ELECTRIC VEHICLE INTELLIGENT CONTROL SYSTEM (EVICS)

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A project report submitted in partial fulfilment of the requirements for the award of the degree of Bachelor (Hons.) of Electrical and Electronics Engineering

Faculty of Engineering and Science
Universiti Tunku Abdul Rahman

May 2011

DECLARATION

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

Signature : _____

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **ELECTRIC VEHICLE INTELLIGENT CONTROL SYSTEM (EVICS)** was prepared by **VINCENT CHEAH BENG KEAT** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Engineering (hons) Electrical and Electronics Engineering Universiti Tunku Abdul Rahman.

Approved by,

Signature : _____

Supervisor : Dr. Chew Kuew Wai

Date : _____

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ABSTRACT ACKNOWLEDGEMENTS

This final year project presents Electric Car Intelligent Controller System project aims to create a multiple platform controller that can control each and every function needed to be implemented in an electric car system such as battery management system, inverters, amplifiers, voltage converters, constant current controllers and many more. However, the main problem faced is that most commonly used microcontrollers usually used in the university assignments and projects such as PIC (Peripheral Control Interface) is not powerful enough to control multiple functions in the electric car intelligent controller system in long term. Despite using a few of the most powerful PICs such as 24, 32, or even 64 series, we will not be able to guarantee the reliability to control such complex systems such as the Lithium-ion battery management system. Hence, Intel Atom processor platform is used. Consequently, the main goal is to have an electric car equipped with a comprehensive intelligent controller system that can manage the battery profile accordingly and display certain interactive data to the users, such as:

- The level of charges left in the battery on a monitor
- Interaction with the user's commands accurately to operate the hardware
- Ensure the safety aspect of the vehicle is always in good condition
- Display warnings if something is not right
- Manage the thermal or temperature level of the battery and controller accordingly

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LIST OF SYMBOLS / ABBREVIATIONS

V	voltage, V
I	current, A
R	resistance, Ω
P	Power, W
T	torque, N.m
F	force, N
r	radius, m
ω	angular velocity, rad/s
V_s	speed, m/s or km/h
Hp	horse power, Hp

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CHAPTER 1

INTRODUCTION

1.1 Background

The application for the designed Pulse Width Modulation Motor Control circuit including Battery Management System is in the field of battery powered cars. This new move towards renewable energy and environmental friendliness is definitely a goal worth aiming for as the Earth's natural resources continue to diminish. Battery powered vehicles are indeed a very important component in the future of electrical and electronics engineering in this nation. This is evident considering Proton's latest offering, the Proton Saga EV Green Propulsion, and is Malaysia's first very electric vehicle. It is hoped that through the execution of this assignment, we as engineering students may someday contribute towards the technological development in the field of electronics of our very own country, Malaysia.

In an Electrical Vehicle (EV) design, the power management system and controller plays an important role as a 'brain' of the EV, to ensure the car can run smoothly and in order. The main functions of a controller is basically to control the main contactor and kill switch contactor, incorporating appropriate safety measures and interlocks, control the reversing contactor, incorporating appropriate safety measures and interlocks, power the vacuum pump in the EV braking System, power the toaster heater contactor and power DC-to-DC-contactor, where as the power management system ensured that the power distribution are in order and at the meantime achieving maximum transfer efficiency. The power management system

includes converter circuit, charging circuit, motor drive and base drive circuit. In this report, the works are mainly focus on power management system and base drive circuit inclusive of their controller and converter circuit. The functionality of each of the controller will be investigated and discussed.

1.2 Aims and Objectives

The overall project mainly focuses on the development of light weight electric vehicles (EVs) using brushless DC motor. In this project, each and every characteristic including the working principle of the electrical vehicle will be studied. The scope in this project covers battery management system, converters and controllers, motor characteristics and selection, braking and gearing system. However, the battery power management system and controller including converters will be examined and discussed in this paper.

.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Recently, Malaysia is owned their first homemade pure electric car, officially known as Proton Saga EV Green Propulsion concept. The whole concept behind this is to produce a fully functioning electrical vehicle with zero emission incorporates with key technology such as battery management system. In order to achieve to this, proton place more attention on the heart of the vehicle (Lithium Balance). This Lithium Balance battery is placed together with plug in and play concept, with built in management electronic (Sandeep Dhameja,2002).

Figure 2-1 Proton Saga EV Green Propulsion

The whole idea behind this concept is basically to develop a system that does battery monitoring, in which it keeps track on the operational parameters charging and discharging. This may also include voltage, currents, battery internal and ambient temperature (temperature surrounding the vehicle). The controller in this case, must be smart enough to provide proper protection to the system by providing an appropriate indication to sound an alarm or electronically disconnect the battery from the load if any of the parameters exceeds its limit.

There are mainly three objectives of having a BMS (Battery Management System) inside an EV which are protecting Lithium Battery from any damage typically by protecting the cells, prolong the lifespan of that battery and to maintain the battery states in which allowed the system to run specific functions and applications specifically attached to it.

The primary application of this BMS is to provide necessary monitoring and control, avoiding the cells from damage due to over rating temperature condition. This is essential as the vehicle may be working under harsh condition or even differences in climate (Tropical Climates, Subtropical Climates, Mediterranean Climates, Temperature climates, Arctic temperature and Desert Climates) within a particular continent which affect the overall ambient temperature. Hence, individual cell in the automotive must be protected by isolating the battery detect the cause of the fault when an external fault takes place. To illustrate this, disconnect the battery source when the heat generated within a system is severe. However, for non-severe cases, we may turn on an additional fan attached in front of the battery.

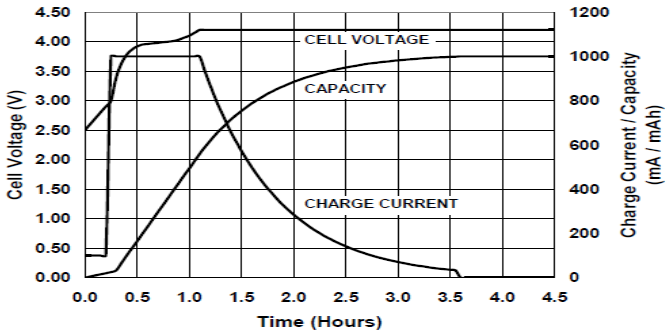


Figure 2-2 Charging profile of Lithium Battery

Secondary major development of BMS refers to state of charge (SOC) determination. This basically providing the user some indication the amount left over before performing any recharging. This SOC estimation is also known as "Gas Gauge" or "Fuel Gauge" functions. In this design, SOC basically calculates each of the individual cells within the battery besides ensuring them from overstressed condition (Zanthic Technologies, 2008). Apart from that, with SOC indicator, over-charging and over-discharging condition can be prevented since each of the charging and discharging cycle can easily be monitored.

2.2 Battery Management System (BMS)

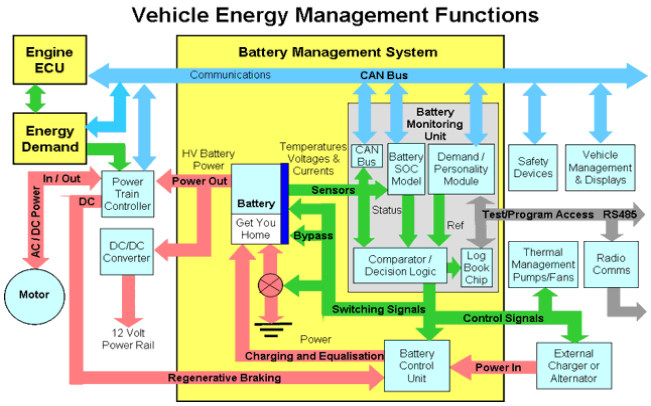


Figure 2-3 Conceptual representation of BMS primary function

According to the figure 3 above, there are basically three main building blocks needed to be considered throughout this design. They are Battery Monitoring Unit (BMU), Battery Control Unit (BCU) and Controller Area Network (CAN) bus vehicle communication network including its internal configuration to the vehicle's management system. Note also that, other parts of the vehicle systems may not only be connected to one another within a system, but more importantly, they are able to communicate with BMS via CAN bus such as Thermal Management System, including anti theft devices which has the capability to disable the battery. The ECU

(Engine Control Unit) module may not be needed, in the case where the parameter concerning Internal Combustion Engine (ICE) is not being examined.

2.2.1 Battery Monitoring Unit (BMU)

The Battery Monitoring Unit is microcontroller based which is mainly used to monitor health of the battery bank. In other words, BMU calculates battery capacities apart from battery efficiency from time to time and simultaneously monitoring each of the cells upon cell deterioration prior to failure as illustrated by three sub-module of BMU. This sub-module is separated for the purpose of clarification. Battery failure can easily be determined by monitoring the cell voltage during discharging. Note that, in this case, the charging voltage drop should not be long enough. This type of failure, however, can be classified as battery abuse in which the main causes are high temperature and excessive charge current. Other typical factors that may give rise to battery failure are ageing and premature-failure where they are caused by corrosion and manufacturing defect respectively.

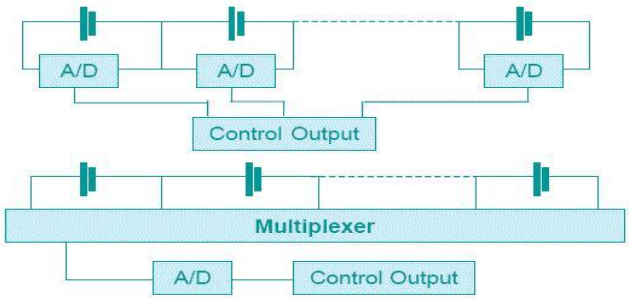


Figure 2-4 Multiplexer to reduce component count

Apart from monitoring all the cells in parallel, a multiplex architecture can easily be interfaced to the BMU in order to reduce cost. Based on this design, only single analog or digital output can be monitored from time to time. One of the drawbacks of this system is that only one voltage cell can be determined at a time. Hence, a very high speed mechanism is required such that each can be monitored sequentially.

2.2.2 Battery Control Unit (BCU)

Power electronics circuitry is the main component that lies within Battery Control Unit (BCU). From figure 3, it is observed that BMU obtains its instruction in terms of control signal from the earlier block that mentioned earlier, BMU to carry out a specific task, such as controlling battery charging profile. In this case, controlling the voltage and current charging profile, providing a top up charge to each of the individual cell serving as a purpose to equalize all the charge within the battery, fault isolation, regenerative braking switching to charge battery whenever it is required, dump out excessive braking charges generated during breaking and last but not least able to respond corresponding to the vehicle's operation mode. In order to have these functions working properly, each of the battery cells must be equip with highly expensive current switch, having the capability to do switching around 200 AMPS or more in order to perform necessary interconnect.

2.2.3 Controller Area Network (CAN)

Controller Area Network (CAN) was developed back in 1985, by Bosch to be used in-vehicle network. Back in the past, automotive manufacturers start of by using point to point wiring. As time goes by, it was realized that having a lot of wires not only result in bulky, heavy but also expensive. Today, CAN is used instead of traditional wiring as CAN not only cheap, less complexity, reduce in weight but more importantly it has high-integrity serial data communication for real-time control application integrated into standard in-vehicle network.

2.2.4 Thermal Management System (TMS)

Thermal Management System is designed to monitor variation in temperature due to battery chemistry and performing necessary task such as heating or cooling the battery cells depending on its state. Tests conducted in the laboratory and with

EV urban driving suggest that using a thermal management system improves the mileage and battery life by at least 20%. Thermal management system plays a very crucial role when performing rapid charging. Imagine, during the charging process, large amount of charge is delivered to the EV, hence temperature issued is inevitable.

The primary design is to keep the battery insulated. The insulation will help to enhance heat generation especially during winter or summer. On the other hands, as for second criterion design, air flow circulation has to be properly distributed to ensure minimum temperature, achieving equilibrium between battery and the surrounding. Note different design criterion should takes place under various operating conditions.

2.3 Component of an Electrical Vehicle

The main components of an electrical vehicle are motor, controller, power supply and transmission channel.

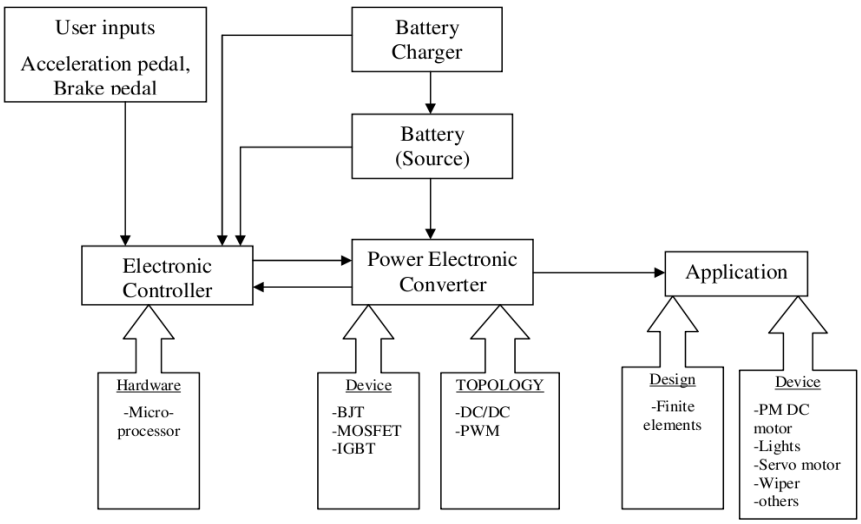


Figure 2-5 illustrates the major component for an electric vehicle

As exhibits from the diagram above, the power supply needs to be charged up in order to restore the energy level once its available energy is near to deletion usage. Note also that the electric motor is driven by a power-electronic-based power-processing unit that converts the fixed DC voltage available from of source into variable voltage to maintain the desired operating of the vehicle. Power electronics is always a driving force key to order to develop a more effective, efficient yet high performance power train unit for the battery. A drive train system simply refers to electromechanical conversion linkage system between vehicle energy source and wheels. In other words, the drive train has combinational of both electrical and electronic components**.**

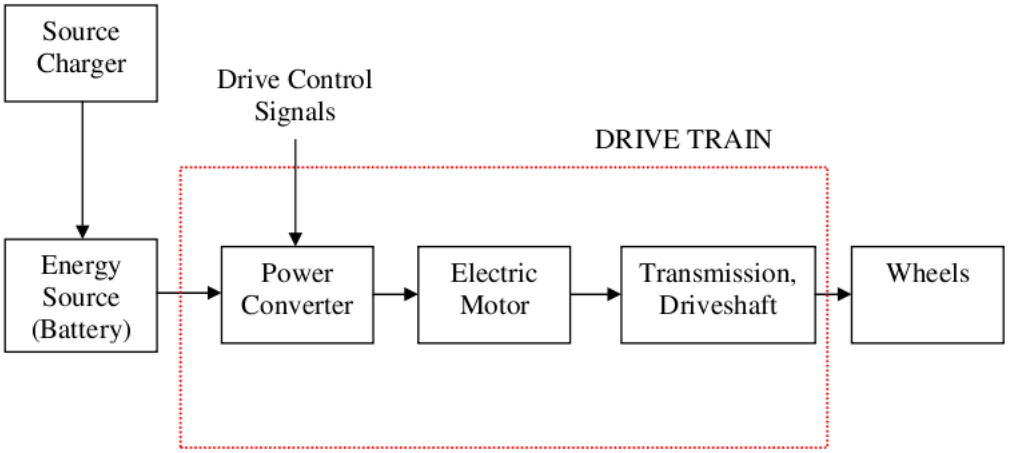


Figure 2-6 illustrates top level perspective of typical EV system conditions

2.4 Overview on EV's Power Management System

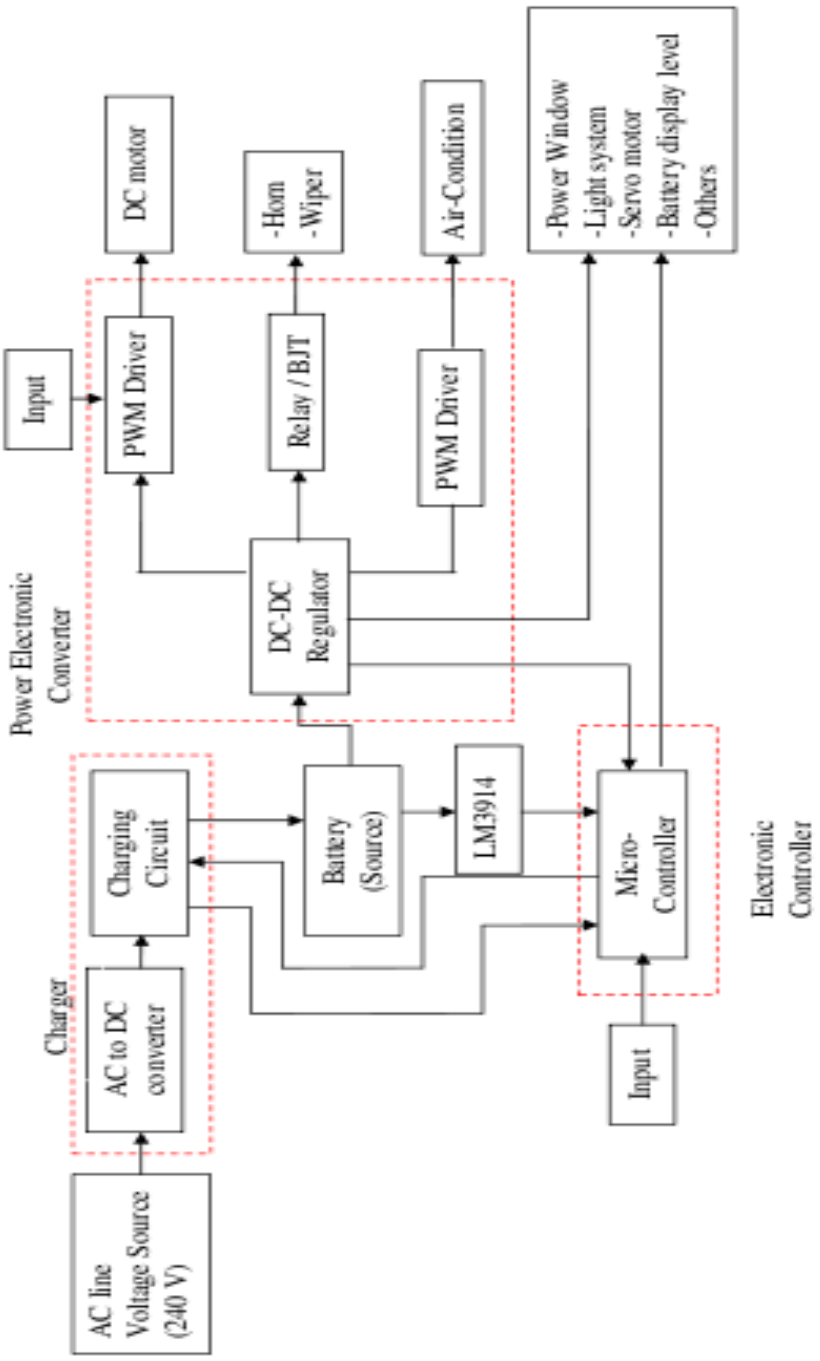


Figure 2-7 shows a very fundamental idea on each module and every single module integrated together in order to create an EV system

CHAPTER 3

METHODOLOGY

3.1 System Consideration

In this project, intelligent electric vehicle controller system, Intel atom board (D510M0) and PICs microcontrollers will be used in this case in order to create a stable and yet reliable system. Note that Intel atom board does not only provide great opportunity for future implementations but more importantly unlike any other processors, it does not consume a lot of power. Hence, in my opinion, it is the one of the most suitable tools to be used as an embedded system of the vehicle.

Besides building and compiling kernel from scratch by repackaging Ubuntu distribution like any embedded system, Linux OS typically Ubuntu 10.10, is being installed on this system. With an OS, generally things become easier as most of the drivers and libraries are right there for us. Moreover, there are also lots of open source codes available in the internet relating to Linux OS which can be used on this project. Take note also that kernel building and compilation may takes up a lot of time and yet it may not be very successful due to software issue. As a result OS is being installed directly instead.

Now let us take a closer look at storage devices that are available to us to hold the contents of this OS. Some of these storage media are hard disks, floppy disk, Zip disk, CDs, DvDs, tape, PC cards, flash memory card, USB flash drive and microfilm. However, since this system is design for an embedded system towards vehicle industries, SSD (solid state hardisk) would be most preferred solution as it

does not only has large storage capacity in nature but more importantly it does not have any mechanical parts. Having no mechanical parts in SSD simply implies that SSD can be avoided from damage due to vehicle shaking caused by uneven surface.

In order to start off with this project, a bootable flash drive with Linux OS lies on to it is created. This however serves as one of the methods to install Linux OS on to a SSD. Since, the price of a SSD is exorbitant in the market; normal hardisk is used instead. A bootable Linux USB flash drive can easily be created using Universal-USB-Installer-1.8.2.6, as shown in the figure below.

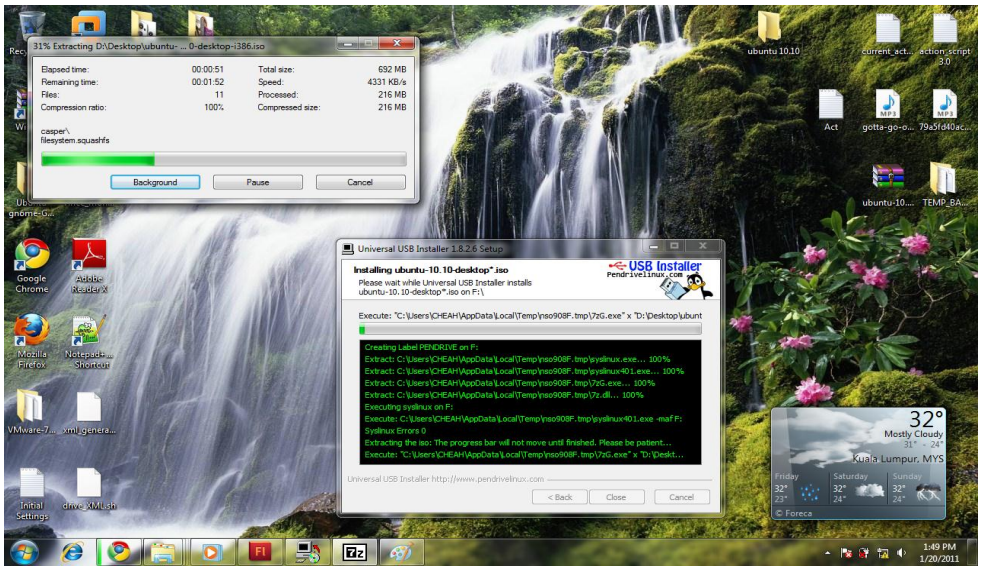


Figure 3-1 shows Universal-USB-Installer-1.8.2.6 in action

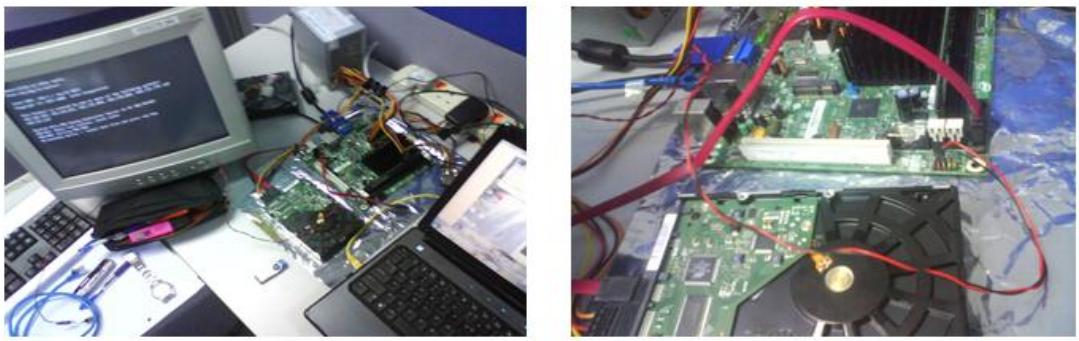


Figure 3-2 illustrates Intel board configuration

Besides that, since the I/O card expansion is not widely used in the computer industries, yet very expensive. To overcome this problem, in term of saving time and

cost, PIC is being used instead. In this event, serial has to be taken in place. Further elaboration on this design will be discussed in the following chapter.

3.2 Software Consideration

Another most essential design is none other than graphic user interface (GUI). GUI provides easy navigation for user to communicate. This means that designed GUI must not only be interactive but also able to provide an easy way as a mean of communication to the users. There are many ways available for us to design GUI on Linux OS. Some of these languages are python script, shell script, perl script, Gambas (visual basic in Linux OS), Linux C programming (Gnome programming using GTK+) and many more.

The easiest way out in order to design GUI is by using Adobe Flash (action script 3.0). Through this way, Application Programmable Interface, API can easily be created by underlying all the database programming underneath the GUI. Moreover, with the use of adobe flash, GUI can easily be developed within a short period of time.

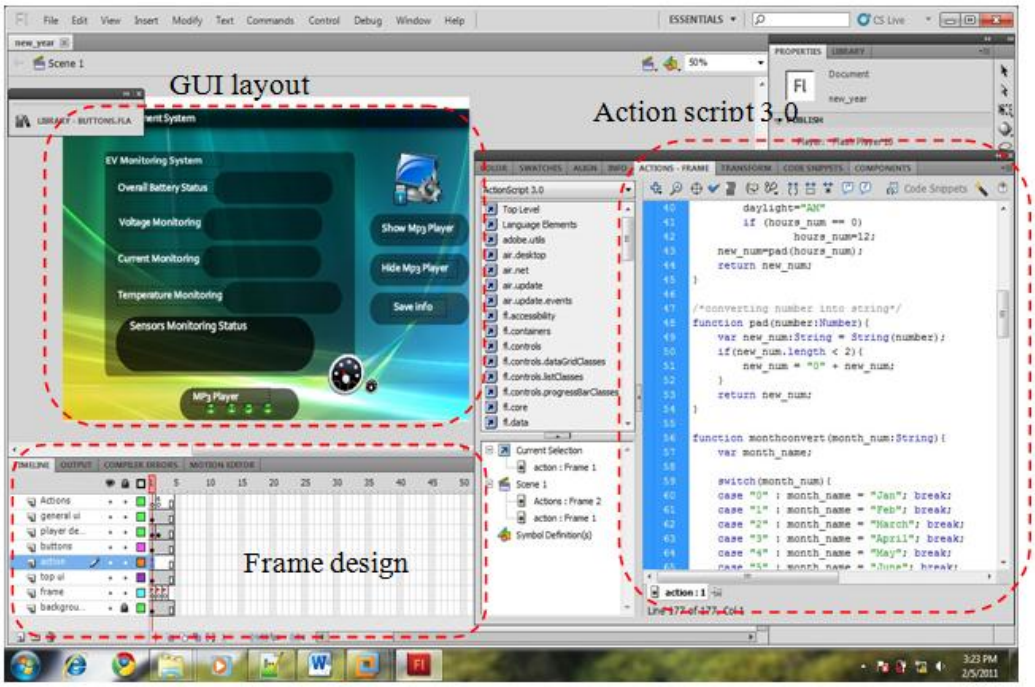


Figure 3-3 Adobe Flash (CS5)

Database such as XML playlist can simply be created by using standard shell called bash which is better known as GNU Bourne Again Shell, from the GNU suite tools. Since this is an excellent shell that is always installed on Linux Systems, open source, and is portable to almost all Linux variant, shell is indeed the best tool to handle the entire database within Linux OS. Of course, with the used of shell script, the level of complexity of a particular code can easily be reduced. Obviously, one must be very well versed in that language. Nevertheless, having the knowledge of Advanced Shell Script may even simplify shell script coding further. This however may not be a good as compared to install Linux natively on the OS. This is because running two OS simultaneously on top of one another may result in the losses of RAM size during execution.

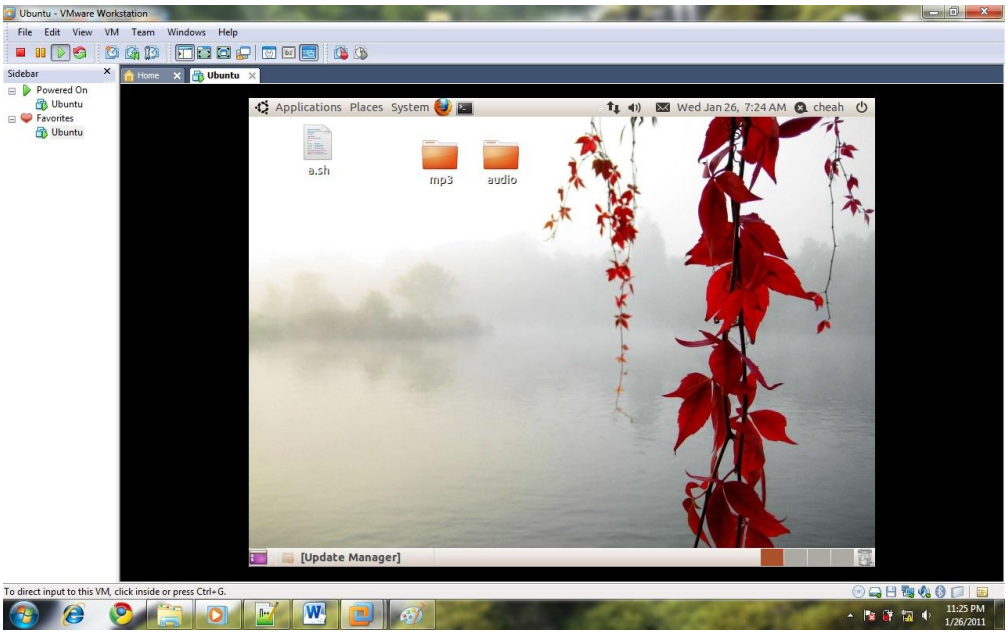


Figure 3-4 Running Ubuntu 10.10 OS using Vmware Workstation

3.3 Hardware Consideration

For hardware implementation, at this point AGM lead-acid will be used as a first testing ground for the overall EV project. Of course, Lithium Polymer (LiPo) battery will be coming into the whole picture once every testing concerning lead acid battery has been done. This however could be done in the second phase of this project.

Next, in order to ensure that the power management system able to run within the whole vehicle, only one lead acid maintenance free battery (12V, 75AH) will be used in this design. The whole idea behind this is to model the overall EV having one enormous power source, approximately 196V of lead acid battery. In addition to that, some of the BMPS feature such as cell monitoring and smart cell isolation will not be taken into consideration since our battery sponsorship willing to do battery research just to produce battery suitable to be used on our EV prototype.

Figure 3-5 16 Lead Acid Batteries from Yokohama for EV testing

Hardware design for this project covers battery monitoring system ranges from monitoring battery status to temperature monitoring system. In this design, watchdog timer will also be taken into consideration, in order to verify that sensors to be used in monitoring those applications are working properly from time to time. Apart from that, before proceeding any further in the design, it is very imperative for us to understand the motor characteristic (torque profile) and state of charge (SOC) before determining safe operating area (SOA) of the battery. Both of these studies will be carried out my colleagues. In this testing, we will be running on motorcycle's motor which then acts as a load for the whole system, as exhibits in the figure below. Note that the batteries must be connected directly to its controller (drivers) before it is ready to be coupled to the load.

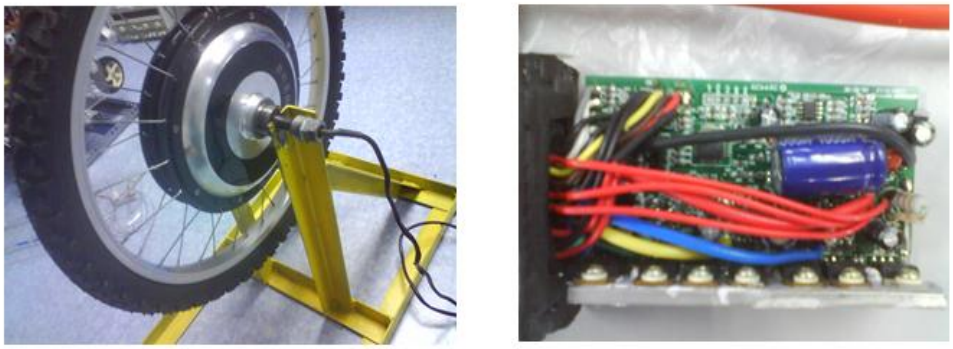


Figure 3-6 Motors and its controller from Yokohama for EV testing

The fundamental connection concept between the battery, controller and motor are almost the same as exhibits in the figure below.

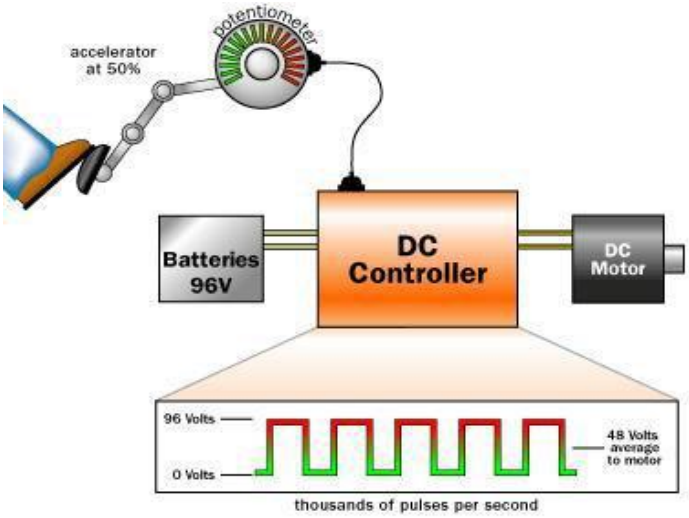


Figure 3-7 Fundamental Concept of Acceleration Pedal in an EV

As seen from the figure above, the variation in speed of the motor is typically controlled by PWM (Pulse Width Modulation). A simple circuit has been developed to fully understand the DC controller's mechanism. In this circuit design, variation in both speed and direction can easily be achieved. On top of that, modelling of the vehicle's stop behaviour can also be attained when the potentiometer (direction and speed controller) is adjusted to a specific value. To achieve this, the potential drops across the potentiometer must be approximately 5V for the reason that both of the op-amps will not be set as high. This simply means that none of the transistors are

forward biased. Hence, there is no force to turn the motor. Note that this circuit design does not permit us to govern the motor's torque.

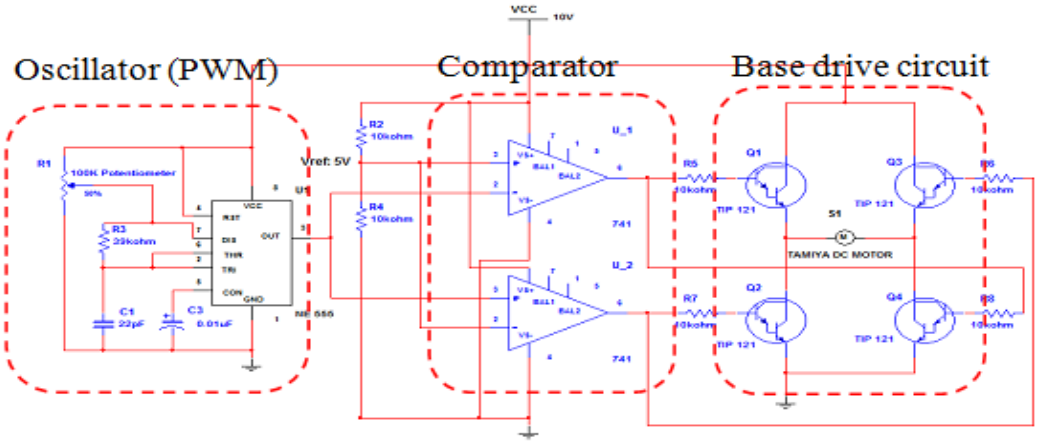


Figure 3-8 Bidirectional and Motor Speed Controller

The most fundamental working principle behind this design is none other than the PWM generator. IC 555, also known as timer chip is indeed one of the easiest yet cost effective ways to produce PWM. In this case, PWM is created by configuring the timer to be astable state (unstable state). Next, the op-amps act as a comparator which then compares one of its input corresponding to 5V (half of VCC). With the difference in the input value of the op-amp, a particular op-amp can either be turned on or off. In other words, digital output will then be created by the op-amp. With the corresponding digital output, the base drive circuit will not only as a directional control but more importantly speed control. The main theory lies behind this speed control is none other than the variation of the pulse. The base drive circuit on the other hands only contributes towards the direction of the motor.

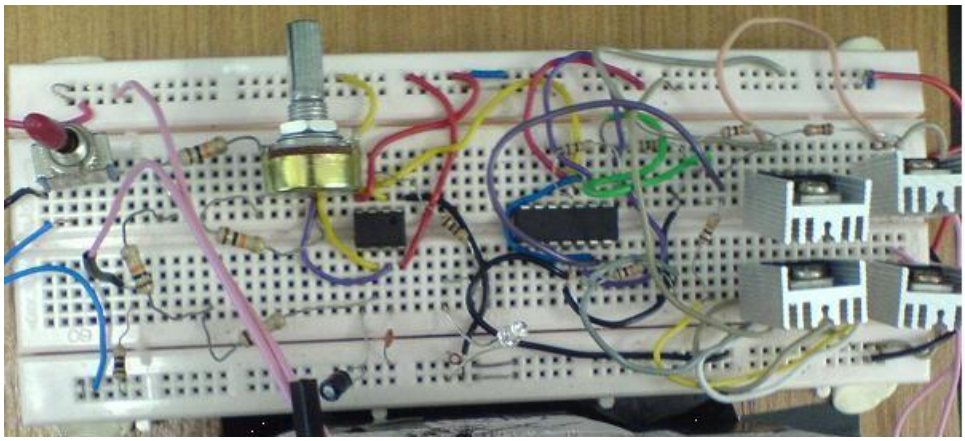


Figure 3-9 Circuit Constructed on Bread Board

3.4 Overview Idea EVICS

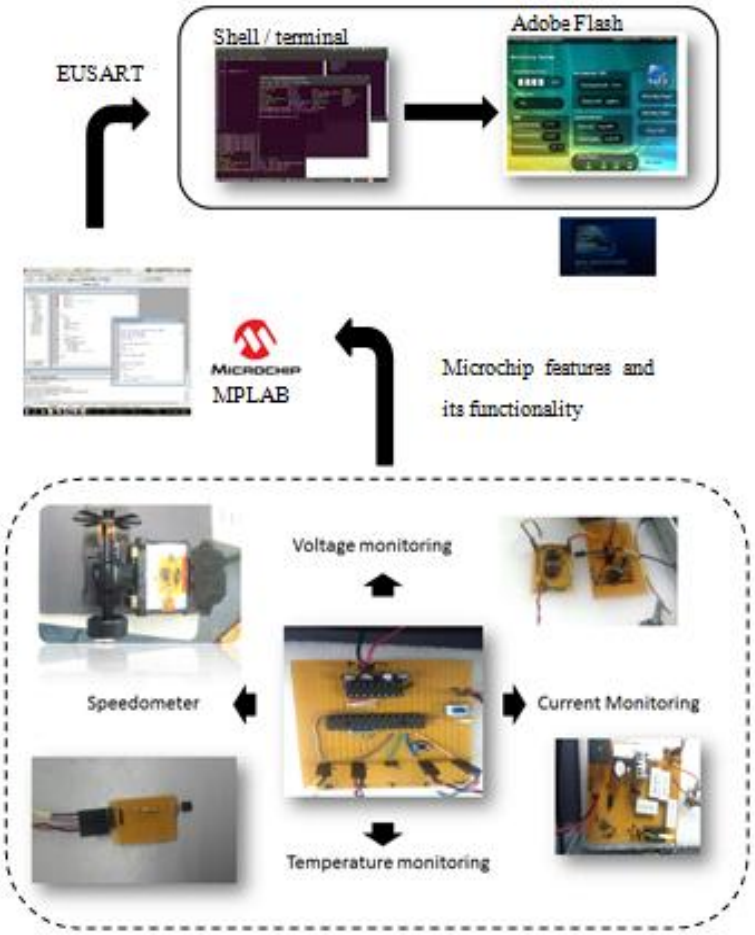


Figure 3-10 EVICS overview

The figure above simply demonstrates how each of these submodules connected between one another in order to form a whole system. Microcontroller in this design does not only manage all those hardware associated to it. Microcontroller does not provide flexibilty in terms of handling those hardware sub modules effective but also serves as a solution to keep the protection system from any undesired circumstances such as Intel board break down. Note also that for any PIC 18F series, the program counter takes in four instructions cycle of the crystal frequency everytime. Hence, the PIC18 divides the crystal oscillator by four to get the instruction cycle time. In this case, since 10MHz crytal oscillator is used in this

project, the instruction cycle frequency 2.5MHz. This basically means that the PIC response time is to peform isolation takes about 400ns .

EUSART is used as a mean to interface to Intel atom board. Since serial only enable one to send one character at a time. These characters must correspond to a unique value in order to be able for board to distinguish among themselves so that it knows where to be updated in the GUI. There is no way for flash to update itself which is why shell script as known as bash script is introduced. Shell script is used in this project to manipulate suitable result to be process by Adobe flash player, web server application, and not be left out file to be copied to flash drive.

Copy to flash drive application can easily be obtained by combining mdm 3.0 features together with action script. With this manner, one can easily write to a file, say text file. Once this text file has been updated, shell script can easily be written to carry out a specific task within an operating system.

Webserver application can easily be set up also be set up with the use of antiweb httpd. As discussed earlier, bash shell script can also be used as a tool to update DHTML. Dynamic HTML (DHTML), enable technicians to obtain information vehicle information directly with the used of website connected wirelessly. On top of that, technicians also enable to access past vehicle records of one vehicle before start to mend. In this case, one is able determine vehicle problem easily. In this case, once the technicians finished repairing, they have to update the vehicle’s database.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 GUI

Graphical user interface (GUI) for this project is basically designed by using Adobe flash for simplicity purposes. To ensure that the system is able to be run as an application file on Linux OS, software such as mdm Zinc builder 3.0 will used in this case. Note that mdm zinc builder 3.0 does not only allow flash file format to be converted into to an application file but more importantly to provide additional feature to assist adobe flash functionality due to its software limitation. The GUI verification test is as shown as below.

Figure 4-1 Flash Design Layouts

4.1.1 GUI Simulation based on Different conditions

Figure 4-2 Dangerous zone

Figure 4-3Hide Player

Figure 4-4 No Flash Drive Detected

Figure 4-5 Flash Drive Detected

4.2 XML Player

XML player in this project serves as an additional feature for users to play songs while they are on the road. To keep the system as simple as possible, the XML player will only play mp3 file format. XML player simply indicates that the player only plays song generated by the XML file. An XML file, in this case, playlist.xml keeps all the songs directories once a flash drive is plug into the system. Once the play button is pushed, each of the songs will be played respectively according to their turn. Note that the playlist must be dynamic as it changes from time to time.

Figure 4-6 XML Player GUI

Next, there is no way for us to update time and date of GUI from time to time. Hence, dynamic text with a little bit of Action Script 3.0 (AS 3) is written to support that application. With the used of this dynamic time generation, updated XML database, generated by unix shell script every 1 second will be read then by flash player. In this case, the number of flash drive and its content will be up to date every microprocessor's clock cycle. This simply means that the flash player has to be updated by unix shell script and without it would be nothing but a static system.

The dynamic XML of a system typically, Linux OS can easily be written in various languages but in this case bash script is considered it is indeed one of the easiest ways to create dynamic database within a Linux webserver, CGI – Common Gateway Interface. Of course, according to Linux GNU programming, Linux C programming language can also be written to replace bash shell script, however one must be very familiar with GNU libraries. Moreover, note that unlike any bash script programming, Linux C programming must be compiled first before it is ready for execution.

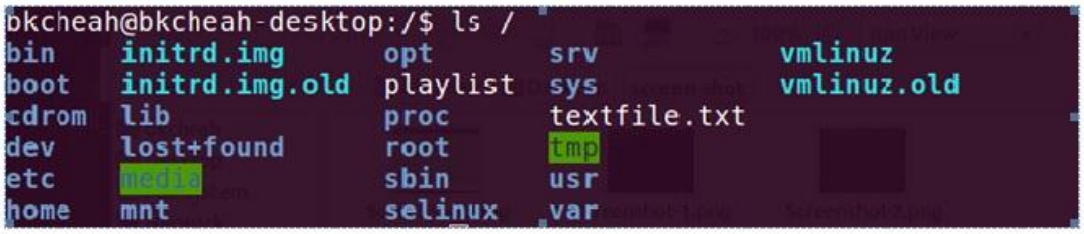


Figure 4-7 Linux Kernel

Now let us look into flash drive detection. In Linux OS it is very obvious that USB storage devices will be auto mounted to the */media* directory directly, as shown in the figure above. Hence, the next stage would be nothing more than searching for mp3 songs from this location. Once the locations of the songs are grabbed, they are then dumped into *playlist.xml*. The XML generally holds the entire songs location database inside a flash drive. As discussed, the XML database enables this player to know which songs to be played at an instance of time besides providing its location. Anyway, searching or even creating dynamic XML file was not as tricky as detecting the presence of flash drive. In this case, the source code should not only be able to perform checking, monitoring device every 1 second within the system but also updating XML file once changes has been detected.

Crontab is generally a program that does task scheduling under Linux OS. In other words, commands or even programs can be executed scheduler based on a specific time attached to that task. This time frame could be as simple as a date or subroutine. To have a better picture concerning subroutine, let us imagine of a task, say XML bash script gets executed every one seconds, the complexity of writing a source code can be reduced. Unfortunately, the slightest subroutine time frame on this system can never be less than 1 minute. Thus, it may not be very so practical to the users (there a long pause in the system – delay). In this case, it is understood that the scheduler's deamon gets executed every 30 seconds. Moreover, it is learnt that crontab can never execute script that contains continuous while loop. From observation, setting the crontab to execute a script during boot up (only once – no subroutine) does not really going to help much since the program stops its execution when it sees while loop.

To solve this problem, the shell script is written in a form of application program. In this case, the file is created such that it will launch basic terminal before executing a program attached to it. This can be achieved by making another bash script file to call for the main program (XML bash script program) upon execution. Once this is ready, it is then to be placed in on Linux start up system called (*system -> preferences -> startup applications preferences*) upon ready to for execution during the next start up. To have a better illustration, please refer to the figure below.

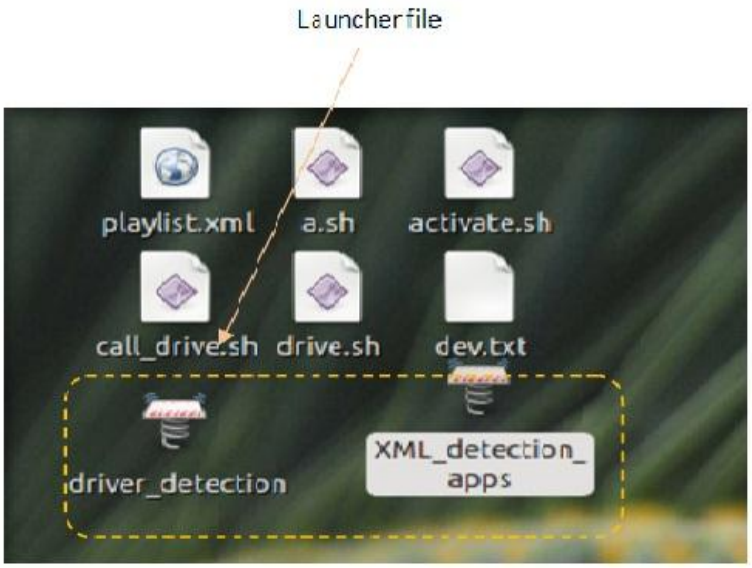


Figure 4-8 Bash Script together with its launcher

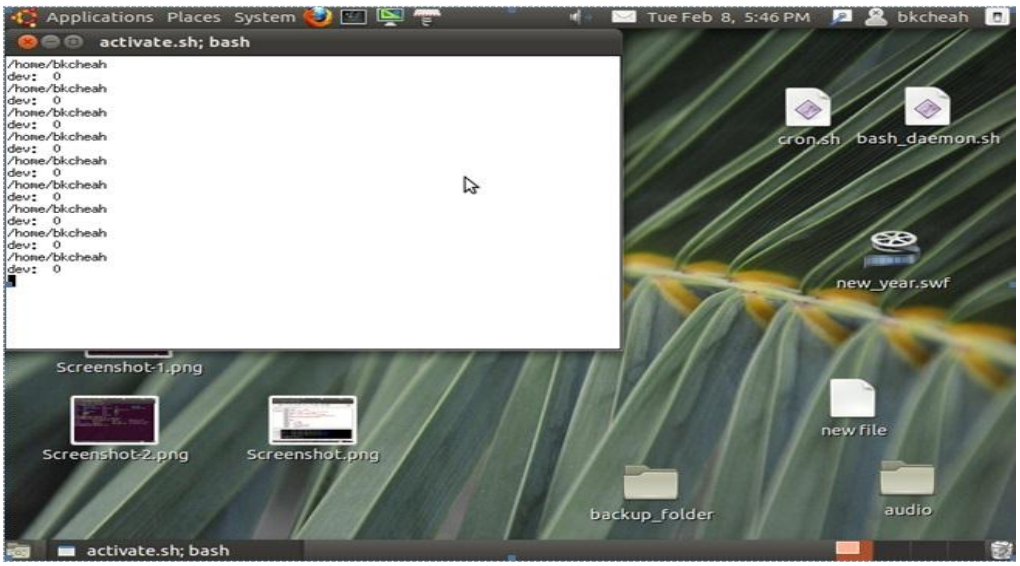


Figure 4-9 Launcher Program in Action Searching for Drive

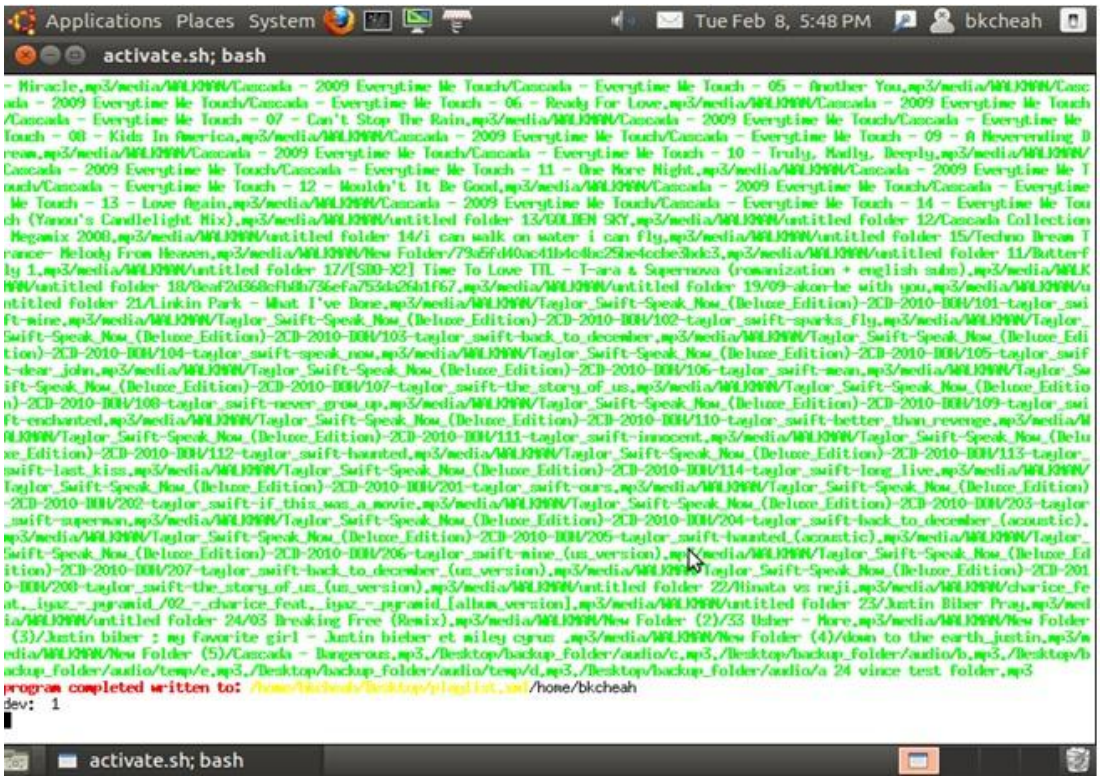


Figure 4-10 Launcher Program detected the existence of Flash Drive

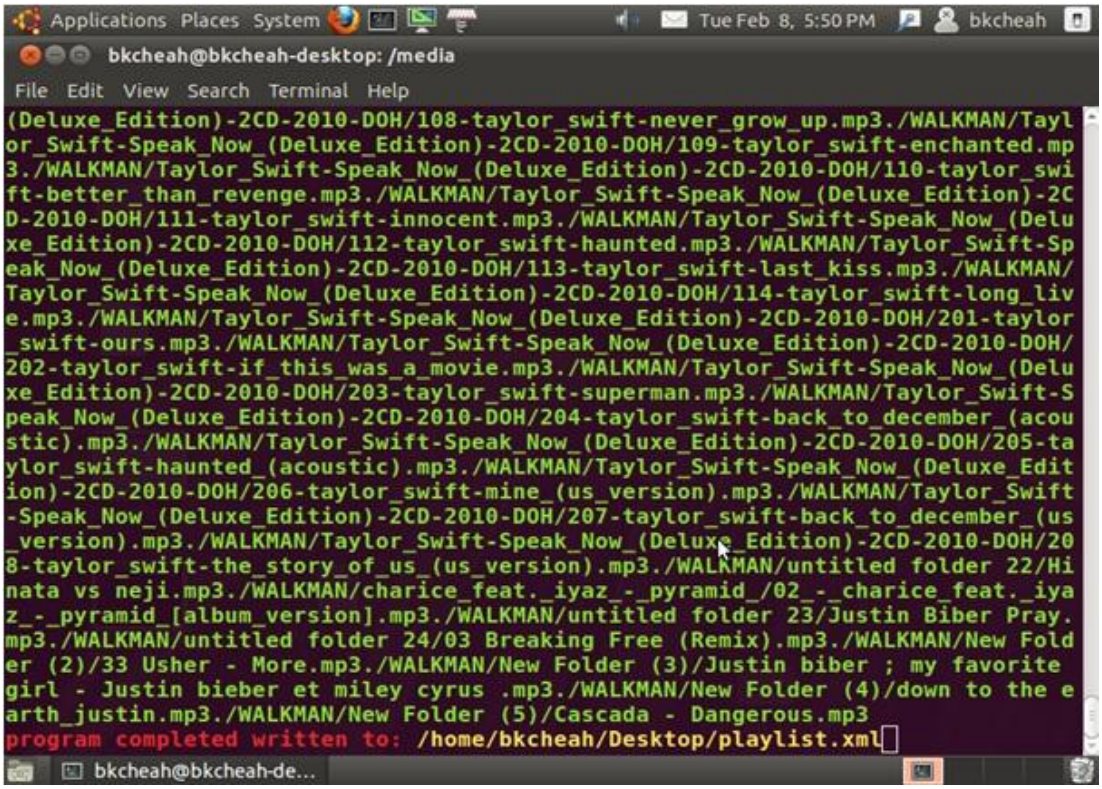


Figure 4-11Similar Program running on Linux Shell

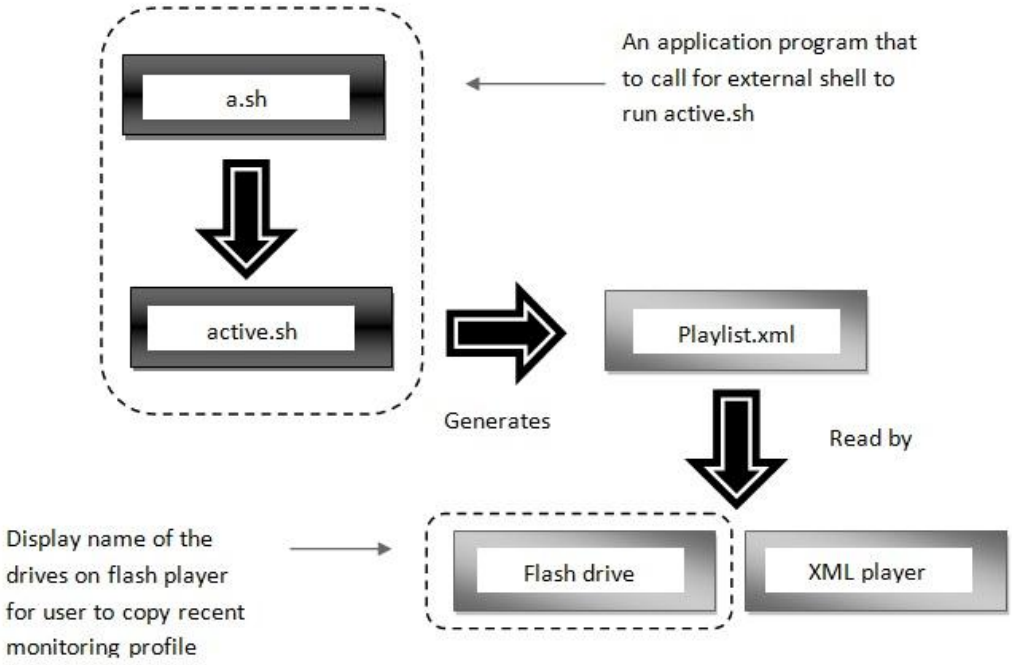


Figure 4-12 Block Behind Flash Drive Detection

Now let us take a closer look at the project modular design in order to understand the program flow better. As seen from the figure above, a.sh is typically a file that calls for an external terminal that is ready to execute another source code, in this case, active.sh. The source code acive.sh typically checks the media directory for any changes (every one second). Once it detects any changes it will write songs url content and name of the flash drive connected to the system directly with the corresponding XML tag. Flash drive detection not only used as mean to detect numbers of songs that a system has but more importantly to be used as mean transfer file directory. Without showing the name for each of the flash drives connected to a system, one is unable to determine where the most updated monitoring status file to be copied to. Apart from that to avoid from any circumstances, the XML player is designed to play mp3 format on XML player.

XML player in flash player on the other hand can easily be designed by using AS 3 (action script). The play function does not differ much as compared to any

other functions of the XML player - they all response to mouse click. As a consequence, the source code for each of these functions will look almost the same as one another. The word *"play_btn"* simply refers to name attached towards the play symbol. From the source code below, once *"play_btn"* is clicked *onPlay function* will then be executed.

AS 3.0 – play function

```
play_btn.addEventListener(MouseEvent.CLICK, onPlay);
function onPlay(e:MouseEvent):void{
/*add source code here*/
}
```

The next function is certainly a very tricky utility to be handled. From the source code, it is clearly understood that *onNext function* may not necessary comes from mouse click. It may also come from *playSong function* since it has to start playing the next song once the current song has already been played. Next, slight modification in the source code has been made to the *onNext function* by making it responses to all sorts of events. Note that mouse click is just one of an event in this case. Part of the source code is as shows as below.

AS 3.0 – Moves to the Next Song

```
/*function designed to play a song */
function playSong(mySong:Number):void{
…
my_channel.addEventListener(Event.SOUND_COMPLETE, onNext);
}

/*using playSong function to call for onNext function*/
next_btn.addEventListener(MouseEvent.CLICK, onNext);
function onNext(e:Event):void{ /*event */
/*add source code here*/
}
```

4.3 GUI Dynamic Time and Date Generation

Figure 4-13 Upper top of EV GUI

There is no way for us to update time and date of GUI from time to time. Hence, dynamic text with a little bit of Action Script 3.0 (AS 3) is written. With the used of dynamic time generation XML database will only be read every 0.25 second at a time. This is essential to avoid the system from crash. Imagine that system tries to read from the database every instruction cycle – not necessary one second. Part of the source code is as shown as below. Do take note that the tick function takes place every 500 ms.

AS 3.0 – Dynamic Reading from XML Database

```
function tick(event:TimerEvent):void {
updateTimer();  /*functions that gets date and time */

/*loading playlist.xml to be used in processXML function */
var myXMLLoader:URLLoader = new URLLoader();
myXMLLoader.load(new URLRequest("playlist.xml"));
myXMLLoader.addEventListener(Event.COMPLETE, processXML);
}
```

Time and date has to be updated dynamically using dynamic text as discussed. Each of these dynamic text created must be given a name in order to for us to distinguish among them. In this case, "*timetxt*" and "*datetxt*" are names that given to the time and date respectively. Note that the date that attained in this project is not written in string data type. Therefore, they are then being transformed with the used of pad*(argument)* function. The add symbol simply denotes appending all the strings together as one entire string.

AS 3.0 – Date and Time Generation

```
function updateTimer():void{
var date = new Date(); /*gets date from the system*/
…
/*display time and date using string data type*/
timetxt.text = hours_check(hours) + ":" + pad(mins)+ ":" + pad(secs) + " " +daylight;
datetxt.text = monthconvert(month) + " " + day + ", " + year;
}
```

4.4 Serial Communication

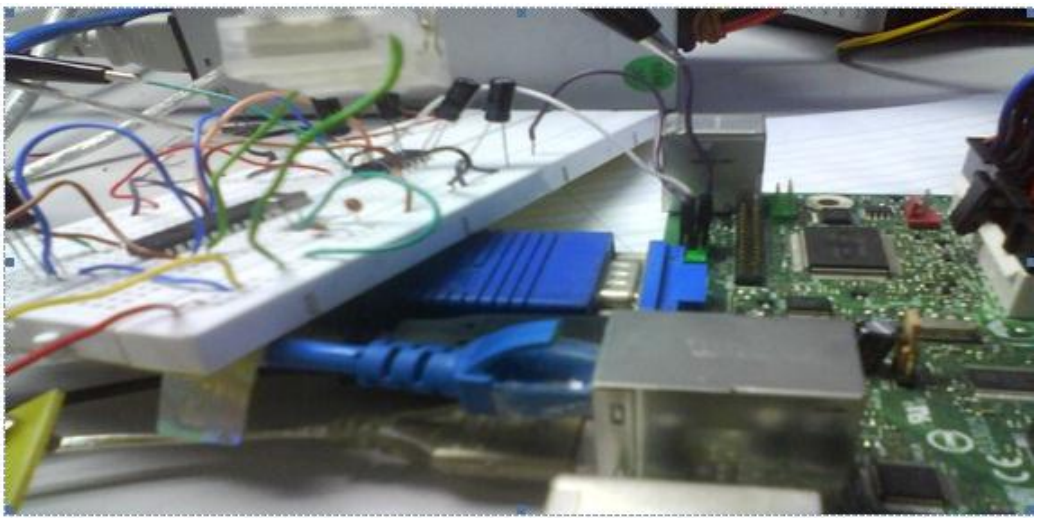


Figure 4-14 Serial Communication between Intel board with PIC18F2550

One of the communications medium between microchip to Intel atom board is none other than serial communication (Enhanced Universal Synchronous Asynchronous Receiver Transmitter - EUSART). This connection can be achieved by means of serial port available by the board, USB-serial (PL3203) or even serial expansion slot (MAX EXPANSION). Alternatively, one can try PCI slot if one has the money and time but keep in mind that I/O expansion ports may not be widely available in the market. As for that reason, the decision ultimately goes back to serial communication. As seen from the figure above, Transmitter (TX) and receiver (RX) pins of the MAX-232 can be connected directly to the Intel board serial port without the use of DB-9

Besides that to ensure that serial communication between the PIC and the Intel board has been established, PIC18F2550 under Linux Operating System, software such as GTKterm, minicom, moserial and Terminal had been tried out. However, at the end of the day only terminal will considered since it has the capability to store whatever it has received from serial just with use of shell script (similar concept to XML generation).

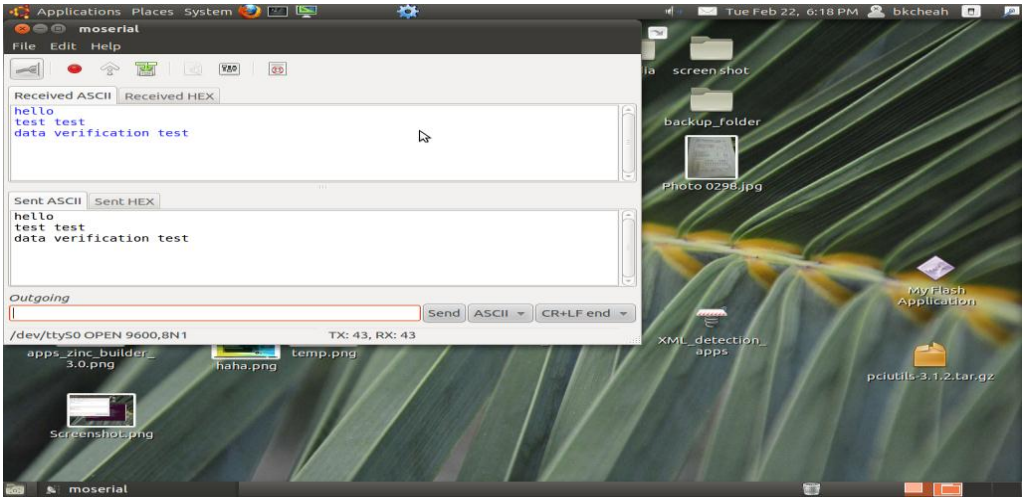


Figure 4-15 Serial Communication using moserial

From our discussion above, it is easily noted that shell script does not only plays an imperative role in terms of database programming (creating dynamic XML) but more importantly serves as intermediate system ensuring that Adobe Flash is able to tag along with serial communication which is then attached to PIC. As stated, there no ways for Adobe flash to obtain information directly from PIC just by using serial communication's software as mentioned above. In other words, with the use Linux programming, for instance shell script or GNU - C programming, suitable dynamic data file can be created to suit the needs of AS 3. In this project, Linux shell is used as a main tool to handle all of these applications.

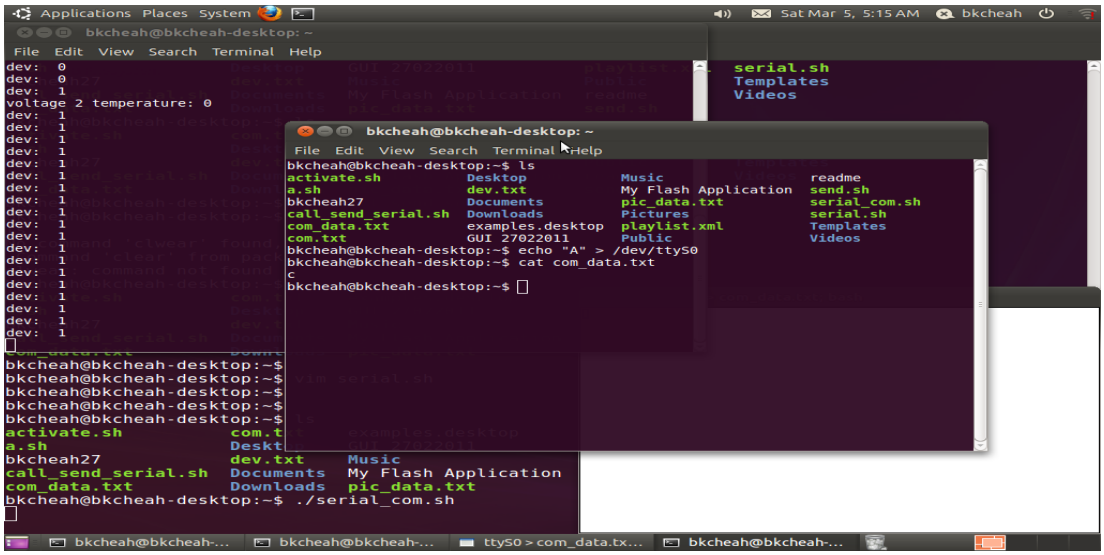


Figure 4-16 Serial communication data processing using shell

To keep things going perfectly, PIC programming is set such that it only sends one character back to PC where by these characters are understood by both Intel board and PIC once it received signal from the personal computer (PC). Two way communications is also used between PC and PIC to ensure that the system has been established for debugging purposes. The figure above simply illustrates, the use of shell not only as an application program but also as debugging message running behind flash player.

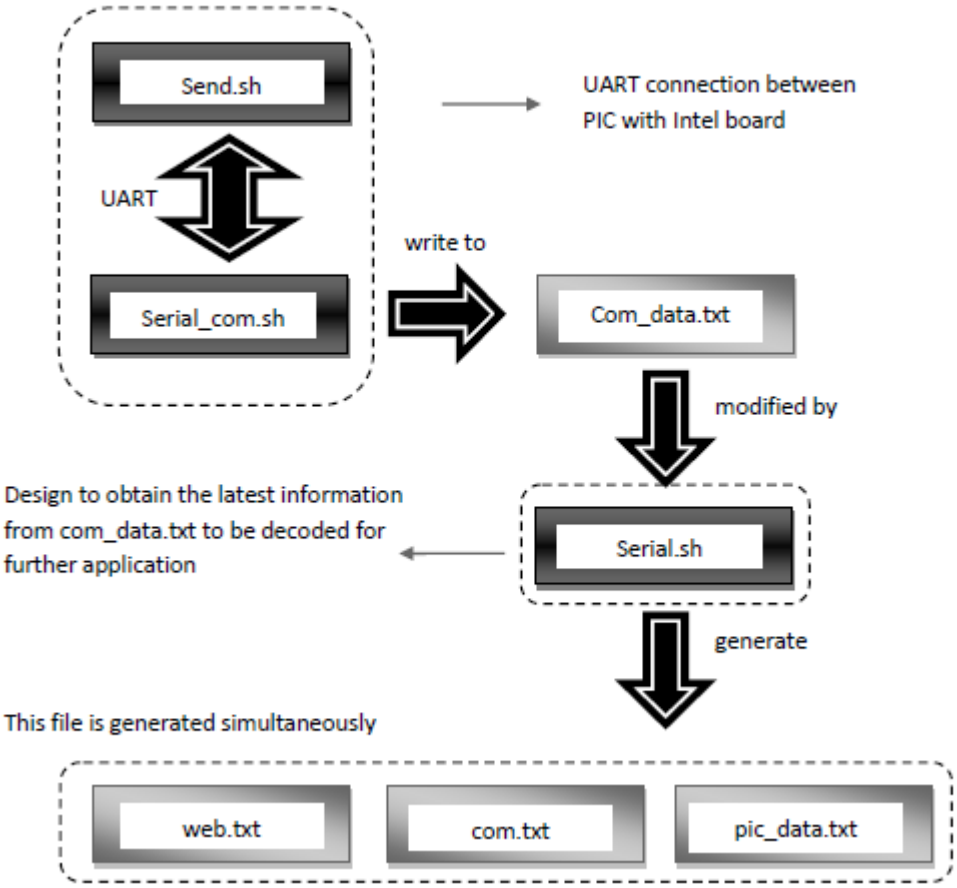


Figure 4-17 Block diagram pertaining to serial communication protocol

Now let us look at the working design behind serial communication protocol. In order to ensure that the system works perfectly, send.sh and serial_com.sh is created so that most recently information obtained by the PIC can easily be determined. In this design, instead of using one shell script to received information from serial, two shell scripts are written so that the most updated information can easily be determined before it is ready to be processed. In this case, PIC programming is set such that it sends only one character back to the PC once it is received from the PC. This simply means that characters used during the transmission must be understood by both Intel board and PIC so that it does not crash or even overlap with other module system attached to the PC. Once serial_com.sh received information, it will then write to com_data.txt for later manipulation and decoding. Of course, the content of the file must not be so much as it may cause the

system response time to be very slow. As discussed earlier, a file is needed to basically gets the most recent information and decode the information to some useful information that people and action script (AS) 3.0 can understand. This is where the file entitled serial.sh comes into picture. Text file entitled, pic_data.txt is designed so that users are able download the monitoring results on the flash drive apart from playing songs on the board itself. Com.txt on the other hand, serves as a communication medium between flash player and bash script. Once, there is some changes in the com.txt file, the flash player will ultimately vary as well.

Character(s)	Representation	Character(s)	Representation	Character(s)	Representation
a	0A	o	12.8V	K	0RPM
b	0.2A	p	14.8V	L	1030 RPM
c	0.3A	q	15.8V	M	3284 RPM
d	0.4A	r	>16V	N	5744 RPM
e	0.5A	s	<20 ℃	O	8279 RPM
f	0.6A	t	22 ℃	P	10915 RPM
g	0.7A	u	27 ℃	Q	13427 RPM
h	0.8A	v	32 ℃	R	15920 RPM
i	0.9A	w	37 ℃	S	18510 RPM
j	>1A	x	40 ℃	T	21213 RPM
k	<9.5V	y	41 ℃	U	23942 RPM
l	9.5V			V	26614 RPM
m	10.5V			W	29102 RPM
n	11.4V				

4-1 Table shows each of the characters shared between Intel board and PIC

4.5 SOC Prediction Estimation

Figure 4-18 Prediction of battery running time and distance left

Another feature attached to the GUI is none other than battery predictions. With the help of this module, one is able to prepare for the worst case scenario. This module can easily be achieved based on some simple experiment. Based on the experiment, it is easily observed that 1V drops across 12V, 75AH Yokohama battery, takes up approximately 10 hours. In this experiment, to ensure that the results are practical, the load used in this experiment is typically the integration of the entire sub module together with speaker simulating the vehicle on the go. Of course, LCD monitor screen will be used instead of touch screen devices in order to cut off some cost. The Distance left can be computed easily by multiplying running time left with current vehicle speed.

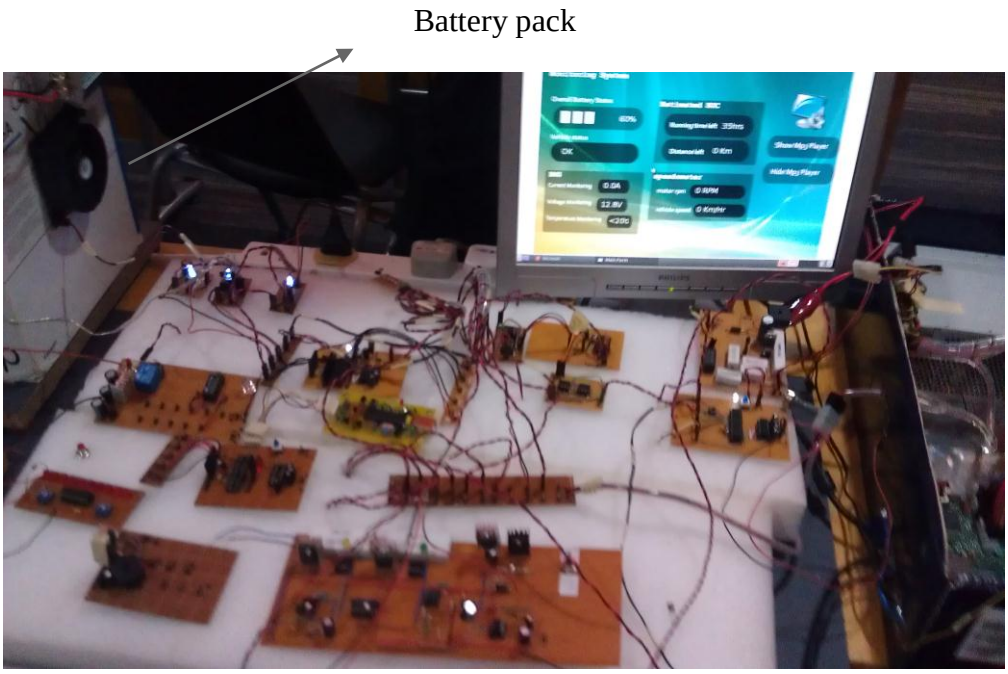


Figure 4-19 Power up the whole system using 75AH Yokohama battery

4.6 Webserver

Figure 4-20 Intel board connects to a router for wireless LAN connection

Another feature embedded into the board none other than to use the board as a server. Of course, a wireless router has to be turned off in this case in order to provide flexibility to the customer during servicing. Having such advantage, technicians whom are servicing that vehicle can easily obtain battery profile information and vehicle past records simply by connecting to the board via web browser. In this case, the device can either be a personal computer or notebook inclusive of todays' smart phones. In this case, one only has to know the board board's IP address (static IP address set by a router – 192.168.0.102) and its port number attached to the system. The port number, on the other hand, can easily be set inside awhttpd.conf. 8384 is the port number set for this web application.

This can module can easily be implemented with the help of anti-web httpd. An anti-web httpd is also known as a single process web server that relies on its inherent simplicity to be robust and secure. It basically supports virtual hosts, CGI, IPv6 and more. In this project, Common Gateway Interface (CGI) will be used instead. CGI programming can easily be written as a mixture of bash scripts (server side programming), HTML, javascript (client side programming), and CSS in order

to generate dynamic HTML with interactive feature and they normally placed in the awhttpd/default directory. Of course in order to run the webserver application during start up, crontab (linux scheduler) has to be used instead.

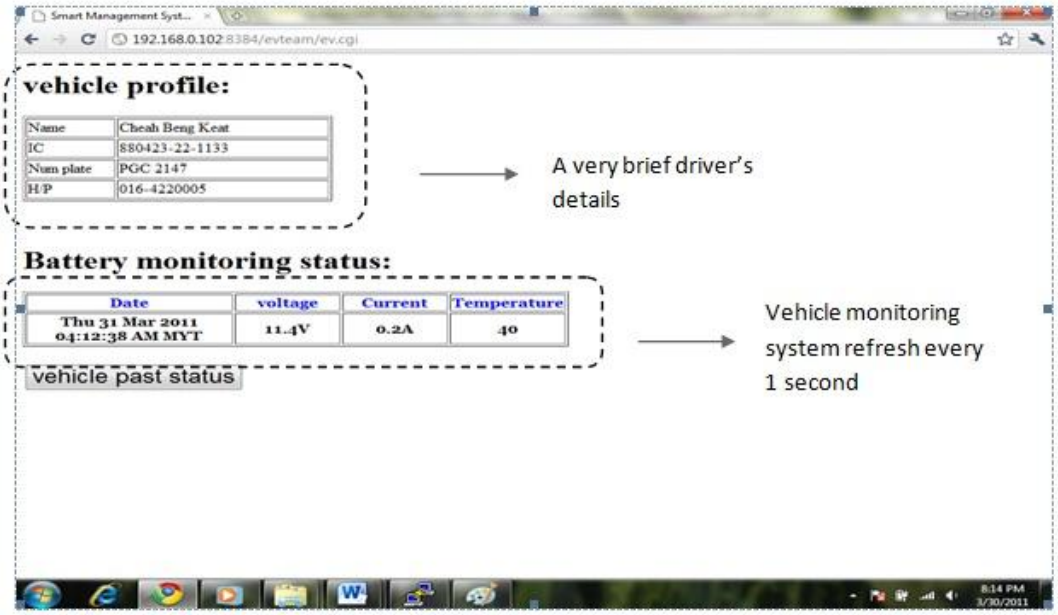


Figure 4-21 Connecting to Intel board using google chrome [ev.cgi]

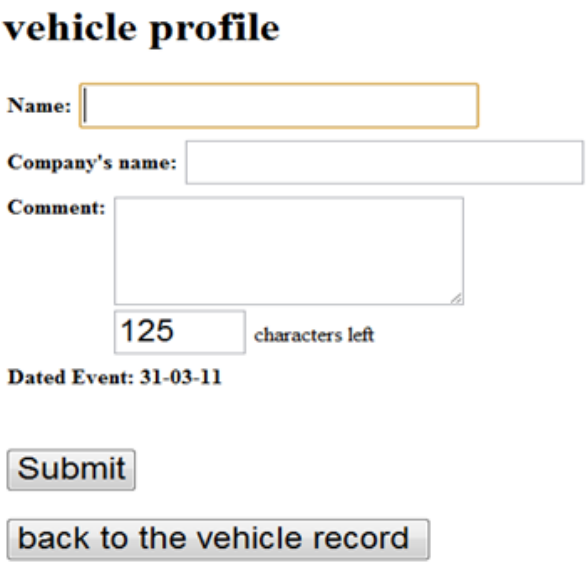


Figure 4-22 Adding vehicle status record [ev_2.cgi]

Figure 4-23 View vehicle records [ev_1.cgi]

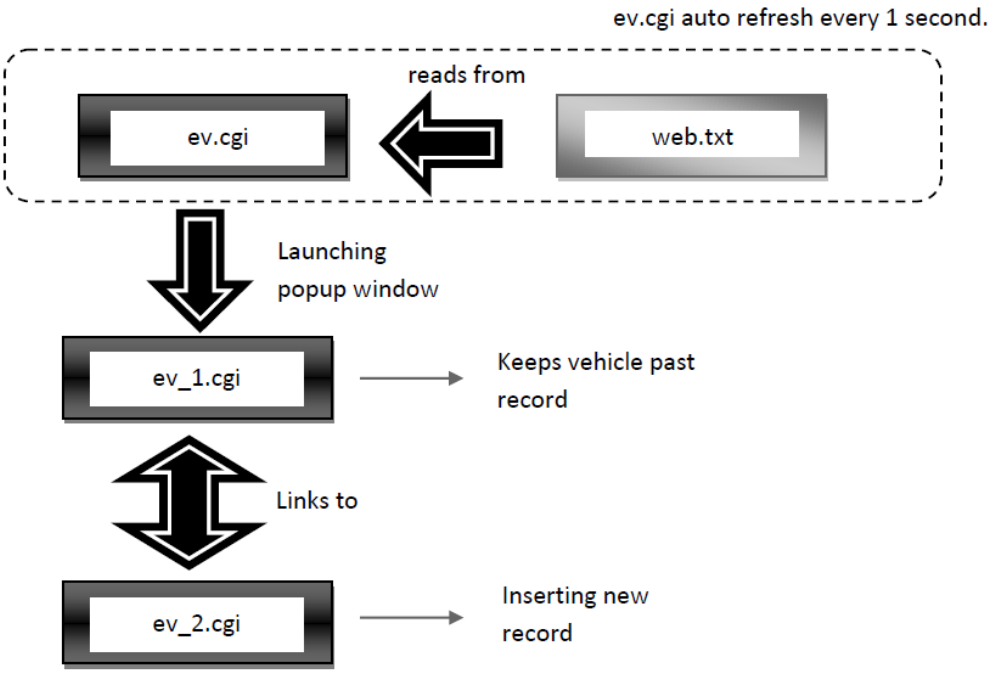


Figure 4-24 Block diagram behind webserver programming

On top of that with this wireless feature also enable Intel board to provide flexibility especially to software engineers who are dealing with software issue. With this, one need not even have to go to near the corresponding vehicle just to do programming. All one has is nothing but connecting to the host computer via wireless connection. This can be achieved by using putty (for window) and shell (SSH – for Linux). By having this connection more than one programmer can gain access to the board at an instant.

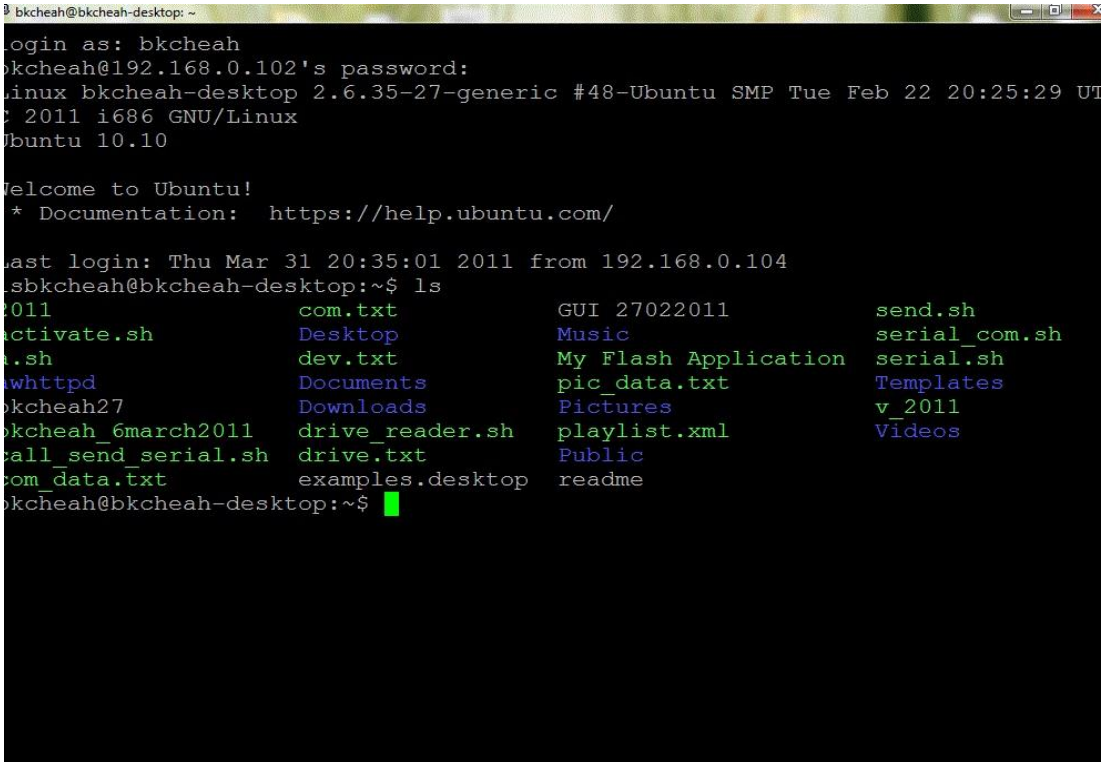


Figure 4-25 Connected to the Intel board via putty - Windows

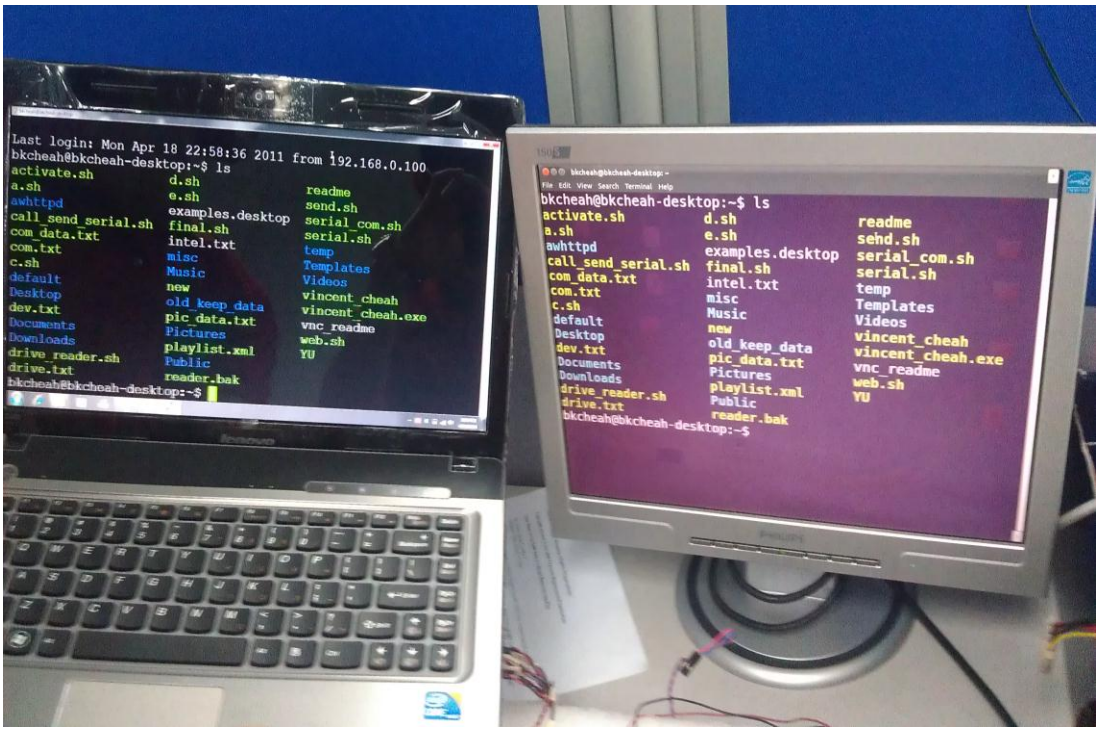


Figure 4-26 Putty connection connecting windows to Linux

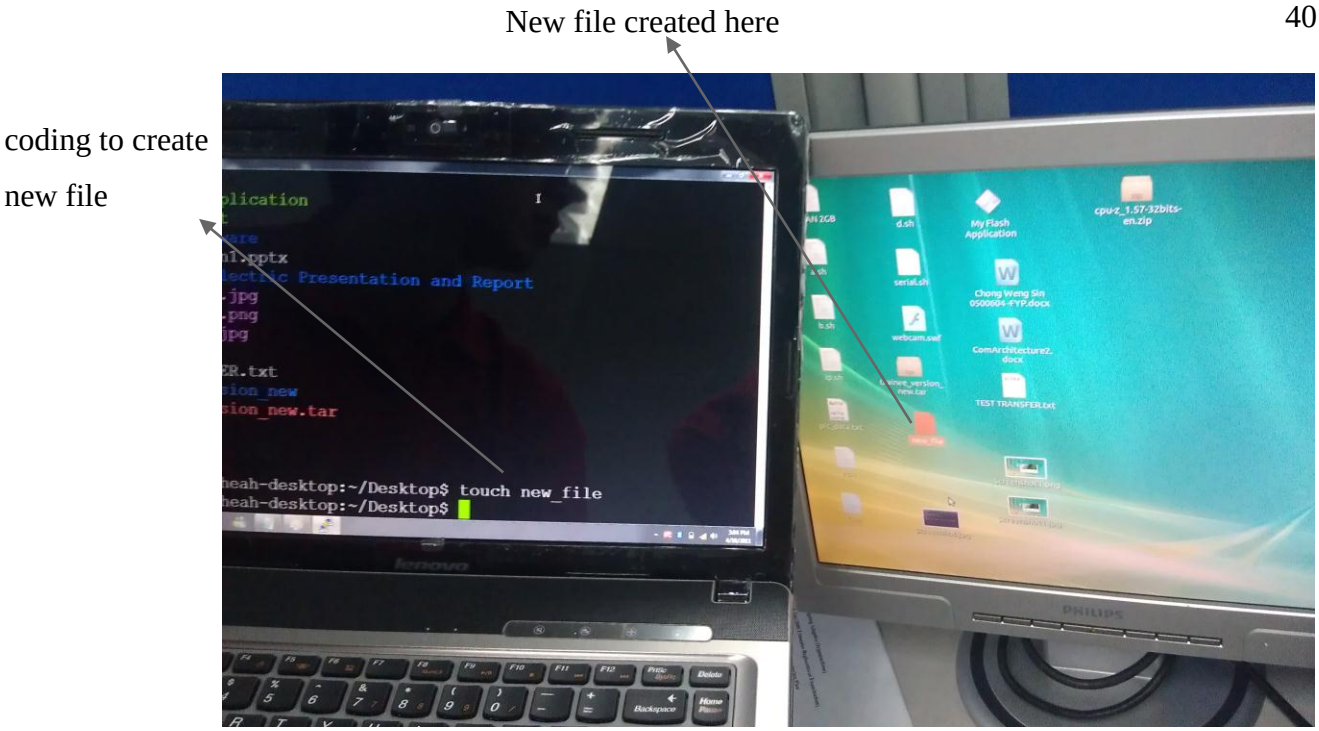


Figure 4-27 creating a new file called “new_file” in putty

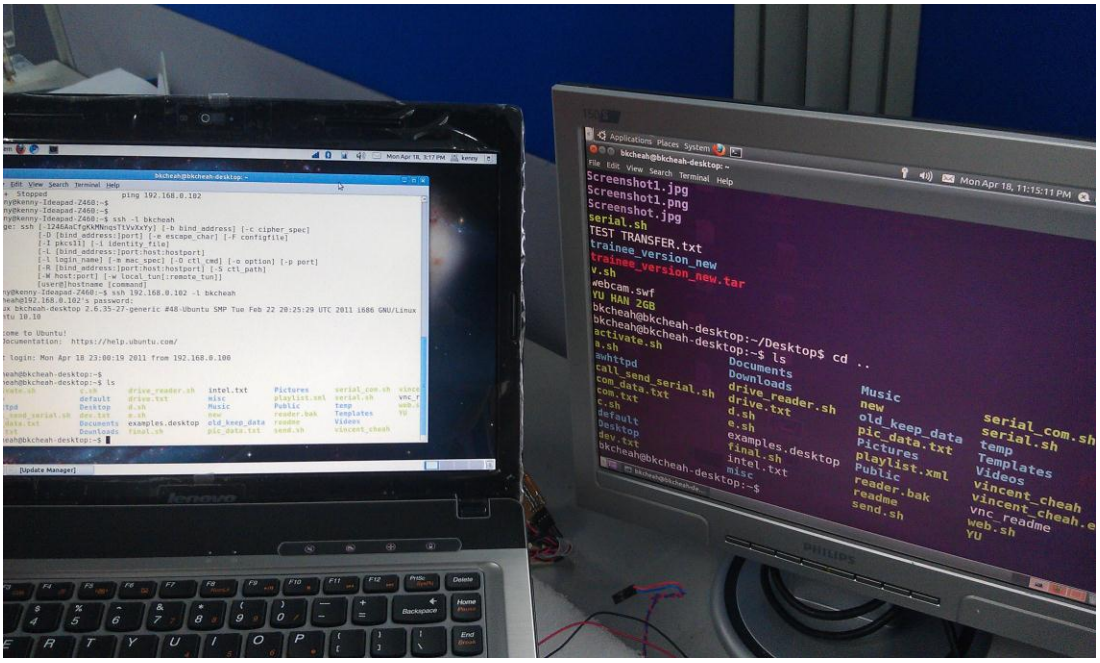


Figure 4-28 connecting to Intel board using Linux OS through via SSH command

4.7 Stage 1 of Battery Monitoring System

Generally, as discussed above, there are mainly three main modules concerning BMS. They are current monitoring system, voltage monitoring system and temperature monitoring system.

The current monitoring system plays a very important role in determining the right amount to be injected into the battery terminal and at the meantime take necessary a measurement if unexpected circumstances occur. In the purpose of developing an effective yet efficient smart monitoring system, it is utmost important for us to understand the battery charger's characteristic. Voltage monitoring and temperature monitoring systems on the other hands are essential to ensure the safety of the vehicle.

All of these monitoring systems can simply be achieved by using ADC conversion of the PIC18F4680. With the use of PIC, not only numbers of wire connection can be reduced, but more importantly enable us to perform direct processing by connecting directly to the Intel board via Max-232. Reducing numbers of wire will eventually enable one to obtain more accurate yet reliable result. Current monitoring devices can easily be designed by placing a low resistance value in between the charging circuit and the battery. These modules later have been followed up by my fellow teammate, Kenny Gan and Gan Yu Han.

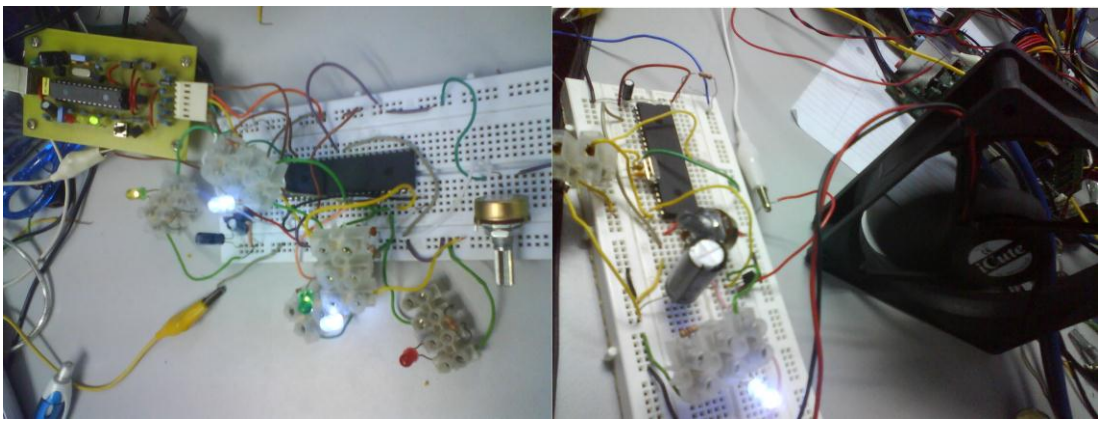


Figure 4-29 ADC in action

Before waiting for real system to be implemented to the BMS, a microchip is program to respond to two ADC functions (for testing purposes). As illustrates from the diagram above, the source code is written such that it reads analogue from channel 0 (RA0) and channel 1(RA2), then perform some specific task such as turning the red led on and off based on certain specify condition. This is very essential in order to ensure that the ADC of the microchip has been functioning

properly. ADC input to the system in this case is model by potentiometer to model variation in the BMS, as comprehended in the figure above. Later the red Led is replace by a fan to confirm that the system able to trigger a transistor to power up a fan as well. Of course, in this case, a capacitor is connected parallel with fan so that there is enough current to produce sufficient to kick start a motor fan.

At this point, it is then realized that this project does not require a lot of ports. This simply means that lesser circuit connections under micro-controller implementation. Therefore, PIC18F4680 can simply be substituted by PIC18F2550 since it is best to implement everything inclusive of applications, functionalities under one roof with a cheaper cost.

4.8 Copy Function from Adobe Flash Player

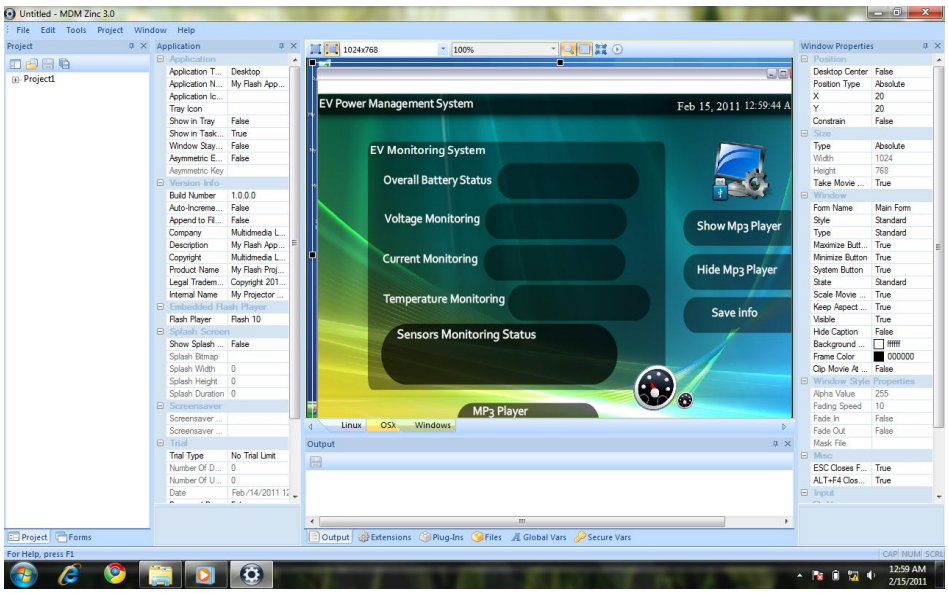


Figure 4-30 Mdm Zinc Builder 3.0

Mdm Zinc builder 3.0 software is more or less similar to Adobe Flex. They are designed for the development and deployment of cross-platform rich internet applications based on Adobe flash platform. In this project, to design the copy functionality, mdm file system utmost important. With the use of this mdm file system, the result of button pressed from flash GUI can then be written to a drive.txt file. Once this updated file has been detected by the shell script, UNIX command pertaining to copy utility will somehow be executed.

AS 3.0 – write to a file from Flash

```
function processXML(e:Event):void {
var myXML:XML = new XML(e.target.data);
/*read XML file*/
if (dev_total == 0){
/*disable flash drive icon and save info navigation tool*/
}
else { /*control invisiblility */
drive.visible = true;
save_txt.text="Save info"
save_info.visible=true;
save_info.addEventListener(MouseEvent.CLICK, function(){gotoAndStop("three");

/*go to frame 3 and shows flash drive names connected on the system*/
switch (dev_total){

/*
The source code below gets the flash drive name from playlist.XML then display in
frame 3. Once the first object is pressed (obj1), say on one flash drive connected to
that system, the flash drive name will then be written on to drive.txt; ready to deploy
by shell scripts.
*/

case 1 : obj1.visible=true;
        obj2.visible=true;
        obj3.visible=false;
        obj4.visible=false;
        str=my_data[0].@URL  /*get flash drive content */

        nav1.text=str;  /*Display dynamic text on the screen */
        nav2.text="Back"
obj1.addEventListener(MouseEvent.CLICK,
function(){mdm.FileSystem.saveFile("drive.txt",  my_data[0].@URL );});
obj2.addEventListener(MouseEvent.CLICK, function(){gotoAndStop("one")});
```

```
break;
… /*source code continue here*/
/*similar concept applies to case 2 and 3*/
}
})

        }//end if
}
```

CHAPTER 5

AWARDS AND ACHIEVEMENT

5.1 Research Paper Publications & Conference

- B.K Cheah*, Y.H Gan, G.D Gan, Z.Y Phuan, M.K Yoong, C.K.Leong. K.W Chew, "Case Study of EV Controller and Power Management System", Malaysian Universities Transportation Research Forum and Conference (MUTRFC), 21 December 2010, Uniten

Website:
http://www.uniten.edu.my/newhome/uploaded/coe_civil/mutrfc2010/020%20CASE%20STUDY%20OF%20EV%20CONTROLLER%20AND%20POWER%20MANAGEMENT%20SYSTEM.pdf
http://www.uniten.edu.my/newhome/uploaded/coe_civil/mutrfc2010/021%20UG.pdf

- Z.Y Phuan* ,B.K Cheah, Y.H Gan, G.D Gan, M.K Yoong, C.K.Leong. K.W Chew, "Design of Battery Pack For Electric Vehicle Based on Lithium-Ion Technology", Malaysian Universities Transportation Research Forum and Conference (MUTRFC), 21 December 2010, Uniten

Website:
http://www.uniten.edu.my/newhome/uploaded/coe_civil/mutrfc2010/014%20DESIGN%20OF%20BATTERY%20PACK%20fOR%20ELECTRIC%20VEHICLE%20BASED%20ON%20LITHIUM-ION%20TECHNOLOGY.pdf

- G.D Gan*, B.K Cheah, Y.H Gan, Z.Y Phuan, M.K Yoong, C.K.Leong. K.W Chew, "Studies of Electric Motors For Light-Weight Electric Vehicle", Malaysian Universities Transportation Research Forum and Conference (MUTRFC), 21 December 2010, Uniten

Website:
http://www.uniten.edu.my/newhome/uploaded/coe_civil/mutrfc2010/016%20STUDIES%20OF%20ELECTRIC%20MOTORS%20FOR%20LIGHT-WEIGHT%20ELECTRIC%20VEHICLE.pdf

- Y.H Gan*, B.K Cheah, G.D Gan, Z.Y Phuan, M.K Yoong, C.K.Leong. K.W Chew, "A Study on Electric Car Chassis and Design Principle", Malaysian Universities Transportation Research Forum and Conference (MUTRFC), 21 December 2010, Uniten

Website:
http://www.uniten.edu.my/newhome/uploaded/coe_civil/mutrfc2010/021%20A%20STUDY%20ON%20ELECTRIC%20CAR%20CHASSIS%20AND%20DESIGN%20PRINCIPLE.pdf

- C.K.Leong *, B.K Cheah, G.D Gan, Y.H Gan, Z.Y Phuan, M.K Yoong. K.W Chew, "Ultra-Fast Charging System On Lithium Ion Battery", IEEE (Sustainable Utilization and Development in Engineering and Technology), 20 – 21 November 2010, UTAR

- M.K Yoong*, B.K Cheah, G.D Gan, Y.H Gan, Z.Y Phuan, C.K.Leong. K.W Chew, "Studies of Regenerative Braking In Electric Vehicle", IEEE (Sustainable Utilization and Development in Engineering and Technology), 20 – 21 November 2010, UTAR

5.1.1 Book Publications

- Green Transportation for Future Generation (ISBN: 978-967-5770-08-1)
  - Perpustakaan Negara Malaysia: Cataloguing-in-Publication Data

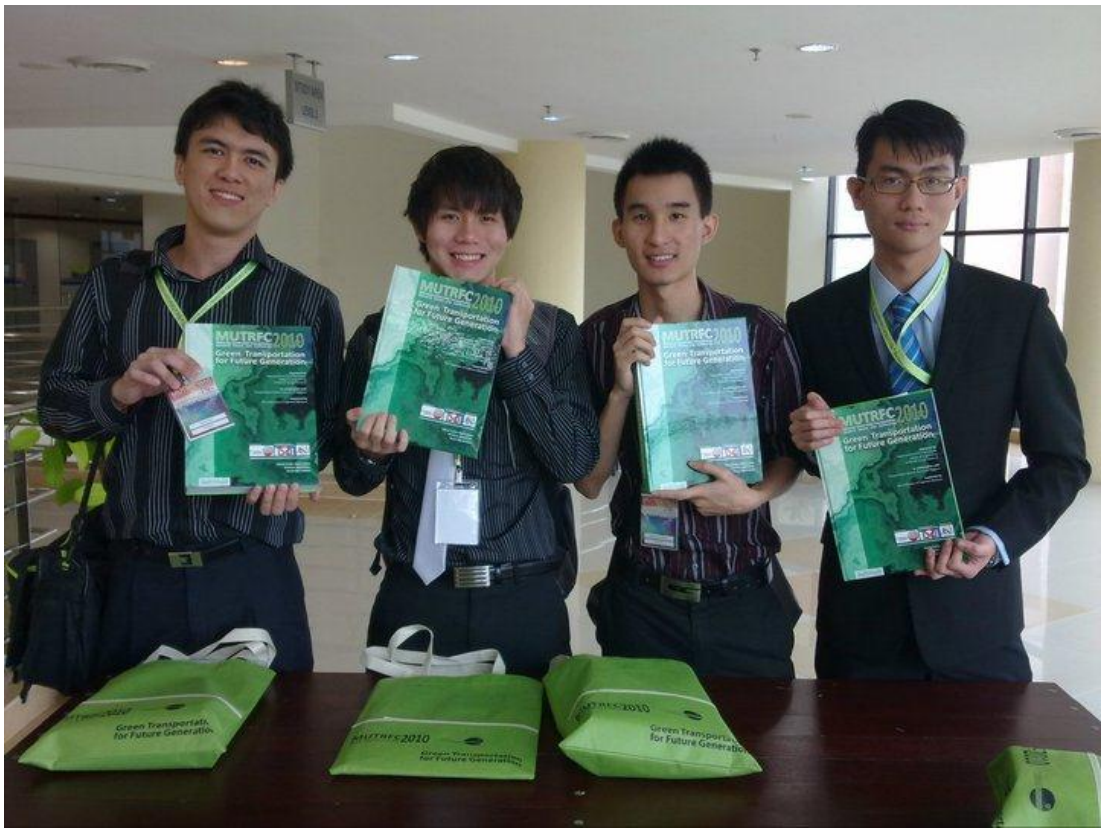


Figure 5-1 MUTRFC publication

❖ IEEE Student 2010 Project Exhibition

Figure 5-2 IEEE Student Exhibition

5.2 Innovate Malaysia Design Competition 2011 (Intel track)

For this project, three of members of our UTAR EV team, Gan Guo Dong, Gan Yu Han and I had participated in the Innovate Malaysia Design Competition 2011 Intel Track during May 2010 by making our final year project as part of the competition. Through this competition we have gained a lot of experience. Some of these experiences may include the Intel platform training at DreamCatcher, Penang in October 2010 for three days and the Preliminary Stage and Hardware Presentation at MSC Malaysia Innovation Centre, Cyberjaya in April 2011. Apart from that, our Utar EV team has also been shortlisted as one of the top 5 teams that made it to the grand finale.

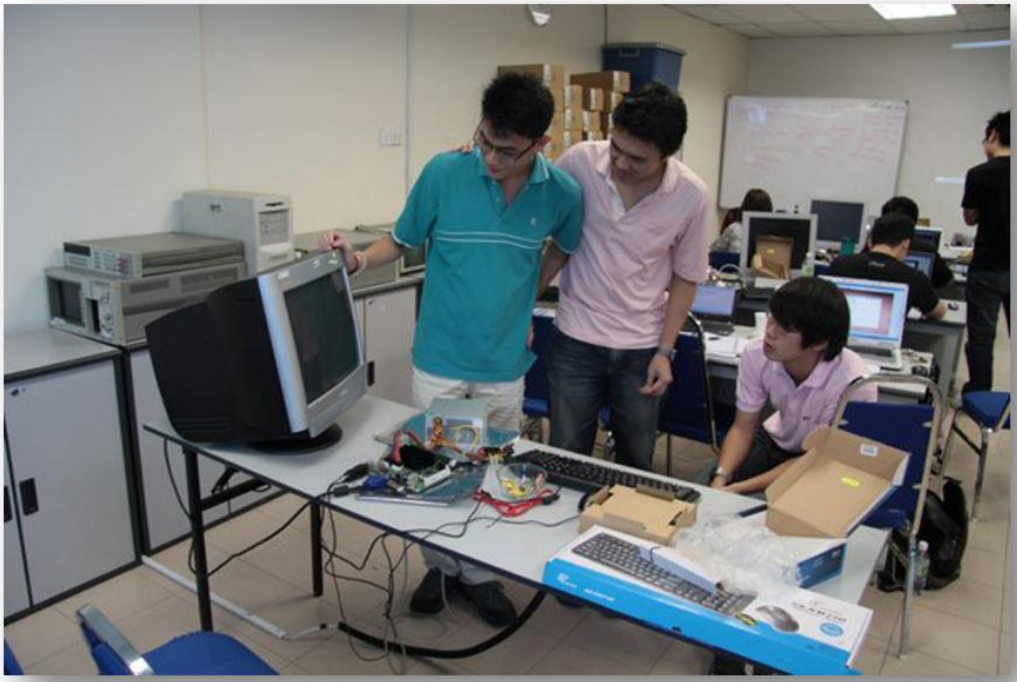


Figure 5-3 Intel platform training October 2010

Figure 5-4 Preliminary Stage and Hardware Presentation April 2011

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 Recommendations

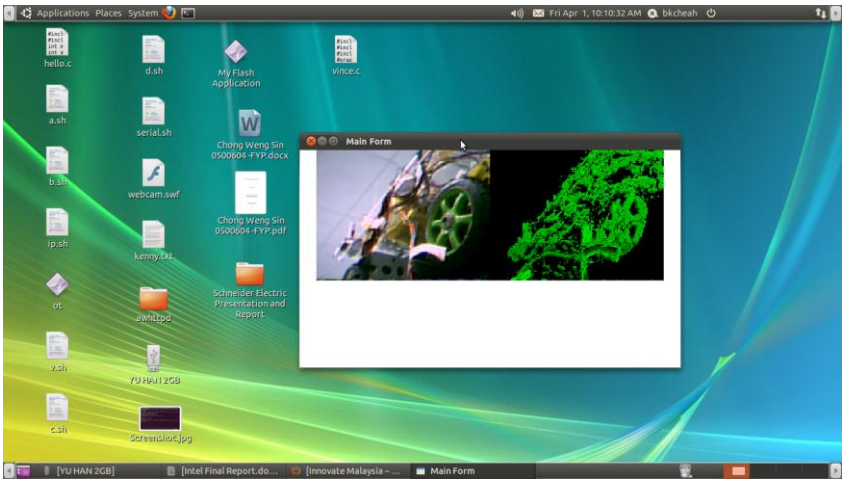


Figure 6-1 webcam application written in action script

In this project, there are lots of rooms for improvements. Webcam application can easily be used to be interfaced to the Intel board for reversed parking utility. On top of that with distance measurement devices, users are not only able to determine how close in terms of visual but more importantly knowing it on the display itself.

Besides that creating a LAN connection for the technicians as a mean to trouble shoot a vehicle effectively and efficiently, one must not only stop over here. Developers should the system connected through the internet. Of course, the

information must be security enable to avoid hackers. Through this idea, technicians from different area are able to provide their suggestion on how to improve the system once they have received a real time data. Apart from that, future developers should also a data logger to keep all the dangerous state information that takes place within the vehicle. With some of these additional features, I believe technicians are able to develop trouble shoot the vehicle better.

Next GPS module can also be integrated into the Intel atom board to improve one's life style. With this, users do not only able to know where they are but more importantly, they are able to determine where is the nearest charging station when they really need one. Besides that, with advancement of technology in the IT area, developers can also look into smart system embedded in vehicle. In this case, the developers can design their system such that the system is able to provide real time information which then enables users to make decision effectively. Those types of information include, parking space availability, LRT expected arrival time, weather forecast, and many more.

6.2 Conclusion

In this project, EVICS at this current stage, it is designed to handle power management system of the vehicle by integrating all those monitoring system together and at the same time perform necessary action once the system detects dangerous area. These monitoring systems include voltage monitoring, current monitoring, temperature monitoring and speedometer. Since this quite is an enormous project, I will be the one fully take charge in software architecture design. In this design, various programming languages had been used as a mean to integrate all the system together. These languages include mcc18 (C programming -PIC), shell script, JavaScript, CSS, HTML and action script. Note that the programming flow in this design is very critical in order to ensure that the system is fully functional.

REFERENCES

Battery Management Systems (BMS) [Battery Management System for EV]. (n.d.). Retrieved July 8, 2010,from Woodbank Communications.Batteries and Energy Storage Magazine (BESTMAG) website: http://www.mpoweruk.com/bms.htm

Dallas Semiconductor. (n.d.). *DS2751 Multichemistry Battery Fuel Gauge* [Data Sheet Specification on DS2751]. Retrieved July 20, 2010, from http://www.alldatasheet.net/datasheet-pdf/pdf/114374/ MAXIM/DS2751.html

Guokai Xu, Xiuchun Zhao, Hang Su, & Zhenqiang Yang. (2008, June 1). [Review of the controller *main and control circuit*]. *A Pulse-width Modulation Based DC-DC Converter for Electric Propulsion, 6*(1), 1-3.

LITHIUM BALANCE A/ S. (n.d.). *Case Study High speed Electric Vehicle* [Lithium Battery Management System]. Retrieved July 17, 2010, from http://www.lithiumbalance.com/attachments/article/88/CaseStudyHighspeedElectricVehiCas.pdf

M J Schofield. (n.d.). *The Controller Area Network (CAN)* [key feature of CAN]. Retrieved July 15, 2010, from http://www.mjschofield.com/

Microchip Technology Inc., T. C., & Microchip Technology Inc., S. D. (n.d.). *"Developing Affordable Mixed-Signal Power Systems for Battery Charger Applications"* [Lithium Ion Charging Profile].
Retrieved July 21, 2010, from http://www.microchip.com/stellent/groups/designcenter_sg/documents/market_communication/en027883.pdf

Mr PenyuBiru ·. (2009, July 20). Proton Saga Ev concept [Online forum message]. Retrieved from http://carca-marba.blogspot.com/2009/07/proton-saga-ev-concept.html

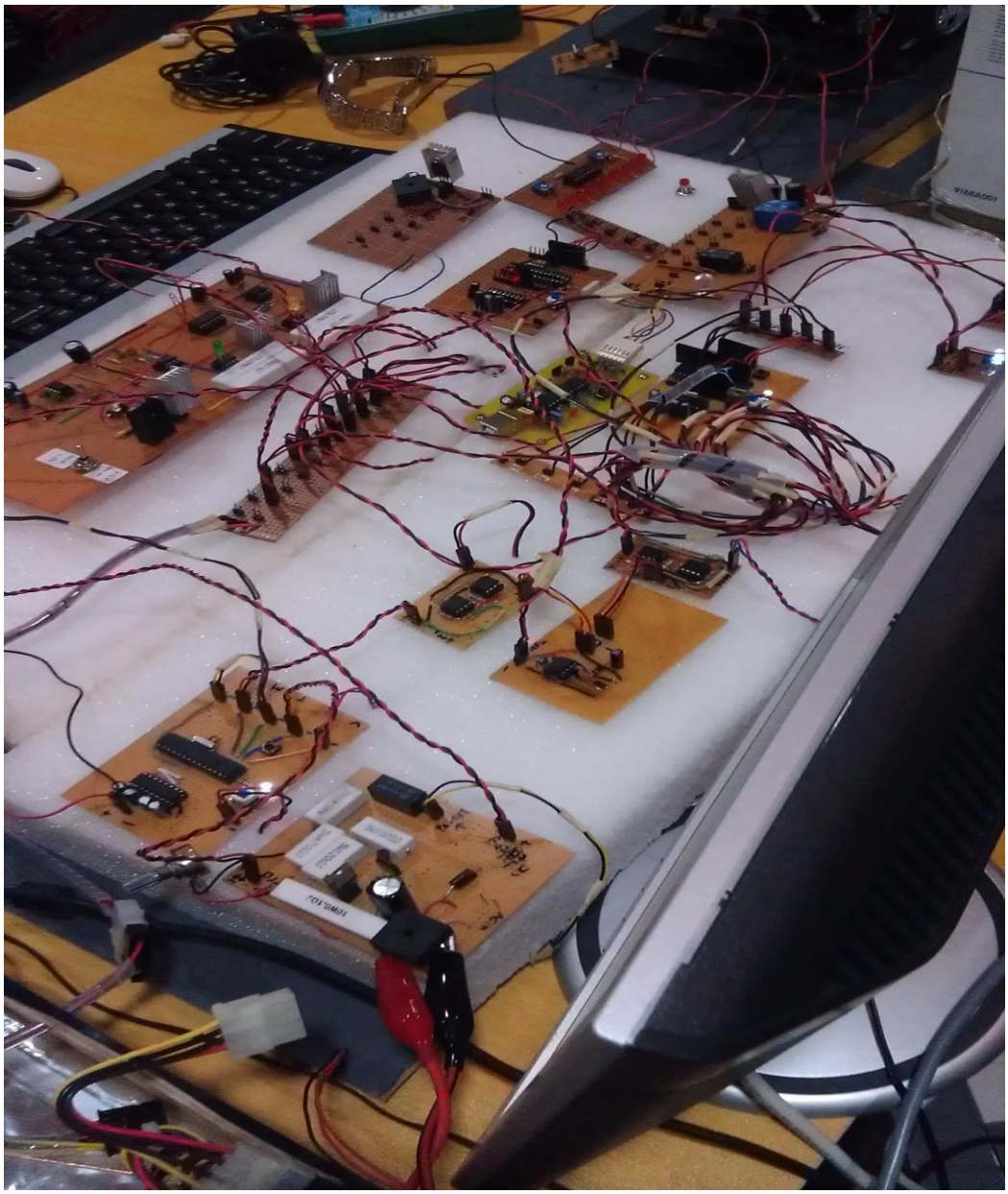
Sandeep Dhameja. (2002). ELECTRIC VEHICLE BATTERY PERFORMANCE. In *ELECTRIC VEHICLE BATTERY SYSTEMS* (p. 133) [Afterword]. (Original work

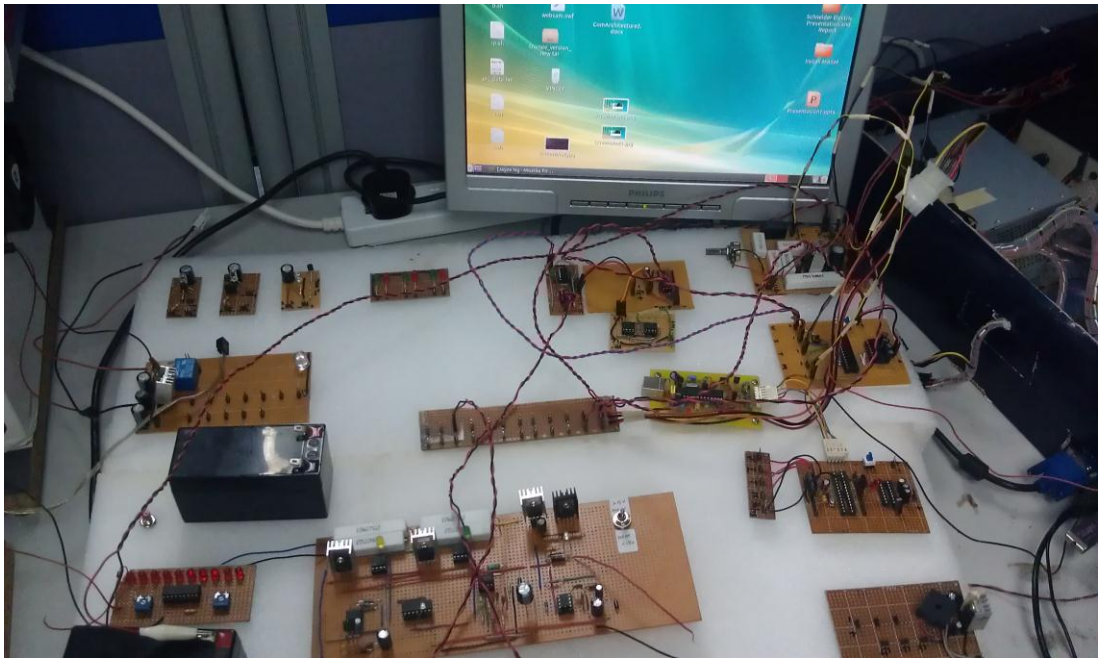
published 2002) Retrieved from http://www.pdfoo.com/ ebook-16617/electric-vehicle-battery-systems.html

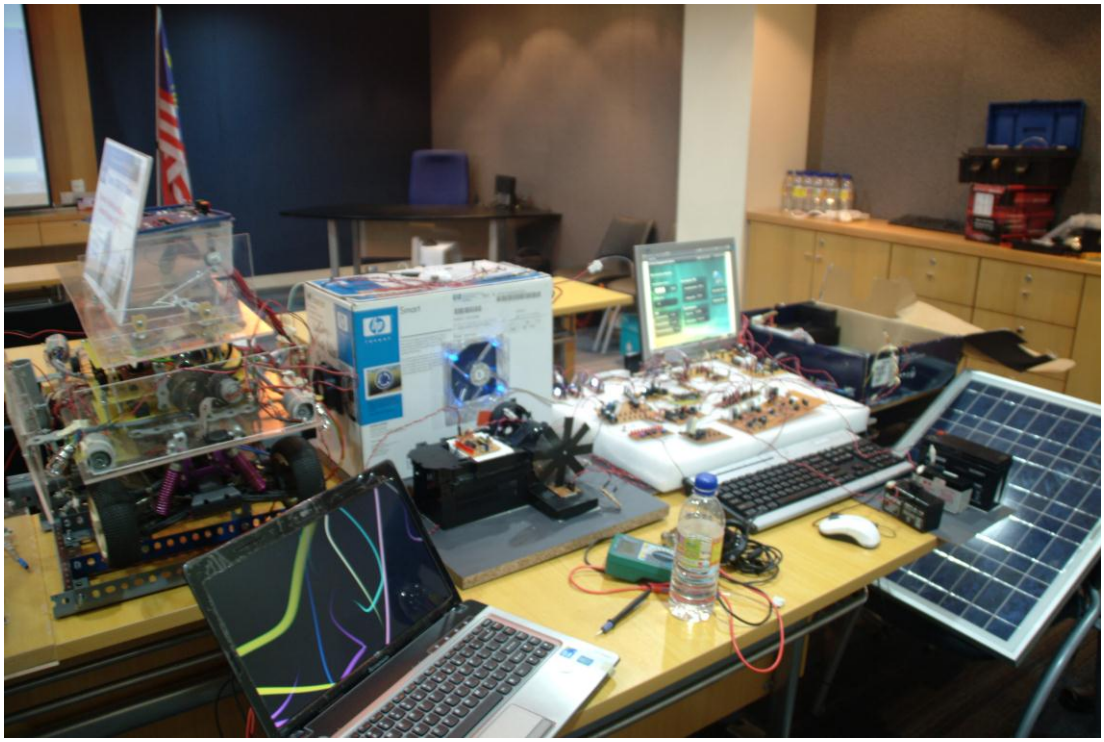
Zanthic Technologies Inc., S. D. L. (2008, June 25). *A low cost Lithium Ion battery management system for a multi-cell, high voltage battery pack* [Low Cost Lithium Battery Management]. Retrieved July 20, 2010, from http://www.zanthic.com/images/ A%20low%20cost%20Lithium%20Ion%20batter %20management%20system.pdf

APPENDICES

APPENDIX A: EVICS Design







APPENDIX B: AS 3.0 GUI Source code

```
/*******************************************
Title: time and date for the top bar
*******************************************/

var myTimer:Timer = new Timer(500);
myTimer.addEventListener(TimerEvent.TIMER,tick);
myTimer.start();
updateTimer();
var daylight:String="AM";


import mdm.*;
mdm.Application.init(this);

function tick(event:TimerEvent):void {
	updateTimer();
	var myXMLLoader:URLLoader = new URLLoader();
	myXMLLoader.load(new URLRequest("playlist.xml"));
	myXMLLoader.addEventListener(Event.COMPLETE, processXML);

	var urlLDR:URLLoader=new URLLoader();
	var urlR:URLRequest=new URLRequest("com.txt");
	urlLDR.addEventListener(Event.COMPLETE,f);
	urlLDR.load(urlR);

	/**
	var myXMLLoader:URLLoader = new URLLoader();
	myXMLLoader.load(new URLRequest("dev.xml"));
	myXMLLoader.addEventListener(Event.COMPLETE, devXML);
```

```
        **/
}

function updateTimer():void{

        var date = new Date();
        /*vince test module 2011*/
        var secs:uint = date.getSeconds();
        var mins:uint = date.getMinutes();
        var hours:uint = date.getHours();
        var day:String = date.getDate();
        var month:String = date.getMonth();
        var year:String = date.getFullYear();
        timetxt.text = hours_check(hours) + ":" + pad(mins)+ ":" + pad(secs) + " "
+daylight;
        //datetxt.text = day + " " + monthconvert(month) + " " + year;
        datetxt.text = monthconvert(month) + " " + day + ", " + year;
}

function hours_check(hours_num:Number){
        var new_num:String;
        if (hours_num > 12){
                hours_num=hours_num-12;
                daylight="PM"
        }
        else
                daylight="AM"
                if (hours_num == 0)
                                hours_num=12;
        new_num=pad(hours_num);
        return new_num;
}

/*converting number into string*/
```

```
function pad(number:Number){
	var new_num:String = String(number);
	if(new_num.length < 2){
		new_num = "0" + new_num;
	}
	return new_num;
}

function monthconvert(month_num:String){
	var month_name;

	switch(month_num){
	case "0" : month_name = "Jan"; break;
	case "1" : month_name = "Feb"; break;
	case "2" : month_name = "March"; break;
	case "3" : month_name = "April"; break;
	case "4" : month_name = "May"; break;
	case "5" : month_name = "June"; break;
	case "6" : month_name = "July"; break;
	case "7" : month_name = "August"; break;
	case "8" : month_name = "Sept"; break;
	case "9" : month_name = "Oct"; break;
	case "10" : month_name = "Nov"; break;
	case "11" : month_name = "Dec"; break;
	default: month_name = "ERROR";
	}
	return month_name;
}



/*******************************************
Title: Time and Date generation
*******************************************/
```

```
var my_songs:XMLList;
var my_total:Number;
var my_sound:Sound;
var my_channel:SoundChannel;
var current_song:Number = 0
var song_position:Number;
var song_paused:Boolean;
var init:Boolean=true;
var my_data:XMLList;// drive <dev>
var dev_total: Number;
var str:String;

function playSong(mySong:Number):void{
var myTitle = my_songs[mySong].@TITLE;
var myArtist = my_songs[mySong].@ARTIST;
var myURL = my_songs[mySong].@URL;

/* songs metadata
title_txt.text = myTitle;
artist_txt.text = myArtist;
*/
if (my_channel){
my_channel.stop();
my_channel.removeEventListener(Event.SOUND_COMPLETE,   onNext);/*remove
listener*/
}

my_sound = new Sound();
my_sound.load(new URLRequest(myURL));
my_channel = my_sound.play();
my_channel.addEventListener(Event.SOUND_COMPLETE, onNext); //jump to next
songs...
}
```

```
pause_btn.addEventListener(MouseEvent.CLICK, onPause);
function onPause(e:MouseEvent):void{
if(my_channel){/*checking channel before exe...20110114*/
song_position = my_channel.position;
my_channel.stop();
song_paused=true;
}
}


next_btn.addEventListener(MouseEvent.CLICK, onNext);
//function onNext(e:MouseEvent):void{
function onNext(e:Event):void{ /*This used to have MouseEvent, change it to Event*/
current_song++;
if (current_song>=my_total){
current_song=0;
}
playSong(current_song);
}


prev_btn.addEventListener(MouseEvent.CLICK, onPrev);
function onPrev(e:MouseEvent):void{
current_song--;
if (current_song<0){
current_song = my_total-1;
}
playSong(current_song);
```

```
}


play_btn.addEventListener(MouseEvent.CLICK, onPlay);
function onPlay(e:MouseEvent):void{
if (song_paused){
my_channel = my_sound.play(song_position);
song_paused=false;
}else if(init){
        playSong(current_song);
        init=false;
}
}


function processXML(e:Event):void {
var myXML:XML = new XML(e.target.data);

my_songs = myXML.SONG;
my_total = my_songs.length();
my_data = myXML.DEV;

//str=my_data[0].@URL;//read from file
//trace(str);
dev_total = my_data.length();

        if (dev_total == 0){
                drive.visible = false;
                gotoAndStop("two");
                save_info.visible=false;
                save_txt.text=""
        }
        else {
                drive.visible = true;
```

```
                save_txt.text="Save info"
                save_info.visible=true;
                save_info.addEventListener(MouseEvent.CLICK,
function(){gotoAndStop("three");
                switch (dev_total){
        case 1 : obj1.visible=true;
                        obj2.visible=true;
                        obj3.visible=false;
                        obj4.visible=false;
                        str=my_data[0].@URL
                        nav1.text=str;
                        nav2.text="Back"
                        obj1.addEventListener(MouseEvent.CLICK,
function(){mdm.FileSystem.saveFile("drive.txt",  my_data[0].@URL );});
                        obj2.addEventListener(MouseEvent.CLICK,
function(){gotoAndStop("one")});
        break;
        case 2 : obj1.visible=true;
                        obj2.visible=true;
                        obj3.visible=true;
                        obj4.visible=false;
                        str=my_data[0].@URL
                        nav1.text=str;
                        str=my_data[1].@URL
                        nav2.text=str;
                        nav3.text="Back"
                        obj1.addEventListener(MouseEvent.CLICK,
function(){mdm.FileSystem.saveFile("drive.txt",  my_data[0].@URL );});
                        obj2.addEventListener(MouseEvent.CLICK,          function()
{mdm.FileSystem.saveFile("drive.txt", my_data[1].@URL );});
                        obj3.addEventListener(MouseEvent.CLICK,
function(){gotoAndStop("one")});
        break;
        case 3 : obj1.visible=true;
```

```
                        obj2.visible=true;
                        obj3.visible=true;
                        obj4.visible=true;
                         str=my_data[0].@URL
                        nav1.text=str;
                        str=my_data[1].@URL
                        nav2.text=str;
                        str=my_data[2].@URL
                        nav3.text=str;
                        nav4.text="Back"
                        obj1.addEventListener(MouseEvent.CLICK,
function(){mdm.FileSystem.saveFile("drive.txt",  my_data[0].@URL );});
                        obj2.addEventListener(MouseEvent.CLICK,
function(){mdm.FileSystem.saveFile("drive.txt",  my_data[1].@URL );});
                        obj3.addEventListener(MouseEvent.CLICK,
function(){mdm.FileSystem.saveFile("drive.txt",  my_data[2].@URL );});
                        obj4.addEventListener(MouseEvent.CLICK,
function(){gotoAndStop("one")});
        break;
        }
                })

        }//end if
}


/*******************************************
Title: scroll bar control
Module: This module reads file that written in a staright line..
*******************************************/

function f(e:Event){
var info:String;
var i:Number;
```

```
var str_status:String;
var str_vehicle:String;
var str_sensor:String;
var str_current:String;
var str_temp:String;
var str_rpm:String;

/*new modifiaction made*/
var temp_1:Number;
var new_result:Number;

/*
string uder modification to suit one needs
bkcheah 20110219
*/
info=e.target.data;
str_status=info.substring(0,1);
str_current=info.substring(1,2);
str_temp=info.substring(2,3);
str_rpm=info.substring(3,5); //2 numbers

//str_current=info.substring(5,7);
//str_temp=info.substring(7,9);
//str_char=info.substring(10,info.length);
//trace(str_status); //disp str;

        /*volatage status and volatge monitoring system*/
        switch(str_status){
        case "1" : movieClip_2.visible = false;
                                movieClip_3.visible = false;
                                movieClip_4.visible = false;
                                movieClip_5.visible = false;
                                movieClip_6.visible = false;
                                batt.text="0%";
```

```
                    vol.text="9.5V";
                    bat.text="0hr"
                    vehicle.text="OK"
                    temp_1=0;
break;
case "2" : movieClip_2.visible = true;
                    movieClip_3.visible = false;
                    movieClip_4.visible = false;
                    movieClip_5.visible = false;
                    movieClip_6.visible = false;
                    batt.text="20%";
                    vol.text="10.5V";
                    bat.text="10hrs"
                    vehicle.text="OK"
                    temp_1=10;

break;
case "3" : movieClip_2.visible = true;
                    movieClip_3.visible = true;
                    movieClip_4.visible = false;
                    movieClip_5.visible = false;
                    movieClip_6.visible = false;
                    batt.text="40%";
                    vol.text="11.4V";
                    bat.text="20hrs"
                    vehicle.text="OK"
                    temp_1=20;
break;
case "4" : movieClip_2.visible = true;
                    movieClip_3.visible = true;
                    movieClip_4.visible = true;
                    movieClip_5.visible = false;
                    movieClip_6.visible = false;
                    batt.text="60%";
```

```
                    vol.text="12.8V";
                    bat.text="35hrs"
                    vehicle.text="OK"
                    temp_1=35;
break;
case "5" : movieClip_2.visible = true;
                    movieClip_3.visible = true;
                    movieClip_4.visible = true;
                    movieClip_5.visible = true;
                    movieClip_6.visible = false;
                    batt.text="80%";
                    vol.text="14.8V";
                    bat.text="55hrs"
                    vehicle.text="OK"
                    temp_1=55;
break;
case "6" : movieClip_2.visible = true;
                    movieClip_3.visible = true;
                    movieClip_4.visible = true;
                    movieClip_5.visible = true;
                    movieClip_6.visible = true;
                    batt.text="100%";
                    vol.text="15.8V";
                    bat.text="65hrs"
                    vehicle.text="OK"
                    temp_1=65;
break;

/*bkcheah special condition*/
case "0" : movieClip_2.visible = false;
                    movieClip_3.visible = false;
                    movieClip_4.visible = false;
                    movieClip_5.visible = false;
                    movieClip_6.visible = false;
```

```
                        batt.text="0%";
                        vol.text="<9.0V";
                        bat.text="0hr"
                        vehicle.text="Dangerous"
                        temp_1=0;
break;


case "7" :   movieClip_2.visible = true;
                        movieClip_3.visible = true;
                        movieClip_4.visible = true;
                        movieClip_5.visible = true;
                        movieClip_6.visible = true;
                        batt.text="100%";
                        vol.text=">17V";
                        bat.text="75hrs"
                        vehicle.text="Dangerous"
                        temp_1=75;
break

}


/*sensor monitoring system*/
/*
switch(str_sensor){
case "0" : sensor.text="OK"
break;
case "1" : sensor.text="System Error" //yet to be modified
                vehicle.text="Dangerous"
break;
}
*/
```

```
/*current monitoring system */
switch(str_current){
        case "0" : cur.text="0.0A"
        break;
        case "1" : cur.text="0.2A"
        break;
        case "2" : cur.text="0.3A"
        break;
        case "3" : cur.text="0.4A"
        break;
        case "4" : cur.text="0.5A"
        break;
        case "5" : cur.text="0.6A"
        break;
        case "6" : cur.text="0.7A"
        break;
        case "7" : cur.text="0.8A"
        break;
        case "8" : cur.text="0.9A"
        break;
        case "9" : cur.text=">1.0A"
                        vehicle.text="Dangerous"
        break;
}

/*temperature monitoring system*/
switch(str_temp){
        case "0" : temp.text="<20"
        break;
        case "1" : temp.text=" 22"
        break;
        case "2" : temp.text=" 27"
        break;
        case "3" : temp.text=" 32"
```

```
        break;
        case "4" : temp.text=" 37"
        break;
        case "5" : temp.text=" 40"
                        vehicle.text="Critical Temp"
        break;
        case "6" : temp.text=">41"
                        vehicle.text="Dangerous"
        break;
}

/*temperature monitoring system*/
switch(str_rpm){
        case "00" : rpm.text="0 RPM"
                                speed.text="0 Km/Hr"
                                new_result=temp_1 * 0;
                                dist.text=pad_str(new_result);
        break;
        case "01" : rpm.text="1030 RPM"
                                speed.text="1.3 Km/Hr"
                                new_result=temp_1 * 1;
                                dist.text=pad_str(new_result);
        break;
        case "02" : rpm.text="3284 RPM"
                                speed.text="4.2 Km/Hr"
                                new_result=temp_1 * 4;
                                dist.text=pad_str(new_result);
        break;
        case "03" : rpm.text="5744 RPM"
                                speed.text="7.4 Km/Hr"
                                new_result=temp_1 * 8;
                                dist.text=pad_str(new_result);
        break;
        case "04" : rpm.text="8279 RPM"
```

```
                    speed.text="10.7 Km/Hr"
                    new_result=temp_1 * 11;
                    dist.text=pad_str(new_result);
break;
case "05" : rpm.text="10915 RPM"
                    speed.text="14.1 Km/Hr"
                    new_result=temp_1 * 14;
                    dist.text=pad_str(new_result);
break;
case "06" : rpm.text="13427 RPM"
                    speed.text="17.4 Km/Hr"
                    new_result=temp_1 * 17;
                    dist.text=pad_str(new_result);
break;
case "07" : rpm.text="15920 RPM"
                    speed.text="20.5 Km/Hr"
                    new_result=temp_1 * 21;
                    dist.text=pad_str(new_result);
break;
case "08" : rpm.text="18510 RPM"
                    speed.text="23.9 Km/hr"
                    new_result=temp_1 * 24;
                    dist.text=pad_str(new_result);
break;
case "09" : rpm.text="21213 RPM"
                    speed.text="27.3 Km/hr"
                    new_result=temp_1 * 30;
                    dist.text=pad_str(new_result);
break;
case "10" : rpm.text="23942 RPM"
                    speed.text="30.9 Km/hr"
                    new_result=temp_1 * 40;
                    dist.text=pad_str(new_result);
break;
```

```
                case "11" : rpm.text="26614 RPM"
                                        speed.text="34.3 Km/hr"
                                        new_result=temp_1 * 34;
                                        dist.text=pad_str(new_result);
                break;
                case "12" : rpm.text="29102 RPM"
                                        speed.text="37.5 Km/hr"
                                        new_result=temp_1 * 38;
                                        dist.text=pad_str(new_result);
                break;
        }



}


/*converting number into string*/
function pad_str(number:Number){
        var new_num:String = String(number);
        new_num = new_num + " "+ "Km";
        return new_num;
}



stop();
xml_player.addEventListener(MouseEvent.CLICK,
function(){gotoAndStop("one")});
xml_exit.addEventListener(MouseEvent.CLICK, function(){gotoAndStop("two")});
```

APPENDIX C: Mplab serial communication source code

```
#include <p18f2550.h>
#include <string.h>
#include <usart.h>
#pragma config WDT = OFF            //watchdog timer off
#pragma config FOSC = HS
#pragma config USBDIV = 2

void send(char);
void init(void);
void main (void)
{
        char data;
        unsigned char battery='a';
        unsigned char current='k';
        unsigned char temp='s';
        unsigned int i,j,k;
        init();
        while(1)
        {

/*********************************************************
MODULE : VOLATGE INDICATOR
CTRL : AN0 [INPUT] RB0 [OUT]
*********************************************************/

                ADCON0=0b00000001;      //AN0
                ADCON0bits.GO_DONE = 1;
                while(ADCON0bits.GO_DONE != 0);/
```

```
                if ( ADRESL < 0xE0 && ADRESH==0b00){
                        //PORTBbits.RB0=0x00;
                        i=0;
//*****************************************************************
**********************
/*      [PROGRAMMING SAMPLING] <USING RB2 TEMP OUTPUT> */
                        if ( ADRESL >= 204 && ADRESL < 224)//1.0
                        battery='q'; //100%
                        else if ( ADRESL >= 183 && ADRESL < 204)//1.0
                        battery='p'; //80%
                        else if ( ADRESL >= 163 && ADRESL < 183)//0.9
                        battery='o'; //60%
                        else if ( ADRESL >= 149 && ADRESL < 163)//0.8
                        battery='n'; //40%
                        else if ( ADRESL >=137 && ADRESL < 149)//0.73
                        battery='m'; //20%
                        else if ( ADRESL >=122 && ADRESL < 137)//0.67
                        battery='l'; //0%

                        else{
                                /*PROTECTION CIRCUIT FOR LESS THAN 9V*/
                                if ( ADRESL < 122){
                                        //PORTBbits.RB0=0xFF;
                                        i=1;
                                        battery='k';
                                }
                                else
                                        i=0;
                                        //PORTBbits.RB0=0x00;
                }////endif
                        }
                else {
                        //PORTBbits.RB0=0xFF;
                        battery='r';
```

```
                i=1;
            }

/*******************************************************
MODULE : CURRENT MONITORING SYSTEM
CTRL : AN1 [INPUT] OUTPUT RB1
*******************************************************/

            ADCON0=0b00000101;      //AN1
            ADCON0bits.GO_DONE = 1;
            while(ADCON0bits.GO_DONE != 0);//Loop here until A/D conversion completes

            if ( ADRESL < 0x14 && ADRESH==0b00){
            //PORTBbits.RB1=0x00;
            j=0;
            if (ADRESL >=0 && ADRESL <3)
            current='a';
            else if (ADRESL >=3 && ADRESL <5)
            current='b';
            else if (ADRESL >=5 && ADRESL <7)
            current='c';
            else if (ADRESL >=7 && ADRESL <9)
            current='d';
            else if (ADRESL >=9 && ADRESL <11)
            current='e';
            else if (ADRESL >=11 && ADRESL <13)
            current='f';
            else if (ADRESL >=13 && ADRESL <15)
            current='g';
            else if (ADRESL >=17 && ADRESL <19)
            current='h';
            else
            current='i';
```

```
        }//endif
        else {
        //PORTBbits.RB1=0xFF;
        j=1;
        current='j';
        }

/*******************************************************
MODULE : TEMPERATURE MONITORING SYSTEM
CTRL : AN2 [INPUT] RB2 [OUT]
*******************************************************/
        ADCON0=0b00001001;      //AN2
        ADCON0bits.GO_DONE = 1;
        while(ADCON0bits.GO_DONE != 0);//Loop here until A/D conversion completes
        if ( ADRESL < 0x54 && ADRESH==0b00){
                //PORTBbits.RB2=0x00;
                k=0;
                if (ADRESL >= 0 && ADRESL < 41)
                temp='s';
                else if (ADRESL >= 41 && ADRESL < 51)
                temp='t';
                else if (ADRESL >= 51 && ADRESL < 61)
                temp='u';
                else if (ADRESL >= 61 && ADRESL < 72)
                temp='v';
                else if (ADRESL >= 72 && ADRESL < 82)
                temp='w';
                else
                temp='x';
        }
        else {
        temp='y';
        k=1;
```

```
                //PORTBbits.RB2=0xFF;
                }
/*********************************************************
MODULE : ACTION CONTROL MODULE
*********************************************************/
        if (i==1 || j==1 || k==1)
                PORTBbits.RB0=0xFF;
        else
                PORTBbits.RB0=0x00;

/*********************************************************
MODULE : COMMUNICATION PROTOCOL
*********************************************************/

                while (PIR1bits.RCIF==0);
           data = RCREG;
                if ( data == 'A' )
                send(battery);
                else if ( data == 'B' )
                send(current);
                else if (data == 'C')
                send(temp);
                else
                        TXREG = data ;

        };

}

void init(void){
        TRISAbits.TRISA0=1;
        TRISAbits.TRISA1=1;
        TRISAbits.TRISA2=1;
        TRISAbits.TRISA3=1;
```

```
        ////////////////////////////////////
        TRISAbits.TRISA4=1;
        TRISAbits.TRISA5=1;
        ////////////////////////////////////
        TRISB=0x0;

        TXSTA = 0x22;
        RCSTA = 0x90;
        SPBRG = 15;

        TXSTAbits.TXEN = 1;
        RCSTAbits.SPEN = 1;


        ADCON1=0b00001010;
        ADCON2=0b10100110;
}

void send(char c){
        while (PIR1bits.TXIF == 0);
        TXREG = c;
}
```

APPENDIX D: Bash Shell script

```
#Author: bkcheah
#Module: obtain flash drive name and song content to be written in playlist.xml
#File name: active.sh
#!/bin/bash

#XML generator

#!/bin/bash
#COLOR CONFIG MODULE ################################
color(){
if [ $1 -eq 1 ];then
echo -en '\E[;32m'"\033[1m$2\033[0m"  #GREEN
elif [ $1 -eq 2 ];then
echo -en '\E[;33m'"\033[1m$2\033[0m"  #YELLOW
elif [ $1 -eq 3 ];then
echo -en '\E[;31m'"\033[1m$2\033[0m"  #RED
fi
}

#DEBUG MESSAGE MODULE ################################
debecho () {
  if [ $2 -eq 1 ];then
    # echo "$1" >&2
    echo -en '\E[;35m'"\033[1m$1\n\033[0m"  >&2
  fi
}

count=0
flag=0
```

```
#SOURCE CODE STARTS HERE
declare -r deb=1            #SETTING FOR DBG_DEBUG
declare -r red=3 yellow=2 green=1

while [ 1 ]
do
        echo `pwd`
        #let count++
        #echo "count: $count"
        dev=`df -h | wc -l`
        let dev-=6
        echo "dev:  $dev"
        if [ $dev -eq 0 ];then

                tmp=$dev
        elif [ "$dev" -ne "$tmp" ];then
                #`$HOME/Desktop/xml_generator.sh`
                #echo "test"
##########################################
: > $HOME/playlist.xml

#`cd /media`
song_name=`find /media . -name "*.mp3"`
rows=`find /media . -name "*.mp3" | wc -l `
#song_name=`find media/ -name "*.mp3" -type f -print`
#rows=`find media/ -name "*.mp3" -type f -print | wc -l`

#echo $song_name

for ((i=0; i<$rows; i++))
do
        tmp=`expr $i + 1`
        TEMP[$i]=` echo -e  "$song_name" | cut -d$'\x0a'  -f$tmp`
done
```

```
#########################################################
# ----------------------display test
for ((i=0; i<$rows; i++))
do
#       echo "${TEMP[$i]}"
        color $green "${TEMP[$i]}"
#       debecho "${TEMP[$i]}" $deb
done
#########################################################

#DESIGN TO BE WRITTEN IN XML FORMAT
echo "<?xml version=\"1.0\" encoding=\"utf-8\"?>" > $HOME/playlist.xml
echo "<PLAYLIST>" >> $HOME/playlist.xml


for ((i=0; i<$rows; i++))
do
        echo "<SONG URL= \"${TEMP[$i]}\">" >> $HOME/playlist.xml
        echo "</SONG>" >> $HOME/playlist.xml
#       debecho "${TEMP[$i]}" $deb
done


###############  PROGRAM ENDS HERE ####################
echo
color $red "program completed written to:"
tput sgr0
color $yellow " $HOME/playlist.xml"

####
file_name=`ls /media`
rows=`ls /media | wc -l`
```

```
debecho "$file_name" $deb

for ((i=0; i<$rows; i++))
do
        tmp=`expr $i + 1`
        TEMP[$i]=` echo -e  "$file_name" | cut -d$'\x0a'  -f$tmp`
done



# ----------------------display test
for ((i=0; i<$rows; i++))
do
        #echo "${TEMP[$i]}" >> $HOME/dev.txt
        echo "<DEV URL= \"${TEMP[$i]}\">" >> $HOME/playlist.xml
        echo "</DEV>" >> $HOME/playlist.xml
done
echo "</PLAYLIST>" >> $HOME/playlist.xml



##############################################
                flag=1
                tmp=$dev
        fi
        if [ $dev -eq 0 -a $flag -eq 1 ];then

################################################
: > $HOME/playlist.xml
################################################

                flag=0
        fi
        sleep 0.25
done
```

#Author: bkcheah

#Module: run active.sh file as an application file

#File name: a.sh

```
xterm -e "bash $HOME/activate.sh; bash"
```

#Author: bkcheah

#Module: communicate with serial communication [send]

#File name: send.sh

```
while [ 1 ];
do
#xterm -e "echo "hello" /dev/ttyS0 > com_data.txt; bash"
echo "A" > /dev/ttyS1 #current monitoring
sleep 0.25
echo "B" > /dev/ttyS1 #voltage monitoring
sleep 0.25
echo "C" > /dev/ttyS1#temperature monitoring
sleep 0.25
echo "D" > /dev/ttyS1#speedometer
sleep 0.25
done
```

#Author: bkcheah

#Module: communicate with serial communication [receive]

#File name: com_serial.sh

```
: > $HOME/com_data.txt  #erase the content of com_data.txt
sleep 1 # delay upon reading module starts up
xterm -e "cat /dev/ttyS1 > com_data.txt; bash"
```

```
#Author: bkcheah
#Module: decode serial for GUI, webserver, and user content (pic_data.txt)
#File name: serial.sh
#File generated: com.txt, pic_data.txt,web.txt

while [ 1 ] #main controller
do
info=`cat com_data.txt`
info_line=`cat com_data.txt | wc -l`

for ((i=0; i<$info_line; i++))
do
        tmp=`expr $i + 1`
        TEMP[$i]=` echo -e  "$info" | cut -d$'\x0a'  -f$tmp`
done

#debug display verificaton test [bkcheah]
for ((i=0; i<$info_line; i++))
do
        echo "temp_data[$i]: ${TEMP[$i]}"
done

#grap the most recent data... [bkcheah 2011]
#echo "${TEMP[(($info_line-1))]}"

# module: modification status
if [ $info_line -gt 3 ];then
        : > com_data.txt #clean file
        echo "${TEMP[(($info_line-1))]}" > com_data.txt
fi

case "${TEMP[(($info_line-1))]}" in
                a)
                        current=0
```

```
        cur=0.0A
;;
b)
        current=1
        cur=0.2A
;;
c)
        current=2
        cur=0.3A
;;
d)
        current=3
        cur=0.4A
;;
e)
        current=4
        cur=0.5A
;;
f)
        current=5
        cur=0.6A
;;
g)
        current=6
        cur=0.7A
;;
h)
        current=7
        cur=0.8A
;;
i)
        current=8
        cur=0.9A
;;
```

```
j)
        current=9 #protective system sctivated
        cur=">1.0A"
;;
k)
        voltage=0
        vol="<9.0V"
;;
l)
        voltage=1
        vol=9.5V
;;
m)
        voltage=2
        vol=10.5V
;;
n)
        voltage=3
        vol=11.4V
;;
o)
        voltage=4
        vol=12.8V
;;
p)
        voltage=5
        vol=14.8V

;;
q)
        voltage=6
        vol=15.8V
;;
r)
```

```
        voltage=7
        vol=">16V"
;;

s)
        temperature=0
        temp="<20"
;;

t)      temperature=1
        temp=22
;;

u)
        temperature=2
        temp=27
;;

v)
        temperature=3
        temp=32
;;

w)
        temperature=4
        temp=37
;;
x)
        temperature=5
        temp=40
;;

y)      temperature=6
        temp=">41"
```

```
;;

#Speedometer starts here..

K)      rpm=00
        rpm_t="0 rpm"
        speed="0 Km/Hr"
;;
L)      rpm=01
        rpm_t="1030 rpm"
        speed="1.3 Km/Hr"
;;
M)      rpm=02
        rpm_t="3284 rpm"
        speed="4.2 Km/Hr"
;;
N)      rpm=03
        rpm_t="5744 rpm"
        speed="7.4 Km/Hr"
;;
O)      rpm=04
        rpm_t="8279 rpm"
        speed="10.7 Km/Hr"
;;
P)      rpm=05
        rpm_t="10915 rpm"
        speed="14.1 Km/Hr"
;;
Q)      rpm=06
        rpm_t="13427 rpm"
        speed="17.4 Km/Hr"
;;
R)      rpm=07
        rpm_t="15920 rpm"
```

```
            speed="20.5 Km/Hr"
        ;;
        S)      rpm=08
            rpm_t="18510 rpm"
            speed="23.9 Km/Hr"
        ;;
        T)      rpm=09
            rpm_t="21213 rpm"
            speed="27.3 Km/Hr"
        ;;
        U)      rpm=10
            rpm_t="23942 rpm"
            speed="30.9 Km/Hr"
        ;;
        V)      rpm=11
            rpm_t="26614 rpm"
            speed="34.3 Km/Hr"
        ;;
        W)      rpm=12
            rpm_t="29102 rpm"
            speed="37.5 Km/Hr"
        ;;
        *)
            echo "Error coding" #bkcheah statement
        ;;
        esac

##################################################
# MODULE: WRITE TO PIC_DATA.TXT [SYSTEM INFORMATION]
##################################################
        echo "voltage $voltage current: $current"
        : > pic_data.txt #clear pic data file <bkcheah>
        echo "Battery Management system" > pic_data.txt
        echo "---------------------------" >> pic_data.txt
```

```
echo "voltage: $vol" >> pic_data.txt
echo "current: $cur" >> pic_data.txt
echo "temperature: $temp" >> pic_data.txt
echo -e "\n" >> pic_data.txt
echo "Speedometer" >> pic_data.txt
echo "----------------------------" >> pic_data.txt
echo "motor rpm: $rpm_t" >> pic_data.txt
echo "vehicle speed: $speed" >> pic_data.txt


#REGENERATION OF THE SYSTEM
: > $HOME/awhttpd/default/evteam/web.txt
echo "$vol" > $HOME/awhttpd/default/evteam/web.txt
echo "$cur" >> $HOME/awhttpd/default/evteam/web.txt
echo "$temp" >> $HOME/awhttpd/default/evteam/web.txt

################################################
# MODULE: WRITE TO A FILE UNDERSTOOD BY AS 3.0
################################################

#voltage=3
echo $voltage$current$temperature$rpm > com.txt
#echo $voltage > com.txt


`sleep 0.25` #quater of a second ...
done
```

#Author: bkcheah
#Module: as an application file to start up webserver application after rebooting
#File name: web.sh

```
xterm -e "cd $HOME/awhttpd/; ./awhttpd . ; bash"
#xterm -e "./awhttpd .; bash"
```

```
#Author: bkcheah
#Module: copy utility behind the scene of BMS GUI
#File name: drive_reader.sh


while [ 1 ]
do
        name=`cat drive.txt`
        name="$name/"
        char_num_check=`cat drive.txt | wc -m`

        if [ $char_num_check -ne 0 ];then

        #echo "copied to $name"
        #data manipulation starts here
        num=$((`echo $name |sed 's/[^ ]//g'|wc -m`-1)) #space counter
        echo "[@@] $name | num of space : $num"

        let num++

        for ((i=0; i<$num; i++))
        do
      tmp0=`expr $i + 1`
      TEMP[$i]=`echo "$name" | cut -d\  -f$tmp0 `
        done

        # vince dislay module
        ##############################################
        for ((i=0; i<$num; i++))
        do
        echo "vince_test_value[$i]: ${TEMP[$i]}"
        done
        ##############################################
```

```
        str=""
        str_1="" #original string
        (( rev=$num-1 ))
        #echo "rev : $rev"

        for((i=0;i<$rev;i++))
        do
                str_1="${TEMP[$i]}"
                str="$str$str_1\ "

        done
        str="$str${TEMP[$rev]}"

        ## display module to check for the link
        echo "final test [@@@] /media/$str"
        echo "test: $((`echo $str |sed 's/[^ ]//g'|wc -m`-1))"

        #ready to be sent to the module and modified
        `cp $HOME/pic_data.txt /media/$str`

        : > drive.txt
        fi
        sleep 0.25
done
```

APPENDIX E: Webserver application

```
#Author: bkcheah
#Module: obtain vehicle information every 1 second
#File name: ev.cgi
# File location: /home/bkcheah/awhttpd/default/evteam


echo "Content-type: text/html"
echo -e "\r\n"

# webserver application starts here
url="http://192.168.0.102:8384/evteam/ev.cgi"

# system specification
name="Cheah Beng Keat"
ic="880423-22-1133"
num_plate="PGC 2147"
h_phone="016-4220005"

cat << 'EOF'
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
EOF

echo "<SCRIPT LANGUAGE=\"JavaScript\">"
echo "myPopup = ";"
echo "function openPopup(url) {"
```

```
echo "myPopup = window.open(url,'popupWindow','width=640,height=480');"
echo "if (!myPopup.opener)"
echo "myPopup.opener = self;"
echo "}"
echo "</SCRIPT>"
echo "<meta http-equiv=\"refresh\" content=\"1;url=$url\" />"

cat << 'EOF'
<title>Smart Management System</title>
</head>
<body>
<h1>vehicle profile:</h1><table width="305" border="1">
  <tr>
    <td width="84">Name </td>
EOF

          echo "<td width=\"205\">$name</td>"

cat << 'EOF'
  </tr>
  <tr>
    <td>IC</td>
EOF

    echo "<td>$ic</td>"

cat << 'EOF'
  </tr>
  <tr>
    <td>Num plate</td>
EOF

   echo "<td>$num_plate</td>"
```

```
cat << 'EOF'
  </tr>
  <tr>
    <td>H/P</td>
EOF

echo "<td>$h_phone</td>"

cat << 'EOF'
  </tr>
</table>
<p> </p>
<h1>Battery monitoring status:</h1>
EOF

#power management system starts over here
info=`cat $HOME/awhttpd/default/evteam/web.txt`
info_line=`cat $HOME/awhttpd/default/evteam/web.txt | wc -l`


for((i=0;i<$info_line;i++))
do
        #tmp= `expr $i +1`
        (( tmp = i + 1))
        TEMP[$i]=` echo -e "$info" | cut -d$'\x0a' -f$tmp`
done

#disp test
#for((i=0;i<$info_line;i++))
#do
#       echo "temp_data[$i]: ${TEMP[$i]}"
#done

# Table Generation
```

```
echo "<table border=1>"
        echo "<tr>"
        echo "<td align=center width=200><font face=Georgia color=blue><b>Date</b></font></td>"

        echo "<td align=center width=100><font face=Georgia color=blue><b>voltage</b></font></td>"
        echo "<td align=center width=100><font face=Georgia color=blue><b>Current</b></font></td>"
        echo "<td align=center width=100><font face=Georgia color=blue><b>Temperature</b></font></td>"
        echo "</tr>"

# 2nd row
echo "<tr>"
        echo "<td align=center width=200><font face=Georgia color=black><b>`date +%c`</b></font></td>"
        echo "<td align=center width=100><font face=Georgia color=black><b>${TEMP[0]}</b></font></td>"
        echo "<td align=center width=100><font face=Georgia color=black><b>${TEMP[1]}</b></font></td>"
        echo "<td align=center width=100><font face=Georgia color=black><b>${TEMP[2]}</b></font></td>"
echo "</table>"
echo "</tr>"

echo "<br>"
cat << 'EOF'
 <style type="text/css">
 input {
 font-size: 18pt;
          }
</style>
EOF
```

```
echo "</body>"
echo "<FORM>"
echo "<INPUT TYPE=\"BUTTON\" VALUE=\"vehicle past status\" onClick=\"openPopup('ev_1.cgi')\">"
echo "</FORM>"
echo "</html>"
```

#Author: bkcheah
#Module: obtain vehicle past records
#File name: ev_1.cgi
 # File location: /home/bkcheah/awhttpd/default/evteam

```
#!/bin/bash
# author: bkcheah

echo "Content-type: text/html"
echo -e "\r\n"

#define absolute path
path="$HOME/awhttpd/default/evteam/intel.txt"
url="http://192.168.0.102:8384/evteam/ev_1.cgi"

cat << 'EOF'
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>

<title>Untitled Document</title>
</head>
<body>
```

```
<h1>Vehicle record:</h1>
<FORM NAME="myform" action="ev_1.cgi" method="get">

EOF

#control element
#echo "<br>"
#echo "\$@ = $@"
#echo "<br>"
#echo "\$? = $?"
#echo "<br>"
#echo "QUERY_STRING = $QUERY_STRING"
#echo "<br>"
#echo "QUERY_STRING_POST = $QUERY_STRING_POST"
#echo "<br>"
#echo "REMOTE_ADDR = $REMOTE_ADDR"
#echo "<br>"
#echo "HTTP_HOST = $HTTP_HOST"
#echo "<br>"
#echo "SERVER_PORT = $SERVER_PORT"
#echo "<br>"
#echo "SCRIPT_NAME = $SCRIPT_NAME"
#echo "<br>"
#echo "REQUEST_METHOD = ${REQUEST_METHOD}"
#echo "<br>"
#echo "CONTENT_LENGTH = ${CONTENT_LENGTH}"
#echo "<br>"

rows=`cat  $path| wc -l`
data=`cat $path`
#num_rows=$((`echo $data|sed 's/[^&]//g'|wc -m`-1)) #And Counter
#(( num_data = num_rows + rows ))
((t_row=rows/4))
```

```
for((i=0;i<$rows;i++))
do
        tmp=`expr $i + 1`
      TEMP[$i]=` echo -e  "$data" | cut -d$'\x0a'  -f$tmp`
      #TEMP[$i]=` echo -e  "$data" | cut -d$\&  -f$tmp`

done

#for((i=0;i<$rows;i++))
#do
#       echo "LINE ${TEMP[$i]}"
#       echo "<br>"
#done

echo "<table border=1>"
 echo "<tr>"
echo "<td align=center width=100><font face=Georgia color=blue><b>check to delete</b></font></td>"
echo "<td align=center width=100><font face=Georgia color=blue><b>Date</b></font></td>"
 echo "<td align=center width=300><font face=Georgia color=blue><b>Name</b></font></td>"
 echo "<td align=center width=300><font face=Georgia color=blue><b>Company's name</b></font></td>"
echo "<td align=center width=500><font face=Georgia color=blue><b>Comment</b></font></td>"
echo "</tr>"

    new1=3
    tmp1=0

    for((i=0;i<$t_row;i++))
    do
    echo "<tr>"
```

```
                echo "<td><input type=\"checkbox\" name=\"checkbox\" value=\"$i\"></td>"
                    for ((j=$tmp1; j<=$new1; j++))
                do
                    if [ "${#TEMP[$j]}" -ne 0 ]; then
                    echo "<td align=center><font face=\"Courier New\"><b> "${TEMP[$j]}" </b></font></td>"
                    else
                    echo "<td><font face=\"Courier New\"><b>"""${TEMP[$j]}"<br>""</b></font></td>"
                    fi
                done
                    (( tmp1+=4 ))
                    (( new1+=4 ))


    echo "</tr>"
    done

      echo "</table>"

##### additional feature
num=$((`echo $QUERY_STRING|sed 's/[^&]//g'|wc -m`-1)) #And Counter

data_num=`expr $num + 1`


#----------------------------cut the '&' and '=' --------------------
for ((i=0; i<$data_num; i++))
do
    tmp0=`expr $i + 1`
    TE[$i]=`echo "$QUERY_STRING" | cut -d\& -f$tmp0 `
done
```

```
for ((i=0; i<$data_num; i++))
do
	tmp0=`expr $i \* 2`
	for ((j=1; j<3; j++))
	do
		data_arr[$tmp0]=`echo "${TE[$i]}" | cut -d= -f$j`
		tmp0=`expr $tmp0 + 1`
	done
done

k=0
for ((i=0; i<$data_num; i++))
do
	let j=2*i+1
	arr[$k]="${data_arr[$j]}"
	let k++
done


## disp control logics ##
#echo "<br>"
#for((i=0;i<$k;i++))
#do
#	echo "${arr[$i]}"
#	echo "<br>"
#done
#########################

flag2=1

for ((i=0; i<$t_row; i++))
do
		for ((k=0; k<$data_num && $flag2; k++))
		do
```

```
                if [ "${arr[$k]}" = "$i" ]; then
                #echo "vince : ${arr[$k]}, $i <br>"
                flag=1
                flag2=0
                else
                #echo "test: ${arr[$k]}, $i <br>"
                flag=0

                fi
        done
        flag2=1
        if [ $flag -eq 1 ]; then
                #echo "no print for $i "
                :
        else
                #echo "print for $i"
                        #temp=`expr $i + 4`
                a[$n]=$i
                        #b[$n]=$temp
                let n++
        fi
done

echo "<br>"
#################################
#for((i=0;i<$n;i++))
#do
#       echo "[!!!] ${b[$i]} | ${a[$i]}"
#       echo "<br>"
#done

first="${arr[0]}"
if [ ${#first} -ne 0 ]; then
: > $path
```

```
for((i=0;i<$n;i++))
do
        temp=${a[$i]}
        (( low = 4*temp ))
        (( upper = low+3 ))

        #echo "$low | $upper"
        #echo "<br>"
        for((j=$low;j<=$upper;j++))
        do
                        echo "${TEMP[$j]}" >> $path
        done
done
 echo "<meta http-equiv=refresh content=\"0;url=$url\">"

fi

##############################
echo "<br>"
cat << 'EOF'
<style>
 input {
 font-size: 18pt;
       }
</style>
<INPUT TYPE="submit" VALUE="Delete" style="height: 3em; width: 5em" >
</form>
<br>
<form method="link" action="ev_2.cgi">
<input type="submit" value="Add remark to vehicle record">
</form>
</body>
</html>
EOF
```

```
#Author: bkcheah
#Module: Inserting vehicle records
#File name: ev_2.cgi
# File location: /home/bkcheah/awhttpd/default/evteam

#!/bin/bash
echo "Content-type: text/html"
echo -e "\r\n"

path=$HOME/awhttpd/default/evteam/intel.txt

#echo "<br>"
#echo "\$@ = $@"
#echo "<br>"
#echo "\$? = $?"
#echo "<br>"
#echo "QUERY_STRING = $QUERY_STRING"
#echo "<br>"
#echo "QUERY_STRING_POST = $QUERY_STRING_POST"
#echo "<br>"
#echo "REMOTE_ADDR = $REMOTE_ADDR"
#echo "<br>"
#echo "HTTP_HOST = $HTTP_HOST"
#echo "<br>"
#echo "SERVER_PORT = $SERVER_PORT"
#echo "<br>"
#echo "SCRIPT_NAME = $SCRIPT_NAME"
#echo "<br>"
#echo "REQUEST_METHOD = ${REQUEST_METHOD}"
#echo "<br>"
#echo "CONTENT_LENGTH = ${CONTENT_LENGTH}"
#echo "<br>"

cat << 'EOF
```

```
<html>
<head>
<SCRIPT LANGUAGE="JavaScript">

//controlling textbox
function textCounter(field,cntfield,maxlimit) {
if (field.value.length > maxlimit)
field.value = field.value.substring(0, maxlimit);
else
cntfield.value = maxlimit - field.value.length;
a}

function check (a)
{

      if ( a != 0 )
      {
      var message="Error message";
      var count="\nplease fill in all the text fields";
      display=message+count
      alert(display);
      }

}

function call(){
         alert("File Successfully written");
}

</script>


<meta http-equiv="Content-Type" content="text/html; charset=windows-1252" />
```

```
<title>vehicle content</title></head>
<body>
<script type=text/javascript>
check(0,0,0,0);
</script>
<script type=text/javascript>
file(0,);
</script>
<h1>vehicle profile</h1>
EOF

string_length=${#QUERY_STRING}

num=$((`echo $QUERY_STRING|sed 's/[^&]//g'|wc -m`-1)) #And Counter

data_num=`expr $num + 1`

#cut the '&' and '='
for ((i=0; i<$data_num; i++))
do
	tmp0=`expr $i + 1`
	TEMP[$i]=`echo "$QUERY_STRING" | cut -d\& -f$tmp0 `
done

for ((i=0; i<$data_num; i++))
do
	tmp0=`expr $i \* 2`
	for ((j=1; j<3; j++))
	do
		data_arr[$tmp0]=`echo "${TEMP[$i]}" | cut -d= -f$j`
		tmp0=`expr $tmp0 + 1`
	done
done
```

```
#----------display the result ------------------------------
#for ((i=0; i<`expr $data_num \* 2`; i++))
#do
#       echo "<br>"
#       echo "vince_test_value: ${data_arr[$i]}"
#done
#-------------------------------------------------------------

(( total=$data_num*2 ))
counter=0

if [  $string_length -ne 0 ]; then
        for ((i=1; i<=3; i++))
        do
                (( j=2*i+1 ))
                temp="${data_arr[$j]}"
                if [ ${#temp} -eq 0 ]; then
                let counter++
                fi

        done
fi

echo "<script type="text/javascript">"
echo "check($counter);"
echo "</script>"


#condition to be check
t_name="${data_arr[1]}"
t_name=`echo ${t_name//+/ }`
```

```
date_day=`date +%e`
date_month=`date +%m`
date_year=`date +%y`
t_date="$date_day-$date_month-$date_year"

# company name
t_company="${data_arr[3]}"
t_company=`echo ${t_company//+/ }`
#echo "company_name: $t_company"
#echo "<br>"

# comment statement
t_word="${data_arr[5]}"
t_word=`echo ${t_word//'%0D%0A'/ }`
t_word=`echo ${t_word//+/ }`
#echo "mesg: $t_word"

if [ ${#t_name} -ne 0 -a ${#t_company} -ne 0 -a ${#t_word} -ne 0  ]; then

        echo "<script type="text/javascript">"
        echo "call();"
        echo "</script>"

        echo "$t_date" >> $path
        echo "$t_name" >> $path
        echo "$t_company" >> $path
        echo "$t_word" >> $path
fi


cat << 'EOF'
<form name="myForm"
action="ev_2.cgi"
method="get">
```

```
 <table width="312" border="0">
   <tr>
   <th width="83" scope="row">Name:</th>
   <td width="219">
<input type="text" name="textfield1" value="" />
</td>
 </tr>
</table>
<table border="0">
 <tr>
   <th scope="row">Company's name:</th>
   <td ><input type="text" name="textfield2" /></td>
 </tr>
</table>
<table width="312" border="0">
 <tr>
<th scope="row">Comment:</th>
   <td width="240" rowspan="2"><textarea name="message1" wrap="physical"
cols="28" rows="5"
onKeyDown="textCounter(document.myForm.message1,document.myForm.remLen
1,125)"
onKeyUp="textCounter(document.myForm.message1,document.myForm.remLen1,1
25)"></textarea>
     <br>
     <input readonly type="text" name="remLen1" size="3" maxlength="3"
value="125">
characters left <br></td>
 </tr>
 <tr>
   <th width="89" scope="row"><p> </p>
     <p> </p></th>
 </tr>
</table>
```

```
<table border="0">
  <tr>
    <th scope="row">Dated Event:</th>
EOF
    echo "<th scope=\"row\">$t_date</th>"
cat << 'EOF'
  </tr>
</table>
<br>
<br>

 <style type="text/css">
 input {
 font-size: 18pt;
            }
</style>

<input type="Submit" name="Submit" value="Submit">
</form>
<form action="ev_1.cgi">
<input type="Submit" value="back to the vehicle record ">
</form>
</body>
</html>
EOF
```