System and Method to Measure Road Roughness Characteristics and Pavement Induced Vehicle Fuel Consumption (UMD18-06)

Arghavan Louhghalam and Mazdak Tootkabani, Inventors

Applications:	• Real-time assessment of road roughness • Real-time calculation of roughness-induced excess fuel consumption and greenhouse gas emissions.
Benefits:	• Real-time and affordable monitoring of pavement conditions, without the need for expensive and intermittent measurements via instrumented vehicles • Improvement of accuracy through the use of crowd-sourcing to generate a large number of independent measurements. • Data-driven and optimal resource allocation for pavement asset management with minimal environmental footprint

The inventors have developed a framework for real-time estimation of road roughness power spectral density (PSD), vehicle fuel consumption and their associated environmental impact, using crowd-sourcing of automobile vibration data measured by passenger cellphones. This technology, which has been named MASS-RIDE, uses novel, proprietary algorithms to provide an affordable replacement for the often-expensive existing methods of measuring roughness in highways and roads in urban and rural areas.

The U.S. roadway network plays an essential role in mobility and national economic growth, but it is also one of the main contributors to greenhouse gas emissions. Road surface roughness is one of the key factors affecting rolling resistance, which in turn affects vehicle fuel consumption and the corresponding environmental impact from emissions. In addition, road surface roughness also affects ride comfort and contributes to damage of freight and goods. Therefore, monitoring and maintaining the nation's roadways in good condition, is crucial both in mitigating the GHG emissions and making the existing transportation system more sustainable and in enhancing the ride quality for passengers and goods.


Today, road roughness indices such as the International Roughness Index are used by federal and state agencies for making maintenance decisions. Road roughness PSD is usually evaluated using road profile measurements conducted via laser-instrumented cars – a remarkably costly procedure. The novelty of the MASS-RIDE technology is that it uses ubiquitous measurements and crowd-sourcing to estimate roughness PSD and the roughness-induced excess fuel consumption, without instrumentation of vehicles, thus enabling quick, wide range and affordable pavement condition monitoring in roadway networks. The technology enhances the accuracy of the estimations through the use of crowdsourcing and the integration of a large number of independent and equivalent measurements from different sensing units.

MASS-RIDE was primarily developed at the University of Massachusetts Dartmouth by Dr. Arghavan Louhghalam, assistant professor and Dr. Mazdak Tootkaboni, associate professor both in the department of civil and environmental engineering, in collaboration with Dr. Franz-Josef Ulm,

professor in the department of civil and environmental engineering at MIT. The technology utilizes proprietary algorithms to allow for the use of a ubiquitous sensing and communication technology to provide real-time estimation of pavement roughness characteristics in the form of road roughness power spectral density and roughness-induced energy consumption for a pavement section or a pavement system. A mobile application for iOS and Android devices called "**Carbin**" has been developed (http://fixmyroad.us/takeaction) that collects the data at the drivers' end and transfers it to a web server where the analysis is performed. The crowdsourced results including road condition, fuel consumption and environmental impact are updated on the web (http://fixmyroad.us) and are updated real-time.

The technology is potentially applicable to governmental or private agencies that administer pavement maintenance; entities that are interested in measuring and/or minimizing their fuel consumption rates of their vehicles or the environmental impact of their developed products; and entities that are interested in quantifying their ride comfort and minimizing damage to the transport goods.

Patent Status: An international (PCT) patent application has been filed on this invention.
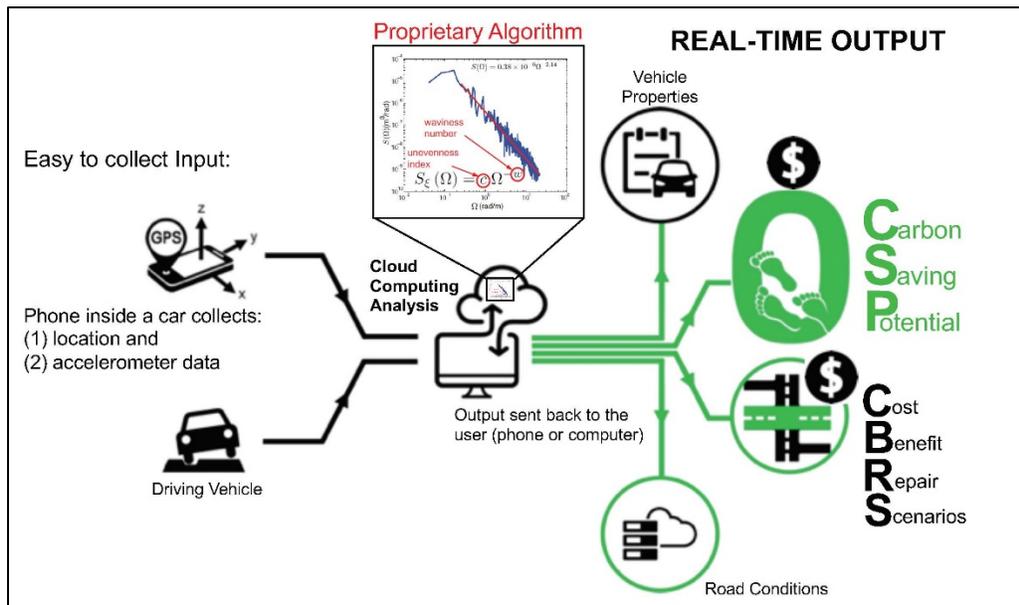
The schematics of the MASS-RIDE technology: The data is collected via the Carbin mobile app installed on drivers' cellphones and transferred to a web server where the analysis is performed. The results in the form of road quality metrics, excess fuel consumption and GHG emissions are sent back to the users' phone and are incorporated in the crowdsourced analysis results and are updated on the website: http://fixmyroad.us. The results can be used for route selection and maintenance decision making in addition to evaluation of fuel and CO_2 saving potentials.

For more information: David J. Glass, Ph.D.
University of Massachusetts Dartmouth
Office: 508-910-9815
Cell: 617-653-9945
dglass@umassd.edu
Return to Available Inventions Page