DEVELOPMENT OF A DRIVER INFORMATION SYSTEM BASED ON ON-BOARD DIAGNOSTIC II COMMUNICATION PROTOCOL

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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DEDICATION

I dedicate this thesis to my family especially my mother and wife who prayed all the time for my success.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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An On-Board Diagnostic II (OBD-II) is a standard diagnostic software management that is installed in a Powertrain Control Module (PCM). It provides some useful data to the driver. There are four different devices using the OBD-II protocol exists in the market that can be used as a driver information system. They are personal digital assistant Dyno/OBD-II scan tool, CarChip Fleet, DriveRight 600, and ScanGauge II. Each of these four devices has some limitation in term of supporting all features for live data monitoring, diagnostic trouble code scanning, trip information, and data logging system. Thus, there is a need for a device that supports all these features together with scheduled service reminder. This thesis describes the design and development of a driver information system based on OBD-II protocol. Its hardware and software systems were designed based on four design considerations: upgrade capability, high data storage capacity, back-up capability, and user friendly. The proposed system consists of an 8-bit microcontroller, a buffer memory, a liquid crystal display, a real time clock, a MultiMediaCard, an OBD-II interpreter unit, and

power supply unit. This system was successfully interfaced and tested with the PCM of Hyundai Getz car.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PEMBANGUNAN SATU SISTEM MAKLUMAT PEMANDU BERASASKAN KOMUNIKASI PROTOKOL DIAGNOSTIK ATAS PAPAN II

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Diagnostik atas papan II (OBD-II) merupakan perisian piawaian pengurusan diagnostik yang dimasukkan ke dalam modul kawalan kuasa enjin (PCM). Ia menyediakan maklumat tertentu kepada pemandu. Terdapat empat peralatan di pasaran yang menggunakan protokol OBD-II ini yang boleh digunakan sebagai sistem maklumat pemanduan. Peralatan-peralatan ini adalah Dyno/OBD-II alat pengesan berasaskan pembantu digital peribadi, *CarChip Fleet, DriveRight 600*, dan *ScanGauge II*. Setiap peralatan ini mempunyai kelemahan dalam memaparkan data semasa, mengesan kod masalah diagnostik, melaporkan maklumat perjalanan, dan penyimpanan sistem data. Oleh itu, sebuah sistem yang mempunyai ciri-ciri tersebut beserta ciri tambahan pengingat servis berjadual perlu dibangunkan. Thesis ini membincangkan rekabentuk dan pembangunan sebuah sistem maklumat pemanduan berasaskan protokol OBD-II. Perkakas dan perisian sistem ini direkabentuk berdasarkan empat pertimbangan iaitu kebolehnaiktarafan, penyimpanan data berkapasiti tinggi, kemampuan penyimpanan kekal, dan mesra pengguna. Sistem

cadangan ini menggunakan satu unit mikropengawal 8-bit, memori sementara, paparan kristal cecair, jam masa sebenar, kad multimedia, penterjemah OBD-II, dan bekalan kuasa. Sistem ini berjaya diuji dengan PCM kereta Hyundai Getz.

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I certify that an Examination Committee has met on 20th July 2007 to conduct the final examination of Mohamad Fauzi bin Zakaria on his Master of Science thesis entitled "Development of a Driver Information System Based on On-Board Diagnostic II Communication Protocol" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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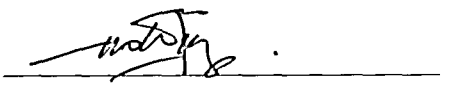
DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.



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LIST OF ABBREVIATIONS

ABS	Antilock Braking System
CAN	Controller Area Network
CRC	Cyclic Redundancy Check
DTC	Diagnostic Trouble Codes
Dyno	Dynamometer
ECG	Electrocardiogram
ECU	Electronic Control Unit
EEG	Electroencephalographic
EOBD	European On-board Diagnostic Systems
ERR	Error Detection Byte
FAT	File Allocation Table
GUI	Graphical User Interface
ISO	International Standards Organization
MAF	Mass Air Flow
MIL	Malfunction Indicator Light
MMC	MultiMediaCard
MMCA	MultiMediaCard Association
MPG	Miles per Gallon
MSB	Most Significant Bits
NTFS	New Table File System
OBD-I	On-board Diagnostic Generation –I
OBD-II	On-board Diagnostic Generation –II
OEM	Original Equipment Manufacturer
PCM	Powertrain Control Module

PDA	Personal Digital Assistant
RTC	Real Time Clock
SAE	Society of Automotive Engineers
SD	Secure Digital
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
SRS	Supplemental Restraint System
UART	Universal Asynchronous Receiver Transmitter
VPM	Variable Pulse Modulation
VSS	Vehicle Speed Sensor

CHAPTER 1

INTRODUCTION

Every automobile is equipped with electrical instrumentation panel as a driver information centre, formerly known as a dashboard. It contains various gauges, indicators and warning lights that provide valuable information to the driver [1]. Gauges provide scaled indication of the system condition. Normally, they come with five basic gauges that are found on all instrumentation panels: a speedometer, an odometer, a tachometer, a fuel level gauge, and a temperature gauge. Whereas, the indicator lights supply information of something that has been turned on, such as high beam and turn signal. While, warning lights give notification to the driver about the functioning problems in some systems or there is a situation exists that must be fixed. The examples of the systems that have warning lights are an engine management system (emission related system), an airbag of supplemental restraint system (SRS), an antilock braking system (ABS), an oil pressure, a brake fluid level and a charging system.

Another system that has been integrated in some of instrumentation panel is a trip information system. This system provides vital data such as average or instantaneous fuel consumption, fuel remaining, average speed, miles to empty fuel tank, estimated time of arrival, time, and date [2]. With this technology, the driver can know the journey cost and try to minimize fuel consumption by controlling the acceleration pedal with suitable gear at certain speed.

Since the on-board diagnostic generation two (OBD-II) exists, there have been two systems appeared in the market: the data logging system and the diagnostic trouble codes (DTC) scanning system.

The data logging system records trip, performance and accident data that provide valuable information to the fleet management, parents, and personal drivers. Drivers can use this data for future analysis especially to monitor their driving pattern for certain trips or to find out the cause of the accident, either by the driving habit or the vehicle problem. The data analysis can be done in a personal computer (PC).

The DTC scanning system has capability like a mechanic's scan tool or a code reader. It informs specific problems that occur in the electronics control units (ECUs) especially powertrain control module (PCM). This system solves the limitation of a malfunction indicator light (MIL). The MIL is warning indicator light that will be set when a malfunction problem of an emission related component arise. Other components are not notified by MIL. However, by using the DTC scanning system, all problems can be detected and zoomed to specific area of the ECU's subsystem components.

1.1 Background

The OBD-II technology is a diagnostic software management compulsory installed inside vehicles PCM in the United State since 1996. It has been standardized by Society of Automotive Engineers (SAE). This standardization includes the common terms and acronyms, common diagnostic link connector and location, common

diagnostic test modes (generic and enhanced), common scan tools, common diagnostic trouble codes, and common protocol standard [3]. The standardization emerged after difficulties to apply on-board diagnostic generation one (OBD-I) that was installed on vehicles produced from 1988 to 1995. Consequently, the OBD-II standards help the diagnostic manufacturer to design the universal scan tool and aid the mechanic to repair the vehicle systematically and quickly. With the success of the OBD-II, European countries require all petrol cars since 2001 and diesel cars manufactured from 2003 onwards, must be equipped with European onboard diagnostic systems (EOBD) which is equivalent to OBD-II standard [4].

The OBD technology is not only protecting the environment but also protecting drivers, by identifying minor problems before they become major repair bills. For example, by recognizing a relatively inexpensive repair like the replacement of a malfunctioning oxygen sensor, OBD can save the cost of replacing the catalytic converter later. Besides, OBD is also to ensure that the vehicle operates within its original design specification.

1.2 Problem Statement

Thanks to OBD-II standards that was primary developed to control vehicles emission level [2], many supporting systems to the driver have been developed to overcome the limitation of instrumentation panel. Four devices are available in the market that can be used as the driver information system are personal digital assistant (PDA) Dyno/OBD-II scan tool, CarChip Fleet, DriveRight 600, and ScanGauge II [4-7].

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