Purdue ECE Senior Design Semester Report

Course Number and Title	ECE 477 *Digital Systems Senior Design Project*
Semester / Year	Fall 2015
Advisors	Prof. Thottethodi, George Hadley
Team Number	3
Project Title	Real Time Vehicle Telemetry (RTVT)

Senior Design Students – Team Composition			
Name	**Major**	**Area(s) of Expertise Utilized in Project**	**Expected Graduation Date**
Garrett Sczechowski	Comp E	Software	May 2015
Brad Warrum	Comp E	Software, PCB Layout	May 2015
Mark Froehling	Comp E	Software	May 2015
James Tay	Comp E	Software, Soldering	May 2015

Project Description: Provide a brief (2-3 page) technical description of the design project, as outlined below:

(a) Summary of the project, including customer, purpose, specifications, and a summary of the approach.

The Real-Time Vehicle Telemetry (RTVT) is a device used to allow drivers to monitor vehicle performance during and after operation of the vehicle. This is targeted at drivers who want to know the general condition of their vehicles, as well as business owners who want to monitor the status of a fleet of vehicles to aid them in maintenance and making cost-saving business strategies.

This device will sit on the dashboard of the vehicle in question, and features a liquid crystal display (LCD) screen that will display the necessary information in real-time. This information is obtained through requests to the On-Board Diagnostics (OBD) module on the vehicle itself, via a Bluetooth connection to the OBD port. In addition, GPS coordinates of the vehicle are also obtained using an on-device GPS module. As well as being displayed in real-time on the LCD screen, the information will also be recorded to an SD card that can be inserted into the device. This historical data can then be analyzed from the SD card, using a desktop application that maps the status of the vehicle to the position of the vehicle, as well as mapping the route of the vehicle itself.

(b) Description of how the project built upon the knowledge and skills acquired in earlier ECE coursework.

This project necessitated the use of skills from a previous microprocessor interfacing class. This includes programming the chosen microprocessor to make use of available peripherals on-chip. In addition, the project required interfacing the microprocessor with external modules, allowing the device to work together and achieve the desired functionalities. In programming the device, the team also made use of Object-Oriented Programming (OOP) concepts on top of embedded C++ skills. Finally, there was a circuit design component to the project that involved the selection and layout of passive components along with the aforementioned modules to ensure that the device will operate smoothly.

(c) Description of what new technical knowledge and skills, if any, were acquired in doing the project.

In order to make progress in the project, new skills and knowledge had to be learned in the hardware aspect. For instance, the layout of the custom Printed Circuit Board (PCB) was a new skill in which members of the team had no experience, as well as soldering the components to the final board. The team also gained technical insight into the communication protocols used by the OBD and GPS modules, which facilitated parsing of the received information. In the building of the device, the use of 3D printing to build the final package for the device was a new experience as well.

In the software aspect, new technologies and languages were used in building the desktop application to be used for post-trip analysis of the data. Specifically, Javascript was used to build the application in order to make use of the Google Maps API for mapping the route, as well as using the High Charts API for graphing the data collected.

(d) Description of how the engineering design process was incorporated into the project. Reference must be made to the following fundamental steps of the design process: establishment of objectives and criteria, analysis, synthesis, construction, testing, and evaluation.

At the start of this project, the problem to be solved was analyzed in the establishment of objectives and criteria, to determine the requirements of our device. In the analysis and synthesis stages, the device was designed on both a hardware level and a software level, with decisions made on the microcontroller, the external modules to be incorporated and the software architecture. In synthesis and construction, the modules were put together while the code was built up, with testing carried out on individual modules to ensure proper functionality. The final packaging of the device was also 3D printed at this stage. After al components were tested individually and put together, the device was tested on a live vehicle during the testing stage. This began the iterative process of evaluating the results of the test, making changes in the synthesis and construction stage, and finally testing it again.

(e) Summary of how realistic design constraints were incorporated into the project (consideration of <u>most</u> of the following is required: economic, environmental, ethical, health & safety, social, political, sustainability, and manufacturability constraints).

Economic: The design process took into consideration a lower cost margin to ensure affordability among individual drivers of the target market. This was done by selecting cheaper modules to be incorporated in the device.

Environmental: The device was designed to have a low environmental impact, creating no waste materials and with no emissions. By drawing its power directly from the vehicle, waste batteries will not be produced.

Ethical: Since the device has a data logging capability, it can be used by business owners to monitor the driving behavior of the drivers employed by the company. Unfortunately, the SD card has no data encryption, leaving the data open for manipulation. Future iterations of this device will have to be refined to encrypt the data recorded on the SD card, preventing the manipulation of recorded data.

Health & Safety: The design process took into consideration reducing distractions to the driver in the operation of the device. This was to ensure that the driver would keep his attention to the road, minimizing risks to the safety of the driver. Thus, user interaction with the device was kept to a minimum.

Social: In doing the research for requirements for our device, we discovered that it is illegal in most states in the US to have a windshield-mounted device. In order to ensure that he RTVT does not violate these laws, the device is designed to be dashboard-mounted instead, allowing the screen to still be in a visible position without compromising the driver's view of the road.

Political:

Sustainability: The device was designed to make use of a range of OBD PIDs that are required by regulation to be supported on vehicles. This standardization ensures that the device can be used in any vehicle, allowing the user to continue using the same device over the course of various vehicles, thus increasing the product lifecycle of the device.

Manufacturability: Assuming that all chips and passive components can be soldered onto the PCB via an automatic process, the manufacturability of the device is quite simple. Once a completed board is available the GPS needs to be plugged in and ribbon cables attached from the board to the LCD screen. All that remains is to assemble the case: drop two nuts into their slots on the bottom of the case, place the PCB into its mounting position, and place the LCD screen at its mounting location. Screw in the LCD screen in at four points, and then slide the LCD front cover on and bolt it on. Not only is the device simple to assemble, but it is also simple to repair or replace components in the future.

(f) Description of the multidisciplinary nature of the project.

This project required computer engineering knowledge and skills, programming the microprocessor to interface with the modules and achieve the required functionalities. The program required knowledge of Object-Oriented Programming as well as other programming knowledge to optimize the program to ensure smooth operation of the device. In addition, electrical engineering knowledge was needed to be able to design the circuit and select the passive components to be incorporated to power the device and interface the modules to the microprocessor. Finally, some technical skills were used in building the final prototype, such as Computer-Aided Design (CAD) knowledge to design and 3D print the packaging, PCB layout knowledge for creating the custom PCB, and soldering knowledge to solder components of various electrical packaging to the PCB.

(g) Description of project deliverables and their final status.

The final prototype was able to achieve the desired functions. It was able to communicate with the OBD port smoothly via Bluetooth and parse the data correctly. The GPS coordinates were obtained through the GPS module and correctly interpreted. All that data was able to be printed to the LCD screen in a clear and intuitive interface, as well as recorded to an SD card. Finally, we were able to create a desktop application that could analyze the data recorded on the SD card and display that information in an easily understandable format in both graph forms and on a map.