MODELING AND ENHANCING FUEL ECONOMY OF FLEET VEHICLES BASED ON DATA ANALYTICS

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Degree of Master of Science

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DECLARATION

"I declare that this is my own work and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgement is made in the text. Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books)."

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The above candidate has carried out research for the Masters Dissertation under my supervision.

Name of the supervisor: Dr. H.M.N.D Bandara

Signature of the supervisor: Date:

Name of the supervisor: Mr. Nishal Samarasekara

Signature of the co-supervisor: Date:

Abstract

Fuel consumption of a vehicle depends on several internal factors such as distance, load, vehicle characteristics, and driver behavior, as well as external factors such as road conditions, traffic, and weather. Moreover, not all of these factors are easily obtainable for the fuel consumption analysis. Therefore, fuel-fraud is relatively easier to conceal; thus, considered a significant threat to the fleet industry by managers. This research model and evaluate the fuel consumption of fleet vehicles based on vehicular data and suggest suitable process improvement actions to improve the fuel economy. We first model and predict the fuel consumption to identify possible frauds. We considered a case where only a subset of the factors mentioned above is available as a multivariate time series from a long-distance public bus. An evaluation of several machine learning techniques revealed that Random Forest could predict fuel consumption with 95.9% accuracy. To verify the detected cases of possible fuel fraud, we propose to use different indicators such as speed profile, the frequency of harsh events, total idle time, and day of the week. Further, we propose a solution to promote fuel-efficient driving through real-time monitoring and driver feedback. A classification model, derived from historical data, identifies fuel inefficient driving behaviors in real-time. The model considers both the driver-dependent and environmental parameters such as traffic, road topography, and weather in determining driving efficiency. If an inefficient driving event is detected, a fuzzy logic inference system is used to determine what the driver should do to maintain fuel-efficient driving behavior. The decided action is conveyed to the driver via a smartphone in a nonintrusive manner. We demonstrate that the proposed classification model yields an accuracy of 85.2% while increasing the fuel efficiency up to 16.4%.

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%IncMSE	Percentage of increment of MSE
3G	The third generation of wireless mobile telecommunications technology
ANN	Artificial Neural Network
API	Application Programming Interface
ARIMA	Auto-regressive Integrated Moving Average
COD	Code of Determination
FC	Fuel Consumption
GAM	Generalized Additive Models
GB	Gradient Boosting
GLM	Generalized Linear Models
GPS	Global Positioning System
HHDDT	Heavy Heavy-Duty Diesel Truck
HMI	Human Machine Interface
M2M	Machine-to-Machine
MAE	Mean Absolute Error
MARS	Multivariate Adaptive Regression Splines
MSE	Mean Squared Error
NSE	Nash-Sutcliffe efficiency
PD	Proportional-Derivative
REST	Representational State Transfer
RF	Random Forest
RMSE	Root Mean Squared Error
RPM	Revolutions per minute
WWO	World Weather Online