Università della Calabria

Dipartimento di Matematica e Informatica

Corso di Laurea in Informatica

Monitoring road surface conditions using IMU

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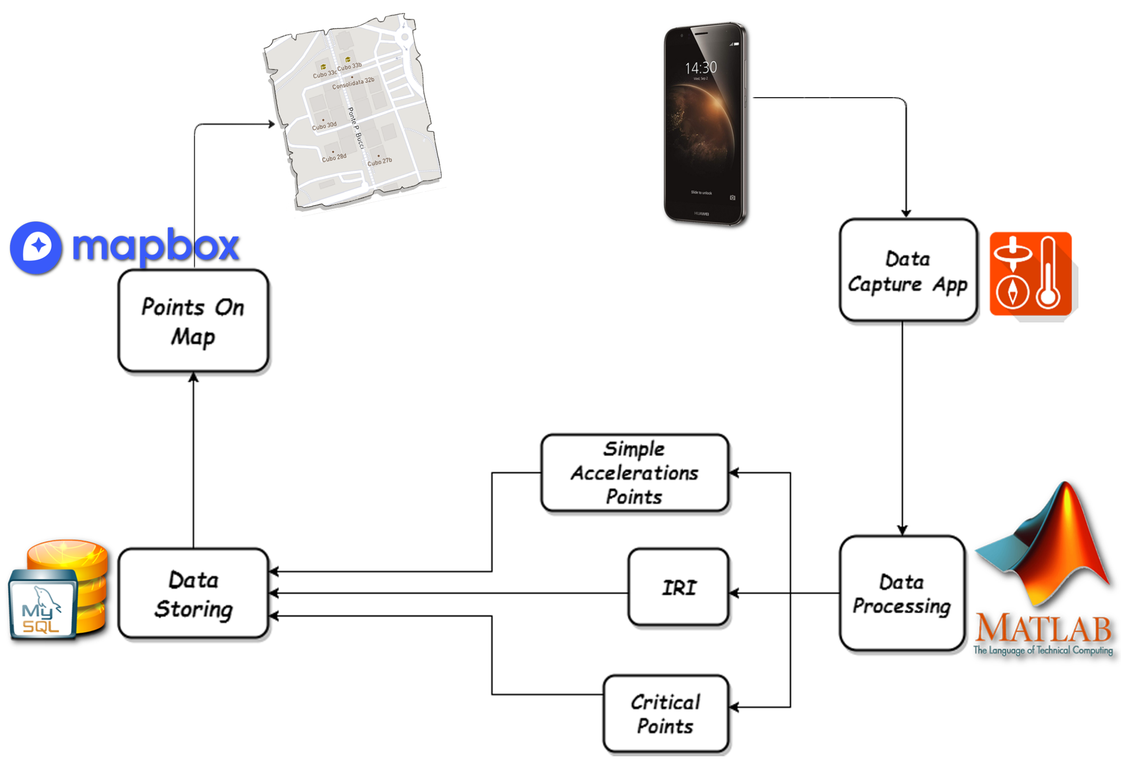
Summary: *This work focuses on the development of a system for the monitoring of road surface conditions, that makes use of inertial measurement units (IMU), electronic hardware systems based on inertial sensors, such as the ones in our smartphones. The system is based on the reading of data collected, and on the post-processing elaborations of the GPS signal and acceleration data, (in which particular attention is given to vertical acceleration impulses, corresponding to high-energy peaks). Three indexes of the road quality are extrapolated.*

Motivation

- Providing both, correct location of the most damaged points and a level of comfort of road quality helps to make the transport system more efficient, comfortable, and secure. Because disadvantages roads increase both the risk of car damage and fuel consume.
- The detection of anomalies, such as potholes, small covering defect, breaks, and their proper location, has a significant impact on road infrastructure maintenance, allowing public institutions to intervene properly.
- The main reason, regard the instrumentation used.
  The profilometers directly measure the quality but their cost is high and a small number of people can do the monitoring.
  In this work only low-cost inertial measurement systems are used, such as the sensors of mobile devices, which, are owned by the majority of drivers, and they are able both to get road quality information and to actively participate in the collection of data.

System Structure



Road Quality Indexes

- **Simple Accelerations Points: (SPA)** interpret how the variation of the acceleration signal changes on predetermined road traits travelled at different speeds.
- **Critical Points: (CP)** index that labels and locate the most damaged points on the road surface, finding on the vertical accereration signal the presence of high-energy peaks generated by the road-vehicle vibration, and can, therefore be associated with "anomalies" on the surface
- **IRI:** Internationa Rougheness Index; the most used road roughness index to evaluate road infrastructure. It is defined as the ratio between the sum of vehicle-wheel displacement, in fact it is calculated simulating the quarter-car mathematical model of a standard vehicle, travelling at 80 km/h. His aim is to show how the elevation varies depending on the lenght of the road in question. The resulting value referes to a single portion of the road, and can be compared with his referencec scale (IRI scale). To calculate this index, a various filtering operation on the acceleration signal was performed, in order to obtain the displacement by a double integration process.

Conclusions

A Monitoring system that collects data from the low-cost sensors, can be developed. During processing an adequate filtering system is required that is strongly dependent on the type of noise the signal is subject to.

Regardless the index it is possible to affirm:
SPA: Notes that an appropriate methodology is needed to calculate the surface conditions beacuse the representation of the acceleration signal alone would not be satisfactory.
CP: Following, both signal and visual inspections it is possible to affirm that it locate accurately the most critical road asperities founded during the signal processing phase, some threshold have been identified, in order to provide a degree of their danger.
IRI: The result obtained have provided good results, compared to the road in question, and moving not much from the IRI scale, indicating the degree of comfort and deterioration. However, a correlation equation from Class1 instrument is necessary, beacuse they may deviate frome the scale, much or little, a factor strongly dependent on the road, despite the results being accurate.