Investigating the Use of Smart Phones as Sensors for Road Condition Monitoring

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Introduction

Dedicated vehicular sensors are currently used as a means to deduce prevailing hazardous road conditions e.g. potholes. With their relative ubiquity and a range of on-board sensors such as GPS and accelerometers, smart phones may be a more affordable alternative to vehicular sensors for road condition monitoring purposes.

Project Goals

- Determine the feasibility of using smart phones for road condition monitoring in real-time.
- Design and implement a gesture detection application as a proof-of-concept on the Google Android platform.
- Develop a failure-tolerant communications platform to accommodate communications failure and intermittent data connections when reporting detected road conditions.

Pothole Detection Architecture

The Road Condition Monitoring system consists of:

- **Pothole Detection Client**
  - Smart phone equipped with accelerometer and GPS sensors. Incorporates failure-tolerant mechanism for relaying data to server. Gesture recognition application was developed as proof-of-concept.

- **Pothole Server**
  - Aggregates probable pothole GPS coordinates reported by the clients and, using a ranking system, discloses highly probable pothole locations.

Gesture Detection Filter

- Road condition related data could not be collected due to project constraints. Gesture detection filter was developed as a proof-of-concept. The gesture detection filter implements a rule-based algorithm.
- Accelerometer data is collected at a rate of 100ms (10Hz) for the x, y and z axes. Buffer size is 20 (2 seconds) and window size is 10 (1 second).
- The average value for each of the three axes is collected and compared to a threshold which is fixed to the smart phone’s natural position for all three axes.

Pothole Server

- The Pothole server allows for multiple client collections to report probable pothole location coordinates.
- To account for inaccuracy of reported GPS coordinates, a margin of error is introduced in the clustering algorithm. The clustering algorithm compares reported pothole coordinates with existing database entries and increases the rank of entry if within error range.
- New entry created if reported data is outside error margin of database entries.

Future Work

- **Gesture/Pothole Detection Algorithms** – Accurate algorithms are needed to reliably interpret gestures from accelerometer data.
- **Location Accuracy** – location-aware technologies for accurate and fine-grained location sensing in GPS blind spots.
- **Smart phone orientation** – Placement of smart phone and the changes in its orientation could alter the axes planes of the accelerometer relative to its natural position. Reorientation of accelerometer is important to avoid compromised data.

Conclusion

- Sensor-rich smart phones offer an affordable and viable alternative to vehicular sensors for detecting and reporting bad road conditions.
- More sophisticated machine learning algorithms are needed to differentiate potholes from other road anomalies.
- For future work, the gesture recognition filter should be replaced by a pothole detection filter solution.
- Satellite navigation devices could be augmented with road condition data to alert road users to hazardous road conditions.

Further Information

- Contact Information
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