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A review on the applications of driving data and traffic information for vehicles' energy conservation

Abbas Fotouhi [a,*], Rubiyah Yusof [a], Rasoul Rahmani [a], Saad Mekhilef [b], Neda Shateri [a]

[a] Centre for Artificial Intelligence & Robotics, Universiti Teknologi Malaysia, 54100 Kuala Lumpur, Malaysia
[b] Department of Electrical Engineering, University of Malaya, Kuala Lumpur 50603, Malaysia

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ABSTRACT

A large portion of energy consumption in the world is related to transportation. In recent decades, a variety of technologies have been innovated and applied in order to decrease vehicles energy consumption. In this paper, a comprehensive review on the use of driving data and traffic information for vehicles energy conservation is done. The main aim of this paper is the development of a framework for classification and comparative assessment of various methods and technologies, in which driving data or traffic information are utilized for vehicles energy conservation. The applications are classified into three main categories including (1) traffic monitoring and management systems, (2) intelligent energy management systems in vehicles and (3) intelligent management of charging issues. Research topics in each category are explained and their respective effectiveness in vehicles energy consumption reduction is discussed. The review concludes that the use of the driving data and traffic information leads to remarkable improvements in vehicles energy consumption reduction.

Contents

* Corresponding author. Tel.: +60 3 2615 4695; fax: +60 3 2697 0815.
E-mail addresses: abfotouhi@gmail.com, fotouhi@ic.utm.my (A. Fotouhi).

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1. Introduction

Energy conservation is a much discussed topic all over the world due to the depleting energy resources as well as the impact to the environment. Energy sources are mainly categorized into two groups which are nonrenewable and renewable. Nonrenewable energy sources such as fossil fuels energies can deplete over the years. On the other hand, renewable energy sources can be reproduced in a short time such as wind, water and solar energies. Energy sources are mainly consumed in industry, transportation, agricultural, commerce and civil areas [95-98].

The energy consumption in the transportation sector is known to be very large, of which the vehicles are responsible for most of the energy consumed [1]. In the worlds terminal energy consumption structure, the total energy consumption is at 6212 million tons of oil equivalent (mtoe), in which the transportation sector consumed 1831 mtoe, equivalent to 29.5% of the total energy consumed [2].

In an effort to reduce the consumption of energy by vehicles, various technologies have been innovated and applied, especially in the consumption of fossil fuels as well as electrical energy. Examples of such technologies are lean-burn engines [3], continuously variable transmission [4] and alternative-fuel vehicles such as electric, hybrid electric and plug-in hybrid electric vehicles which are the most successful achievements in this area. Many previous studies have proven the effectiveness of such modern vehicles comparing to conventional vehicles in energy conservation.

More recently, studies on the effect of using driving data and traffic information for energy conservation are actively done. Traffic information and driving data analysis have many applications in various areas such as intelligent transportation systems (ITS), traffic flow modeling [5–7], pollutant emissions dispersion investigation [8–10], accident prevention and safety [11,12], etc.

This review paper encompasses historical and ongoing research into the applications of driving data and traffic information in energy consumption reduction in vehicles. These applications are classified into three categories in this study, including (1) traffic monitoring and management systems, (2) intelligent energy management systems in vehicles and (3) intelligent management of charging issues. Each category is also divided into some research topics as demonstrated in Fig. 1.

2. Driving data and traffic information: definitions and characteristics

As this paper deals with the applications of driving data and traffic condition information in vehicles energy conservation, it is necessary to introduce some definitions in this area. In this section, a short description of expressions, definitions and characteristics of driving data is made, followed by the description of the driving data, driving segments, driving features and traffic conditions.

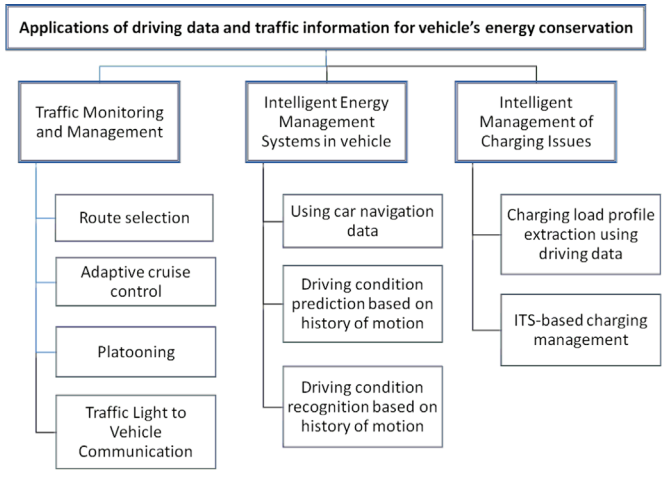

Fig. 1. Applications of driving data and traffic information for vehicle's energy conservation.

2.1. Driving data

Driving data includes date/time, longitude, latitude, speed and altitude of vehicle in every second. Driving data gathering can be performed using Advanced Vehicle Locating (AVL) devices. The AVL device (shown in Fig. 2) works using Global Positioning System (GPS) and is placed inside the car. The velocity of the vehicle is considered as a very important driving data because the driving segments and driving features are defined based on velocity time series.

2.2. Driving segments

A driving segment is defined as the velocity values in a period of time with a distinct length. Four consecutive real driving segments with length of 150 s are illustrated in Fig. 3. The driving time series partitioning is performed for data characteristics analysis. Another common method for driving data time series partitioning is micro-trip which is defined as velocity profile from stop to stop. Fig. 4 depicts six real consecutive micro-trips on the same velocity profile.

2.3. Driving features

Driving features are defined and used for analysis of driving segments characteristics. Various driving features have been defined in the previous studies [13–15]. For example two of these driving features are average velocity (V_{ave}) and variance of velocity

Fig. 2. An AVL device.

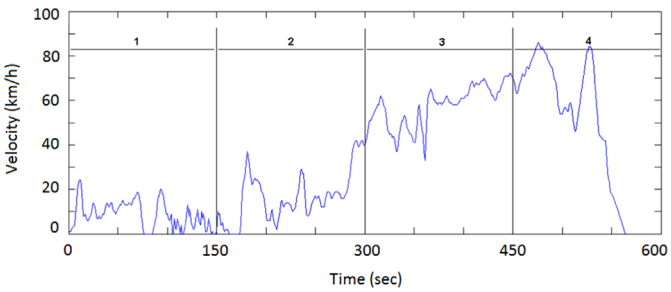

Fig. 3. Four consecutive real driving segments.