Grand Valley State University
ScholarWorks@GVSU

Undergraduate Research | Mathematics Department

2011

Wavelet-Kruskal Solution to the InnoCentive Boston Pothole Challenge – Software Release

Edward Aboufadel
Grand Valley State University, aboufade@gvsu.edu

Nathan Marculis
Grand Valley State University

SaraJane Parsons
Indiana University of Pennsylvania

Clark Bowman
University of Rochester

Follow this and additional works at: http://scholarworks.gvsu.edu/mathundergrad

Recommended Citation
Aboufadel, Edward; Marculis, Nathan; Parsons, SaraJane; and Bowman, Clark, "Wavelet-Kruskal Solution to the InnoCentive Boston Pothole Challenge – Software Release" (2011). *Undergraduate Research.* Paper 1.
http://scholarworks.gvsu.edu/mathundergrad/1

This Article is brought to you for free and open access by the Mathematics Department at ScholarWorks@GVSU. It has been accepted for inclusion in Undergraduate Research by an authorized administrator of ScholarWorks@GVSU. For more information, please contact scholarworks@gvsu.edu.

Wavelet-Kruskal Solution to the InnoCentive Boston Pothole Challenge – software release
Copyright 2011, Edward Aboufadel
contact: Edward Aboufadel -- aboufade@gvsu.edu, 616-331-2040

In 2011, the City of Boston partnered with InnoCentive, along with researchers at the Worcester Polytechnic Institute and the Santa Fe Complex, to seek a solution to the problem of efficiently identifying potholes. They challenged InnoCentive "Solvers" to predict where potholes are located on the streets of Boston, using data collected by an app called "StreetBump" that runs on Android smart phones and can be used by volunteers traveling the city. The StreetBump app addresses the dynamic nature of potholes by recording acceleration, orientation, location, and other data. See http://www.innocentive.com/mayor-menino-launches-contest-enhance-smart-phone-app-detects-and-reports-potholes.

Our solution to the problem uses wavelets, Kruskal's algorithm, and other mathematical tools to identify potholes. The steps of our solution are as follows: (1) apply rotation matrices to the accelerometer vectors of data collected by the StreetBump app, so the data is consistently oriented; (2) apply a high-pass wavelet filter to the transformed accelerometer data, followed by thresholds on the filter output and the speed data, which will identify accelerometer spike locations (via GPS) where a pothole is likely to occur; (3) cluster these spike locations through an application of Kruskal's algorithm to a carefully-defined graph of nodes and weights; (4) calculate an average position within a cluster, and adjust this position due to the lag in recording of GPS data, in order to locate the position of each pothole; and (5) estimate the severity of each pothole by a function we have created for this application.

In this release is our C++ source code for our algorithm, which is made available through the GNU Lesser General Public License. A detailed report of our algorithm will be made available in the future.

Project Team: Prof. Edward Aboufadel (Grand Valley State University), Nathan Marculis (Grand Valley State University), SaraJane Parsons (Indiana University of Pennsylvania), and Clark Bowman (University of Rochester).

December 12, 2011