ROAD QUALITY CHECKING SYSTEM USING MAHALANOBIS–TAGUCHI SYSTEM

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Abstract - *Road quality checking is of vital importance for the traveling comfort and driving safety. While high-end automobiles are already equipped with road detection function, most mid-range cars can only detect and evaluate road conditions leveraging remodeled or additional hardware devices built on vehicles, thereby constraining the road quality checking. For low cost budgeting smartphone is used as it already have inbuilt sensors. The acceleration sensor and gyroscope have fluctuations when the vehicle passes through the larger pothole, and there is a connection between them. A novel road detection approach based on Mahalanobis–Taguchi system (MTS), leveraging smartphones for data collection and involving the correlation between characteristics is used. The application was developed to collect and process the data, and then classify road quality conditions. In addition to experiment quality of newly constructed road is checked in certain intervals of time. The strategy of marking road conditions to the navigation map and providing road quality check report can effectively improve not only driving experience and traveling comfort but also driving safety, thereby providing more supports for the maintenance units*.

***Key Words*: Road Quality Detection, Smartphone, Mahalanobis-Taguchi System (MTS), Road Surface Condition, Driving Safety, Accelerometer Data.**

1. INTRODUCTION

The project is to automate the checking of quality of road using Mahalanobis-Taguchi System. Using smartphone sensors data will be collected and stored with help of application. The stored data is then process and benchmark is set. MD of various road is calculated and depicted .MD of testing road is then compared with the MDs which are previously calculated and classified. Then testing road is classified accordingly. In addition, rate of change of MD is evaluated to check the degradation of quality of road.

2. LITERATURE SURVEY

J. Eriksson, L. Girod, B. Hull, R. Newton, S. Madden, and H. Balakrishnan Pothole Patrol, a taxi - based mobile sensing system studied by Eriksson et al. [1]; This a was proposed for monitoring and assessing pavement conditions. In this, a taxi is equipped with three-axis acceleration sensors, a Global Positioning System (GPS) receiver, and a laptop computer with the data aggregation and processing unit. They build a detector which can analyse and misidentify good road segments as with potholes less than 0.2% which is good.

K. Chen, M. Lu, G. Tan, and J. Wu, CRSM, a crowdsourcing based road surface monitoring system," [2]: This was proposed for effectively detecting road potholes and evaluating road roughness using their hardware modules embedded in distributed vehicles. The proposed system uses low-end accelerometers and GPS devices to obtain vibration pattern, location, and vehicle velocity, and has been considered among the first few methods putting forward crowdsourcing mode in road quality detection.

X. Yu and E. Salari, ''Pavement pothole detection and severity measurement using laser imaging,' An efficient and more economical approach for pothole and crack detection with laser imaging is introduced. The detection equipment consists of an active light source. That projects a line pattern of laser beams onto the pavement surface, and a camera for image captures. Moreover, the proposed method is capable of discriminating the dark areas that induced by lane marks, oil spills, etc

C. Van Geem et al., ''Sensors on vehicles (SENSOVO)—Proof-of-concept for road surface distress detection with wheel accelerations and ToF camera data collected by a fleet of ordinary vehicles,'' Transp. Res. Procedia, vol. 14. In this, two scenarios were considered, i.e., data collection already available on the CAN-bus using a fleet of ordinary cars or trucks, and one or more Time-of-Flight cameras (ToF) to be installed on a group of vehicles. Data on the CAN-bus is collected using either a CAN-logger trans- mitting data to a central server with GPRS, or an OBD scan- tool sending data to a mobile phone with Bluetooth that has processed data as detection event.

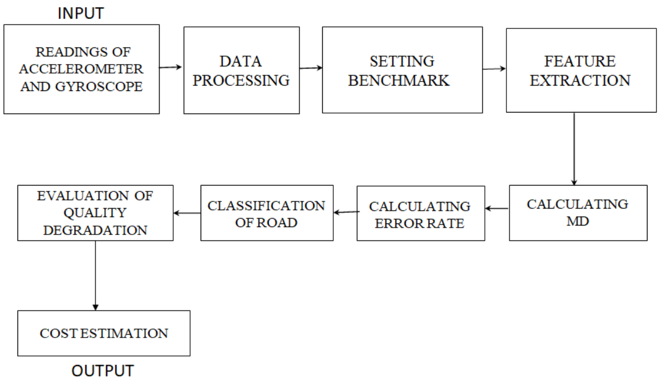

Chart -1: Block Diagram

3. Data Collection

The data collection process is a critical step in this topic. Different methods have been used in previous work; however, all work include the collection of accelerometer data, in one way or another. This subchapter aims to provide an overview of the techniques used to collect this data.

4. Data Processing

Accelerometer data readings usually contained irrelevant data (noises). Therefore, a pre-processing phase should be applied in order to reduce noise and improve the road quality recognition. Due to several factors such as jerks or vibrations, turning, veering, braking, and as well as subtle changes in sensor orientation, a considerable amount of noise is added to these signals.

5. Feature Extraction

When machine-learning algorithms are processed, representative tuple of features rather than raw data is a more effective input. Thus, it is necessary to extract effective features from road conditions patterns. In order to reduce input data, the raw data obtained from the sensors is first segmented into several windows, and features such as frequencies are extracted from the window of samples.

6. Road Condition Classification

While most non-flat roads can be characterized as abnormal ones in the detection, the road anomaly is not sufficient as an accurate classification, since each road classification is obtained by the MD within a certain interval, and different intervals are overlapping. Therefore, we define different abnormal spaces. The road anomalies can be roughly classified into three categories: manhole cover, pit, speed bump.

7. ALGORITHM

Road Detection Algorithm Based on MTS

Input: Four types of sample data: flatroadList data [1, . . ., n*m], manholecoverList data [1, . . ., n*m], speedbumpList data [1, . . ., n*m], potholeList data [1, . . ., n*m]

Output: The actual quality information of the road S_{type}

1: Initialize temp:intermediatevariable, max:maximum, min:minimum, mean:mean, std:standard deviation
2: /*CalculatestandardMatrixMDRange(flatroadList)*/
3: for j = 1 ← MD.size() do
4: mi,g ← (floatRoad(:, 1) − mean)/std
5: end for
6: for j = 1 ← MD.size() do
7: /*H:StandardizedFloatRoad
C: Correlation Coefficient*/
8: MDi ← sqrt (H (1, :) ∗ C ∗ HT
(: 1)/m)
9: end for
10: /*CalculateMDRange(flatroadList)*/
11: /*CalculateMDRange(speedbump,pothole, manholecover) */
12: for j = 1 ← MD.size() do
13: if temp > max then
14: max ← temp
15: end if
16: if temp < min then
17: min ← temp
18: end if
19: end for
20: /*Arrive at the type of the smallest markov distance*/
21: if MDX < MDY < MDP < MDQ then
22: S_{type} ← X
23: end if
24: /*The type of Y, P and Q by analogy*/
25: Output S_{type}

8. CONCLUSIONS

In this paper, an Android application (Road Surface Data Collector) for linear acceleration data collection, was developed. The application makes use of the Android Sensor framework in order to gain access to Gyroscope, gravity and linear accelerometer sensors. Based on the input from a magnetometer and a gravity sensor, a transformation process, that allows the phone to be in any orientation during data collection, was described and implemented. The application was used to collect acceleration data on different roads in and around the city of Nashik. Three types of road surfaces were distinguished: smooth, bumpy and rough.

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