The 12th INTERNATIONAL CONFERENCE **INFORMATION TECHNOLOGIES AND MANAGEMENT 2014**
April 16-17, 2014, Information Systems Management Institute, Riga, Latvia

USING CAR VIBRATION DATA FOR ROAD PROMINENCY IDENTIFICATION

S BRATARCHUK♥, R DUBOVSKA

Institute of Aeronautics, Riga Technical University
Lomonosov 1, bldng V, LV-1019, Riga, Latvia

ABSTRACT

Research is devoted to the problem of computer recognition of vibrations that car receives while moving by the road. Roads' roughness, holes cause additional mechanical load on a car and may lead to its damage. For timely reaction of road service on roads' impairments is necessary to create geographical information system that allows gathering operative data about the condition of roads. During the era of mobile devices this data can be gathered by traffic participants. Ways of gathering data and automatic roughness type determination are considered in the research. This study is the first necessary step to creating city notification system. The main result of the research is functioning software that implements assigned task.

Keywords: Vibration, road prominence, obstacle type automatic detection

THE OBJECT OF THE RESEARCH: Sensor data processing algorithms
THE SUBJECT OF THE RESEARCH: Moving car vibration data
THE PROBLEM: Defining parameters of sensors and software for subsequent data analysis. Finding optimal analysing method and its parameters for road prominences automatic classification
THE AIM OF THE RESEARCH: Expanding knowledge about usage of kinetic sensors for road surface condition analysis. Improving data gathering and processing methods for prospective road vibration geographic information system creation.

1 MAIN RESULTS

Kinetic accelerometer was chosen as data gatherer. Frequency of discretization was defined - not less than 14 samples per second for maximum car travel speed 130 kph. Road surface condition data gathering experiment was conducted and 4 classes of most typical road prominences were defined. Initial training vibration templates of 18 speed-breakers, 11 bridge conjunctions, 9 rail passes and 4 stone-paved streets were created. Smartphone usage possibility for vibration data recording was evaluated and proved. Software for vibration data analysing and automatic prominency recognition was created for Python interpreter. Optimal signal data processing sequence was determined for fastest reliable prominency classification (in order of application on sample): vibration signal normalization, dynamic processing (square normalization), resolution reduction to 3 levels — lower-threshold (5%) turns signal to zero, upper-threshold (30%) sets signal to maximum value, the other signals are set to "one-half". The sample of data processing shown at Figure 1. Car moves along a paved road at 30 kph speed; at the end of route car passed speed breaker (starting at sample N1500 at upper graph)

♥***Corresponding author*** e-mail *sergey.bratarchuk@gmail.com*

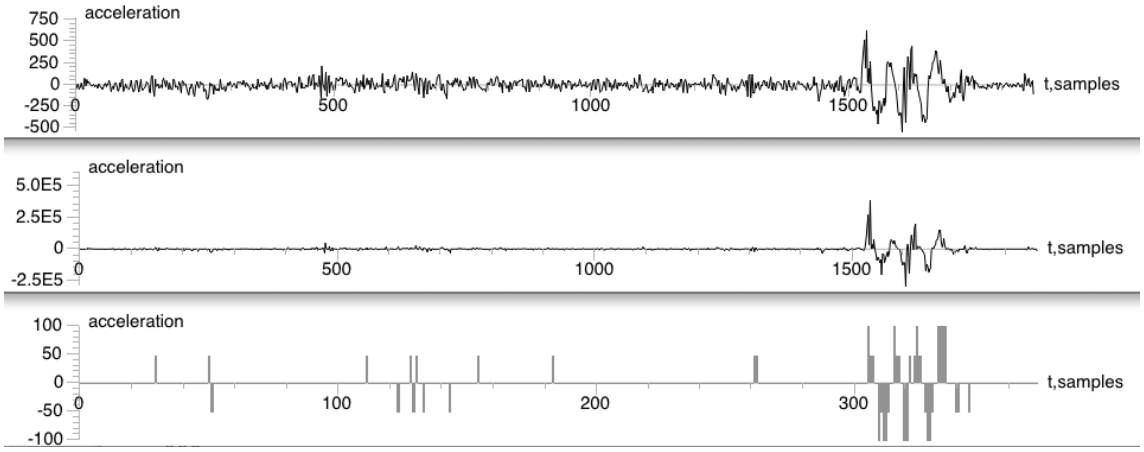

FIGURE 1 MOVING CAR VIBRATION DATA CHANGE AFTER 3-STEP PROCESSING. UPPER-NORMALIZATION; MIDDLE-DYNAMIC SQUARE FUNCTION; LOWER GRAPH: RESOLUTION AND SAMPLING REDUCTION

The final step in sequence is 5x downsampling, that allows to detect prominency type in realtime mode with using regular single-core laptop computer. After the sample processed, it is compared with pre-recorded training prominency data using fingerprinting method. If training sample matches with at least 70% accuracy with any fragment of examined sample, the prominency is considered as detected.

2 FURTHER STEPS

Possible practical application of described method may be realized in creating geographical information system that informs car drivers and municipal authorities about most vibration-causing roads. For that purpose an Android application was created and a number of volunteers have already installed the application onto their smartphones. After a day of driving, they upload G-sensor reading vs GPS position data onto the project server. Riga road vibration map is gradually creating. Then the described algorithm excludes prominencies that are meant to be on roads as engineering elements (i.e. speed-breakers, bridge thermal conjunctions etc.). Later, the server-side application is to be created using crowd-recorded data. Different road information may be shown using different prominency data layers. For instance, travellers could choose routes that are safer for their cars. Other option may be useful for sport car owners. These cars have very low road clearance and the presence of speed-breakers may harm the vehicle.