EcoDrive: Sensing and Controlling Fuel Consumption in Automobile Systems

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1. INTRODUCTION

Modern vehicles, as an emerging smart mobile platform, are equipped with operating systems to help or even replace human drivers [1, 2, 3, 4, 5]. The computational capabilities provide opportunities and challenges to manage and control vehicles safer and more fuel efficient. Morgan Stanley reports that 100% adoption of self-driving cars is expected to have $158 billion annual savings [6] is US. The higher fuel efficiency comes from cruise control and smooth driving. However, it is still an open question how human drivers or automobile operating systems can adjust driving behaviors according to various car types and road conditions to improve Kilometer Per Liter (KPL). [1]

In this paper, we discuss the feasibility and design of a fuel management and control system, called EcoDrive, that can estimate fuel consumptions of different driving behaviors and control vehicle acceleration and speeds based on the properties of individual vehicle and road conditions. It senses the standard OBD parameters available from vehicle CAN bus [7, 8] and learns the relations among the parameters, human operations and road conditions. Based on the sensed parameters and learned relations, it is able to estimate instant fuel consumption and advise the most economic driving behaviors based on vehicle type and road conditions. EcoDrive can be used as a subsystem of modern car system to assist human drivers. It can also be integrated into autonomous vehicle operating systems to control the accelerations and vehicle speeds in the perspective of fuel efficiency.

As shown in Fig. 1, EcoDrive consists of three modules, sensing module, modelling module and a controller. The sensing module senses vehicle parameters through OBD port. The modelling module models various forces based on the OBD parameters. We consider drivetrain loss, wind resistance, engine propulsion and grade resistance in our work. The controller utilizes throttle-by-wire technology and sends gas pedal position value to the throttle by an Arduino board.

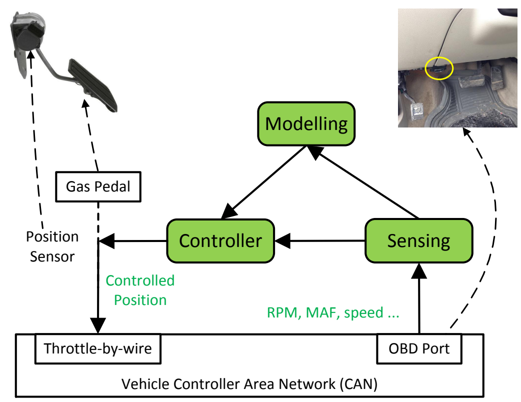

Figure 1: EcoDrive Architecture.

Our initial results show that, in urban area, where driving behaviors are dominated by frequent accelerations and stops, achievable KPLs of EcoDrive are 10%-40% higher than those observed from collected human driving datasets in 80% cases, and on highway, where driving behaviors are dominated by constant speed, achievable KPLs are 5%-30% higher than those observed from collected human driving datasets under similar average vehicle speeds in most cases. On highway, higher KPL can be obtained by using better KPL speeds.

[1] We use KPL instead of Mile Per Gallon (MPG) to measure fuel efficiency, as the unit of vehicular speed based on OBD standard is Km/h. It is interchangeable with MPG, i.e., 1 KPL = 2.35214583 MPG.

2. REFERENCES

[1] Google driverless car. *http://en.wikipedia.org/wiki/Google_driverless_car*.
[2] Qnx operating system for diverless car by blackberry. *http://www.qnx.com/*.
[3] Swarun Kumar, Lixin Shi, Nabeel Ahmed, Stephanie Gil, Dina Katabi, and Daniela Rus. Carspeak: a content-centric network for autonomous driving. In *Proceedings of the ACM SIGCOMM 2012*. ACM.
[4] Chris Urmson, Joshua Anhalt, Drew Bagnell, Christopher Baker, Robert Bittner, MN Clark, John Dolan, Dave Duggins, Tugrul Galatali, Chris Geyer, et al. Autonomous driving in urban environments: Boss and the urban challenge. *Journal of Field Robotics*, 2008.
[5] Todd Litman. Autonomous vehicle implementation predictions. 2013.
[6] Morgan Stanley Research. Autonomous cars: Self-driving the new auto industry paradigm. 2013.
[7] Obd. *http://en.wikipedia.org/wiki/On-board_diagnostics*.
[8] Obd pids. *http://en.wikipedia.org/wiki/OBD-II_PIDs*.