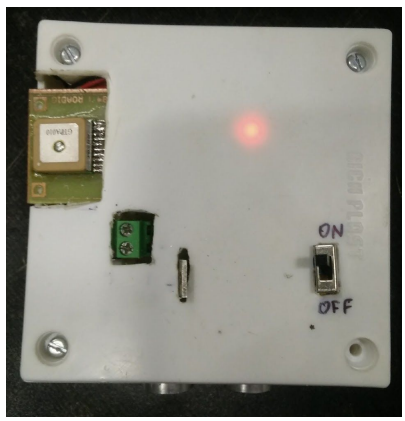


Our hardware is basically Ultrasonic Distance Sensor, Accelerometer, GPS Module, SD Card interfaced onto a TIVA C Series microcontroller TM4C123GH6PM. (*Bluetooth is currently not interfaced in the device)



The device is mounted on the undersurface of a vehicle. It consists an ultrasonic sensor to measure distance from the road surface, an accelerometer to record changes in the car's motion such as jerks due to bumps or craters, and a GPS module to store the location corresponding to every dataset of the road profile. This data is then processed and analysed to assign a single numerical score (from 0 to 10) to represent the road quality at that point. These scores are then mapped onto an app on the user's smartphone to create a road quality map of the city. The app points out the user's location and depicts surrounding road quality.





5. Working of the System and Test results

The first part of the project consisted on interfacing the individual sensors independently on MCU. The requirements for individual sensors were as follows:

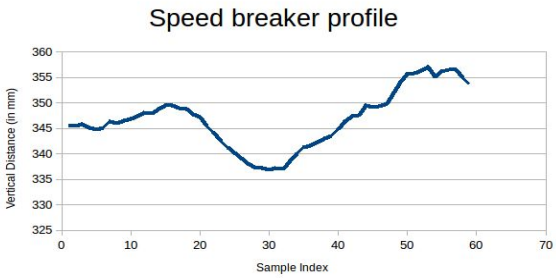
- Ultrasonic Distance Sensor – Timers and interrupts
- Accelerometer - I2C
- GPS module – UART
- SD card – SSI

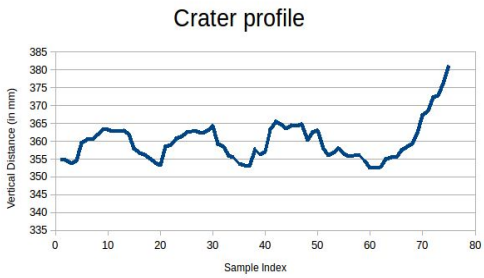
Each module was separately tested and the accuracy of the data was verified.

The next task was to integrate all the sensors on the MCU. Once this was done we made a booster pack to put together all the sensors, SD Card Module and voltage regulator circuit onto a PCB. Having realized the full-fledged working of the system, we encased it in a PVC box and mounted it on the bicycle to collect some real data from the road.

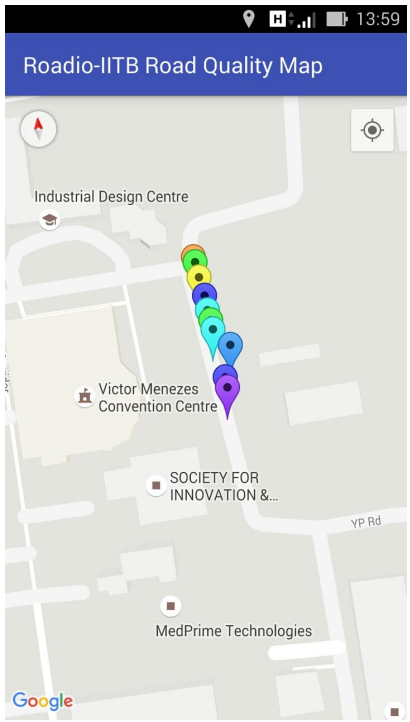
We collected some data from rough patches and bumpers and using elementary signal processing tried to extract those features form the collected data.

We used Moving Average filter to plot Ultrasonic Sensor data and the graph seemed to resemble the feature.





The road quality score can then be showed on an Android App using Google Maps.



6. Discussion of System

a) All modules of the project have worked reasonably according to the plan set out in the SRS.
b) Additionally, we have also created an Android app that maps the road scores and provides visual representation of analysed data.

7. Future Work

- The interfacing sensors with TIVA - ultrasonic, accelerometer (MPU9250), GPS module (MT3333) and SD card are fairly independent - so can be used in individual interfacing as well.
- There is lot of potential work that can be done at the data processing end, even with this device being mounted on a bicycle.
- Bluetooth can be interfaced on the device to transfer data wirelessly to the smartphone or cloud
- Hardware can be made sleek by just including the necessary components and embedding them on a PCB.

8. Conclusions

We are looking forward to develop this as a full fledged product and actually go ahead in making a difference. This has the potential of creating a whole new realm of transparency and accountability in the way the road infrastructure will be managed.

9. References

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