Drive-Vehicle-Environment Monitoring Platforms for Fuel Efficiency Assessment

Taeyoung Lee[1], Suwan Park[1], Joonwoo Son[1]

HumanLAB, Daegu Gyeongbuk Institute of Science & Technology[1]
Daegu TP Venture Plant 1-202, 75 Gongdanbuk2gil, Dalseo-gu, Daegu, South Korea

Abstract

High oil prices and a treaty on global climate change are driving are driving motor vehicle manufacturers and suppliers to improve vehicle fuel efficiency through sophisticated and expensive systems and components. However, if the most efficient vehicle would be used by an aggressive driver, it would have poor efficiency.

Although it is known that driving style strongly affect the fuel efficiency, existing empirical knowledge about the relationship between driving style and fuel efficiency was limited. Furthermore, driving style is also influenced by other variables such as the driver parameters, road environment parameters, and vehicle parameters.

Therefore, in order to assess fuel efficiency, a platform which can capture all driving events in synchronized manner is required.

This paper describes real-time monitoring systems for recording driving style, vehicle status and road environment. The monitoring systems consists of six video cameras (two for driver and four for road environment monitoring), high speed and low speed CAN logger, driver gaze tracking system, global position system (GPS), real-time fuel consumption measuring system, vehicle gradient measuring system, image processing system for detecting lane position, and physiological signal measurement system. All of the data is synchronized by broadcasted master time.

The recorded data will be used to assess driving style and fuel efficiency, and to develop Eco-Drive guidance systems based on driving style expectation.

Introduction

Using driver training, campaigns and vehicle control to improve vehicle fuel efficiency technology are being developed because of international fuel prices rise due to the depletion of oil resources and fuel economy regulations.

As well as, There are way to improve method that checking type pressure, Eco-driving coaching, Eco-driving assistant, choice of fuel-efficiency route, etc.

Specifically, change of the driving style were announced to save fuel consumption of 10~20% by using a low cost. (1)(2)(3) Various parameters have been analysed to assess the abatement costs of the different measures able to reduce fuel consumption from vehicles. Specifically, Fig. 1 show that Eco-driving coaching and Eco-driving assistant is the easiest way for reducing the Green-House gases and improved the fuel consumption. (1)

Also, improved driving behavior is the most effective in terms of cost-benefit ratio. Eco-driving coaching and Eco-driving assistant show that the most effective by using a low cost. (2)

However, improved driving style through Eco-driving coaching method (coaching through Eco-Driving golden rules) is limited because of driver's gender, driving experience, differences in learning ability and road environments. In other words, Eco-Drive guidance systems are needed to develop by measuring driving style, vehicle environment and road environment of each driver's.

Driving style can be determined by measuring such as selection of appropriate gear, using style of acceleration-pedal, break-pedal and engine Fuel Cut-off mode.

In this paper, we have built a gasoline vehicle for measure way of South Korea and driving style for correlation of driving style and fuel economy.

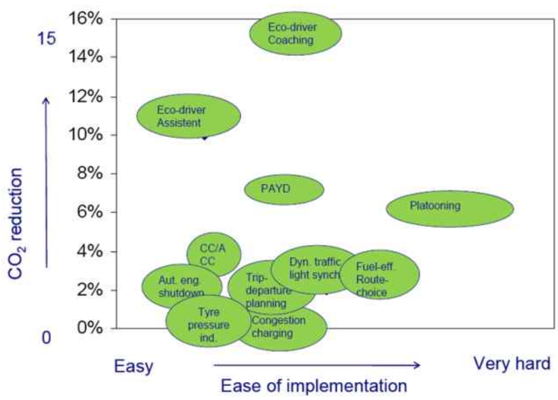

Fig. 1 Overview of potential CO2 effects versus the ease of implementation

Real-time vehicle and driver behavior, environmental monitoring system consists of driving style measuring devices such as speed, RPM and steering, and fuel economy measuring devices such as real-time fuel consumption, mileage and acceleration characteristics, and driver behavior measuring devices such as driver's attention, electrocardiogram, skin conductance and temperature, road environment measuring devices such as camera and slope measuring device. Each equipment is measured variables for determining the driving style.

Driving Style and Fuel Efficiency

Eco-Driving is a smart way of driving, which contributes to reduce fuel consumption, the emission of green house gases. Eco-Driving means smart, smooth and safe driving. Making small changes in your driving can be the most effective way to reduce fuel use and carbon dioxide emission. Driving style can be change through educating novice drivers and re-educating licensed drivers. (4)(5)(6)
However, fuel consumption is affected by a variety of sources road environment, vehicle environment and driving style, as shown in the Fig. 2.

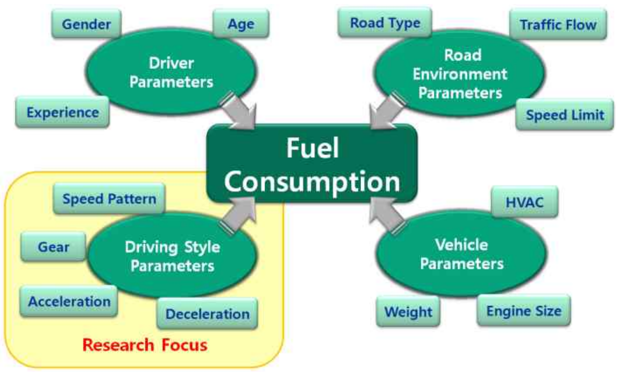

Fig. 2 Various Causes of Fuel Consumption

Fuel consumption is affected by a variety of sources road environment such as curve, ramp, dirt roads, speed bumps and vehicle environment such as vehicle weigh, engine size, tire pressure, HVAC (heating, ventilating, and air conditioning) and driving style such as select gear, accelerated style. (7)(8)(9)(10)
Fig. 3 show that there are a variety of way for reducing CO_2. Especially, improved driving behavior is the most effective in terms of cost-benefit ratio. Eco-driving coaching and Eco-driving assistant show that the most effective by using a low cost. (2)

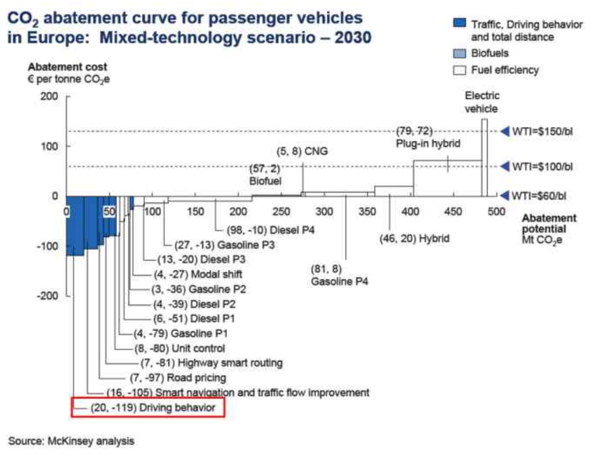

Fig. 3 The Costs and Benefit of Various Technologies for Reducing CO_2

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Real –time Drive-Vehicle-Environment Monitoring Platforms

Driving style parameters for judging are as follows. First, driving behavior parameters for determine are used selection of gear, accelerator pedal usage, brake pedal usage and engine fuel cut-off mode.
Second, road environment parameters can be used street type and road gradient.
Finally, driver information can be pre-survey such as age, gender, driving experience.
Fig. 4 show that the driver aware vehicle platform consists of six video cameras (two for driver and four for road environment monitoring), high speed and low speed CAN logger, driver gaze tracking system, global position system (GPS), real-time fuel consumption measuring system, vehicle gradient measuring system, image processing system for detecting lane position and angle, and physiological signal sensing system.
It runs through four PCs which are Main Control PC, Sub Control PC, Driver Gaze Tracking PC, and Physiological Signal PC. Each PC has signal acquisition module from sensor systems and real-time visualization module. They are independent, work separately to give specific information about driver's behavior, and store synchronizing data with master time.

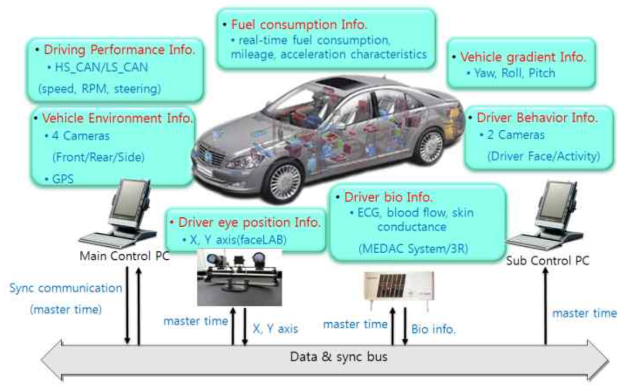
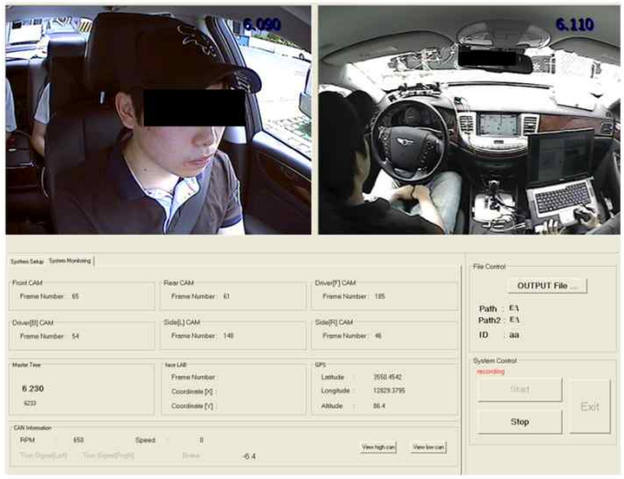


Fig. 4 Real-time Driver-Vehicle-Environment Monitoring Platform

Main Control PC includes 4 modules: master time generating module, CAN module, driver behavior recording module, and GPS module. They write their data with master time sent by master time generating module for data synchronization when recording their data from devices connected to themselves.
Fig. 5 show that vehicle environment recording module and lane detecting module. The vehicle environment

recording module records driving road through four analogue cameras in four locations, which are at the front, the rear, the left, and the right side, as shown in the right picture of Fig. 5-(b) for providing data related to the driving context and traffic situations. It sends frame numbers of 4 video frames to Main Control PC via TCP/IP on every master timer tick. Video flux (NTSC) is processed in the same way as driver behavior module. In off-line, the lane detecting module computes lane position and angle of a vehicle from the front-view and right-side rear view videos.

The faceLAB™, the head and gaze analysis tool, is used for driver gaze tracking in Driver Gaze Tracking PC. (11) The faceLAB is a software package that uses a set of stereo cameras as a passive measuring device. Images from the cameras are analyzed to work out characteristics of a subject's face, including the current position and orientation in 3D space, the gaze direction and several other measurements. It saves driver gaze tracking data and sends eye gaze position and frame numbers of cameras, which give driver gaze tracking data, to Main Control PC via UDP.



(a)

(b)

Fig. 5 Screen shots of Main Control PC (a) and Sub Control PC (b) during a driving experiment

Three physiological measures are recorded through MEDAC System/3 in physiological signal PC: Electrocardiogram (ECG), skin conductance, and respiration wave. Electrocardiogram (ECG) monitors the electrical activity of the heart over time for tracking heart rate and variability. Skin conductance and temperature sensor monitor electrodermal activity and skin temperature change from a finger.

Experiment Data

Fig. 6 show that an example of experiment data changes such as vehicle speed, engine speed (RPM), fuel consumption (FCO), accelerator pedal usage by driving behavior. Pattern of accelerator pedal usage is confirm to changes vehicle speed, engine speed (RPM), fuel consumption (FCO).

Various parameters can be analysed that unique driving style of each driver's.

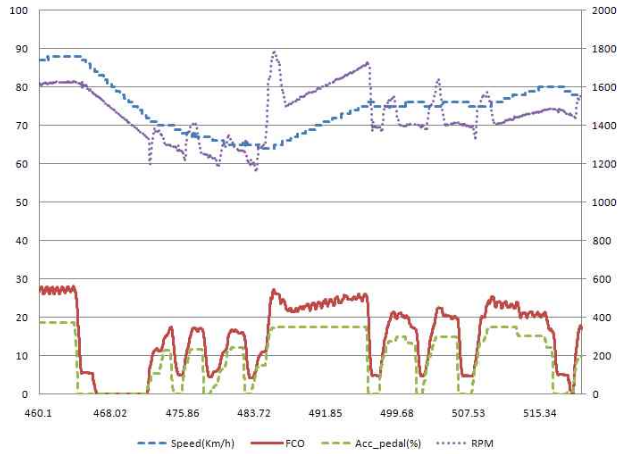


Fig. 6 An example of experiment data changes by driving behavior

Driving style can be determined by measuring such as vehicle speed, engine speed (RPM), fuel consumption (FCO), accelerator pedal usage.

Conclusion

We implemented a driver aware vehicle platform to detect driver state using various information from a driver, a vehicle and an environment. This platform records multimodal information through six video cameras, high speed and low speed CAN logger, driver gaze tracking system, global position system (GPS), and physiological signal, and provides the synchronized data collection and integration of inputs from multiple domains with a master timer. The measured data is used to determine the driver's style.

Future Goals

Driving style and road information can be evaluated through the measured data of real-time monitoring platform. The future goal is to add real-time Eco-Driving guidance systems depending on driving style, vehicle environment and road environment of each driver.

Acknowledgement

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