DISSERTATION

LINUX BASED APPLICATION LAYER FOR VEHICLE BASED ROAD/ENVIRONMENT CONDITION WARNING SYSTEM USING VEHICLE AD-HOC NETWORK (VANET)

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ABSTRACT

Road accidents kills a lot of people. With recent development in the transportation industry, a lot of vehicles are produce everyday for road usage. The development of the vehicle now focuses more on the efficiency of the vehicle and the safety of user and the surrounding. Safety is one important factor that helps selling this vehicle. To increase the safety of the vehicle, many vehicle manufacturers has implement new safety features like air-bags, electronic braking system and many mores. Not to forget the basic safety feature which is the safety belt or also called seat belt. These safety feature will not help reduce road accidents but it helps minimising the damage done to people inside a vehicle.

Prevention is better that cure. An english proverb that means it is better to try stop a thing from happening than to fix it when it happened. From other point view, we can make do something to prevent road accident but the safety features cannot be neglected as it reduced the damage. Collisions on the road can be avoided if the driver is warned a few moments between the collision.

This study is focusing on the wireless communication between vehicle in order to warn the driver about dangerous situation ahead so that the driver can react accordingly. This is also include analysing dangerous condition while driving to aid the system send a warning message to other driver.

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ABBREViATION AND NOMENCLATURES:

VANET	-	Vehicle Ad-hoc Network
V2V	-	Vehicle-to-Vehicle
V2I	-	Vehicle-to-Infrastructure
IEEE	-	Institute of Electrical and Electronics
DSRC	-	Dedicated Short Range Communication
WAVE	-	Wireless Access in Vehicular Environmnet

Chapter 1: Project Background

1.1 Background of study

Communication is the exchange of information from one person to another. Human communicates to each other in many ways. With improved technologies, human can easily communicated even when they are separated by distance. Nowadays, scientists and researchers are developing a new means of communication for vehicle that is known as Vehicular Ad-Hoc Network (VANET). VANET uses wireless network to transmit and receive data between vehicle.

In this project, VANET is use to transmit information from a vehicle to another vehicle in order to alert the driver concerning the condition of the road ahead to increase safety and traffic flow. This will help to avoid traffic accidents and improve the transportation system.

Sensors are use to detect the current condition of a particular car and is transmitted to the car behind that are approaching in the same direction/road. The sensors help receive information of the environment and detect the wether the car is decelerating, or it is raining at the car current location and transmit to the vehicles behind as a warning to increase awareness of the driver. An application layer is used to locate the car's movement and location using a Global Positioning System (GPS) device. The application the sent the information or warning messages to other vehicles using VANET to alert the drivers approching the area.

1.2 Problem Statement

The number of road accidents and death cause by accidents involving vehicles is increasing. This occurence will not stop increasing as the number of cars registered is rapidly increasing.

The mass increasing of cars will not help in decreasing the number of accidents that occurs. Many actions had been done by the government to minimise the number of accidents. There are many factors that contribute to road accidents beside from human mistakes and carelessness. Some of the factors are mechanical issue, road condition, environment condition and poor road design. By implementing a vehicle networking system, it helps the drivers communicate and receive information that could help in reducing the number of road accidents.

1.3 Objectives

The purpose of this project is to develop an application that can warn driver in the vehicle on the surrounding road/environment condition and send it to other vehicle. This is to prevent accident by giving the driver enough time to react to the warning received accordingly.

- To design a warning system application with graphical user interface
- To send information to other vehicle about the road/environment condition

1.4 Scope of Study

These are the scope of study for the Final Year Project.

- Study about the Vehicular Ad-Hoc Network
- Study about Intelligent Transport System
- Java Programming using Netbeans IDE
- Study the implementation of Java for Windows and Linux platform.

1.5 Relevancy of the Project

Study made on the project shows that Vehicle Ad-Hoc Network (VANET) is widely being developed and improved as it will encourages more application that can fully utilised VANET.

Chapter 2: Literature Review

2.1 INTELLIGENT TRANSPORT SYSTEM

Nowadays, transportation system is becoming more complex due to the growth of economy and increasing car usage. So a proper intelligent transport system is important to manage the traffic to avoid any accidents from occuring.

In this context, vehicle itself played a very important role in the Intelligent Transport System. By having a vehicle that is capable of collecting information of the environment and the driver condition and providing necessary feedback such as assisting vehicle control and passing information to the driver. . The intelligent vehicle will function on tactical level of driving supported by multitude of onboard informative sources and also external information sources received from other vehicles, assisting the driver [1]. The common scenario that the ITS has to accomodate is as below.

Attribute	Rural	Urban	City	Highway
Speed	Low	Medium/High	Low/Very Low	Very High
Vehicles Density	Low	Medium	Very High	Medium/Low
Interference	Low	Medium	Very High	Low
Infrastructure	Low	Medium	Very High	Medium/Low

Table 1: General communication condition analysis [8].

2.2 Wireless Technology

Over the past year, the technology in wireless communications has improved so much. The development of wireless technology helps in terms of portability, efficiency and economically. Most of the device now have wireless technologies such as the Wireless Local Area Network (WLAN). WLAN uses the 802.11 standard from Institute of Electrical and Electronics Engineer (IEEE) [19].

WLAN provide a very reliable connection. Everywhere in the world there will be an access point that is easily accessible. The network connectivity is also very reliable as it can support up to 300 Mbps of bandwidth (802.11n).

There is also a system created specially for vehicle communication which the the Dedicated Short Range Communications. DSRC provide communication service in a short or medium range for vehicle to communicate with other vehicle near it or to an infrastucture.

The most recent wireless technology developed for vehicle communication and network are known as Wireless Access in Vehicular Environment (WAVE). WAVE system is also based on the 802.11p standards form IEEE. WAVE provide high speed communications, internet access and safety enhancements from the previous systems.

WAVE functions in a way that vehicle is connected to other vehicle and to a infrastructure on the road side. It is known as V2V (vehicle-to-vehicle communications) and V2I (vehicle-to-infrastructure communications).
The protocol stack of all these systems is shown below

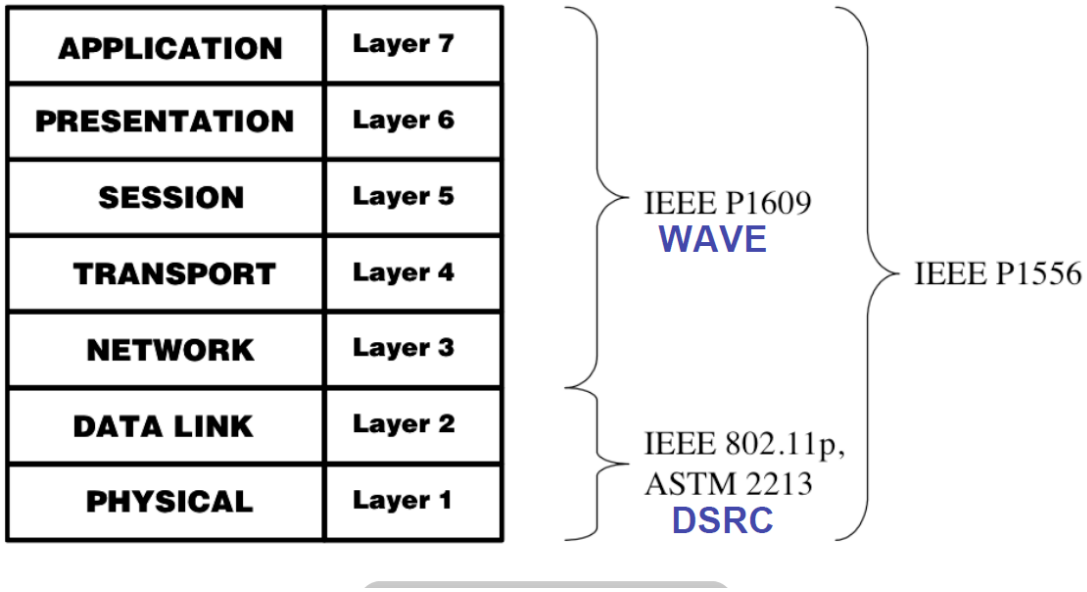

Figure 1 : Protocol Stack [10]

All the vehicles is connected through a dedicated network or the intenet through wireless links. The infrastructure which is also known as the road information infrastructure is connected to many local road areas network which is connected wired or wireless to the internet. This allow communication to cover a large area and a lot of vehicle will be connected. The figures below describe the V2I connection and V2V connection.

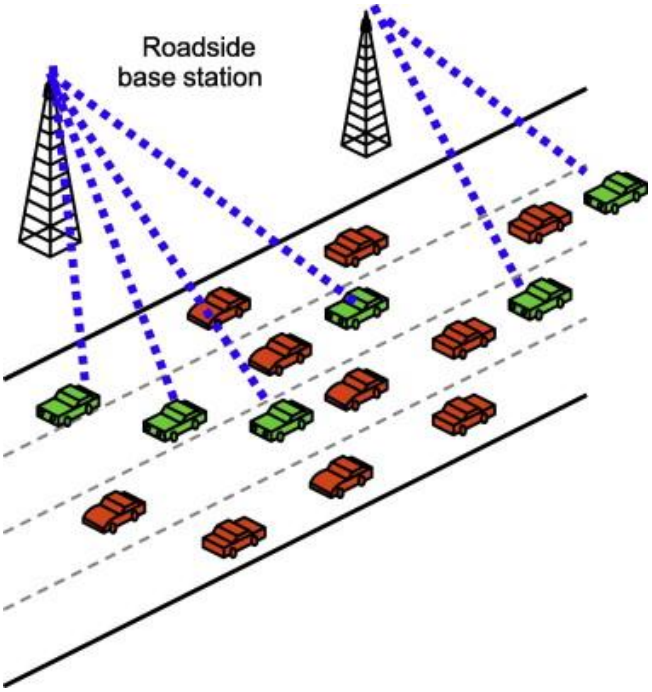

Figure 2 : V2I Communication

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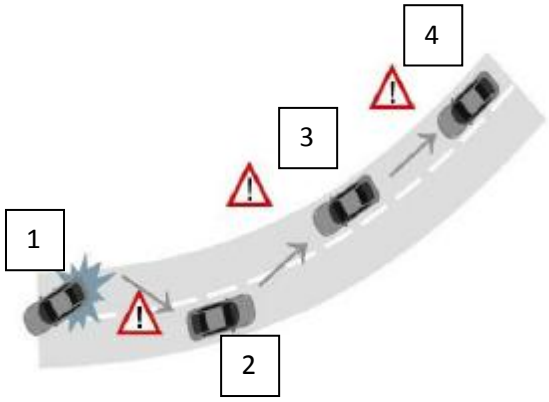

Figure 3 : V2V Communication [11]

For V2I communication, vehicle are connected to an infrastructure known as the road side unit (RSU). By communicating like the figures above, the car number 4 can react faster to the emergency situation that happen at the first car. In normal condition, when there in no information sharing using WAVE, it will take approximate 1second for the 4th car to notice the emergency on the first car. This will also depends on the reaction of the driver on car number 3. With wave, car

number 4 will directly receive information at the time of emergency and will have more time to react to the emergency.

The WAVE protocal architecture with its major components is shown in figure below.

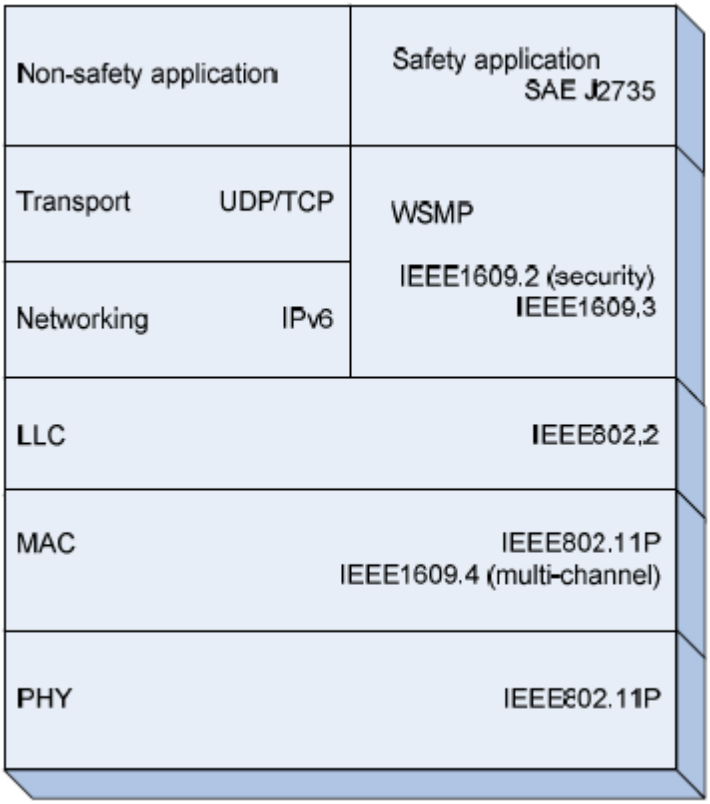

Figure 4 : The WAVE Protocol Stack and Its Associated Standards [10]

2.3 CVIS Technology

Another application of VANET, Cooperation Vehicle Infrastructure Systems (CVIS) is also developed with similar aims to VANET. It focused to the interaction between vehicles and infrastructures to provide all information that can incrase road safety and efficiency to transport system.

2.4 JAVA in LINUX

Many development of VANET and CVIS was implemented in LINUX based platform. CVIS software architecture was also developed based on LINUX platform. So, UBUNTU, one of LINUX distributor is chosen for developing this project as it is possible as it is developed before. UBUNTU is also a free open-source software can run JAVA runtime environmnent for the project [9]. With JAVA, the application can be run multiple platforms such as Windows and Mac for future development.

2.4 Information Gathered From Vehicle

There are many situation that occurs when driving are vehicle. We cannot predict when or where an accident will occur. One of the best way to prevent accident is to take precaution at certain situation. So, by gathering information on the environment/situation and displaying and relaying the message, this may help in giving faster reaction to people to avoid car accident. The information that need to acquired by the vehicle in order the transmit the warning message are as follows:

Road Condition	Mechanism
Emergency Brake	Speed sensor or speedometer is use to detect the sudden drop of speed
Slippery Road	A sensor is put a the wheel to detect the sudden change drop of rpm of the tyre. Whenever the rpm of the tyre drop it will compare with the change speed of speed. If the speed remain constant that will give output of slippery road
Car Impact	Speed sensor or speedometer is use to detect the sudden drop of speed and a circuit to compare it with the airbag signal.
Poor Visibility	Fog sensor is applied on the vehicle.

Table 2 : Road Condition and Mechanism

Chapter 3: Methodology

3.1 Research Methodolgy

1. Gather resources on VANET

Study more information on VANET. The resources can be obtain from journals, research paper, and books.

2. Choice of Sensors to Collect Required Data

Study on the sensors that are going to be used to collect the information from vehicle

3. Protocol Analysis and Simulation Studies

Investigate the best protocol to be used in transferring

4. Protocol and Application Design and Development

Design of application on linux-based system to display the gathered data

5. Sensors Simulation Circuit Building

Design a simulation circuit to represent the sensor that are going to be implemented in the vehicle

6. Sensors integration

Another project that is applicable to this project is running concurrently with this project. The project focuses on data acquisition of the vehicles being experimented. These data includes the data from the sensors need to be implemented in the hardware for it to monitoring and information analysis.

7. Experiment and test bed measurements

Different cases and scenarios was used to test in order to obtain many variables outcome. Compare the test results with the simulated scenarios results. The compared data will be use for future upgrade or modification

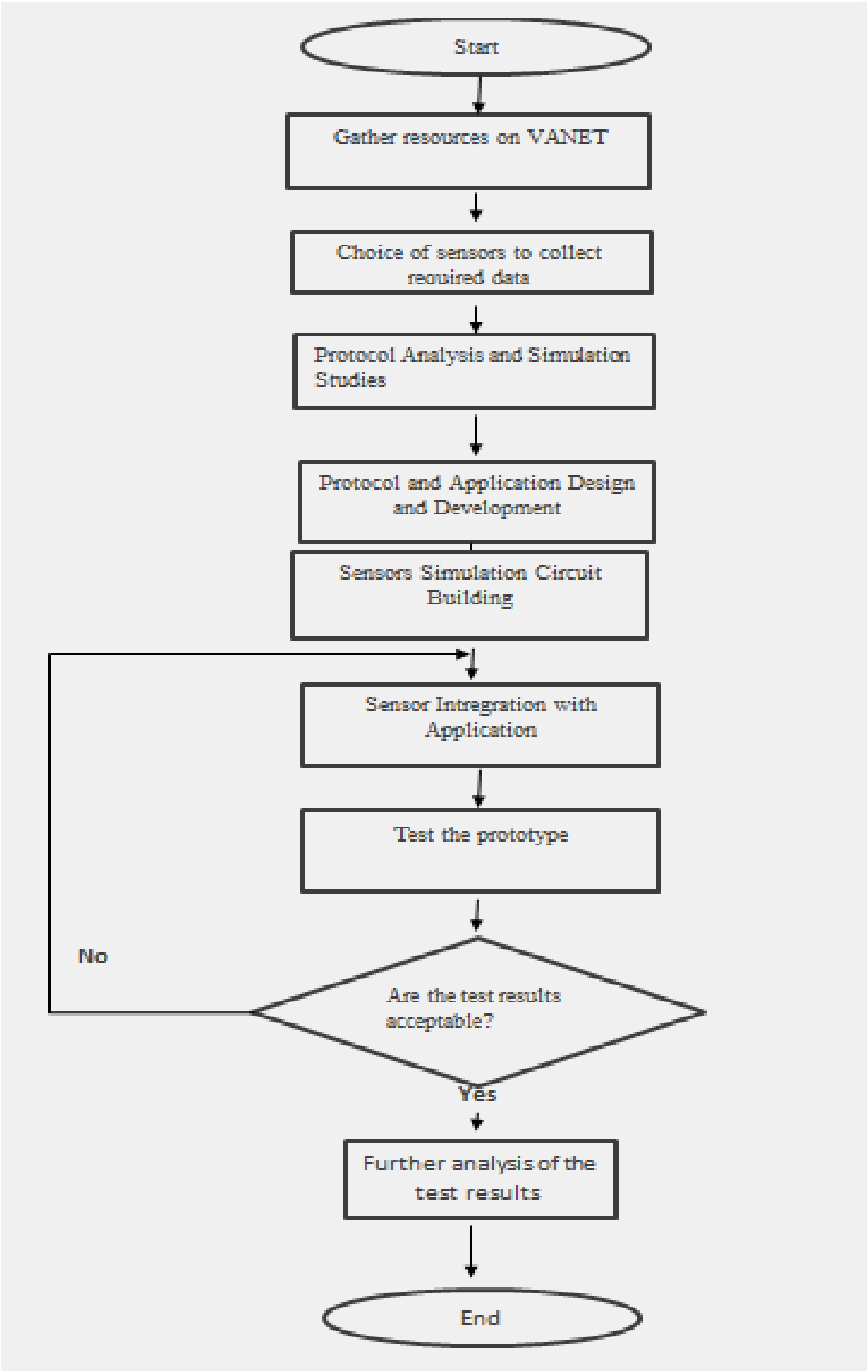

Figure 5 : Flow Chart of Project

3.2 Tools required

i. A linux-based platform
ii. A gps receiver
iii. Netbeans IDE software

3.3 Gantt Chart and Key Milestone

No	Detail / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Order and buy components														
2	Simulation Circuit Building and Sofware Developing														
3	Progress report														
4	Sofware Improvement and Circuit Improvement														
5	Test and Completion														
6	Pre-EDX														
7	Viva														
8	Final Report														

Table 3: Gantt chart for the first semester project implementation

Processes

Milestones

Chapter 4 : FINDINGS

4.1 APPLICATION-BASED GUI WARNING SYTEM

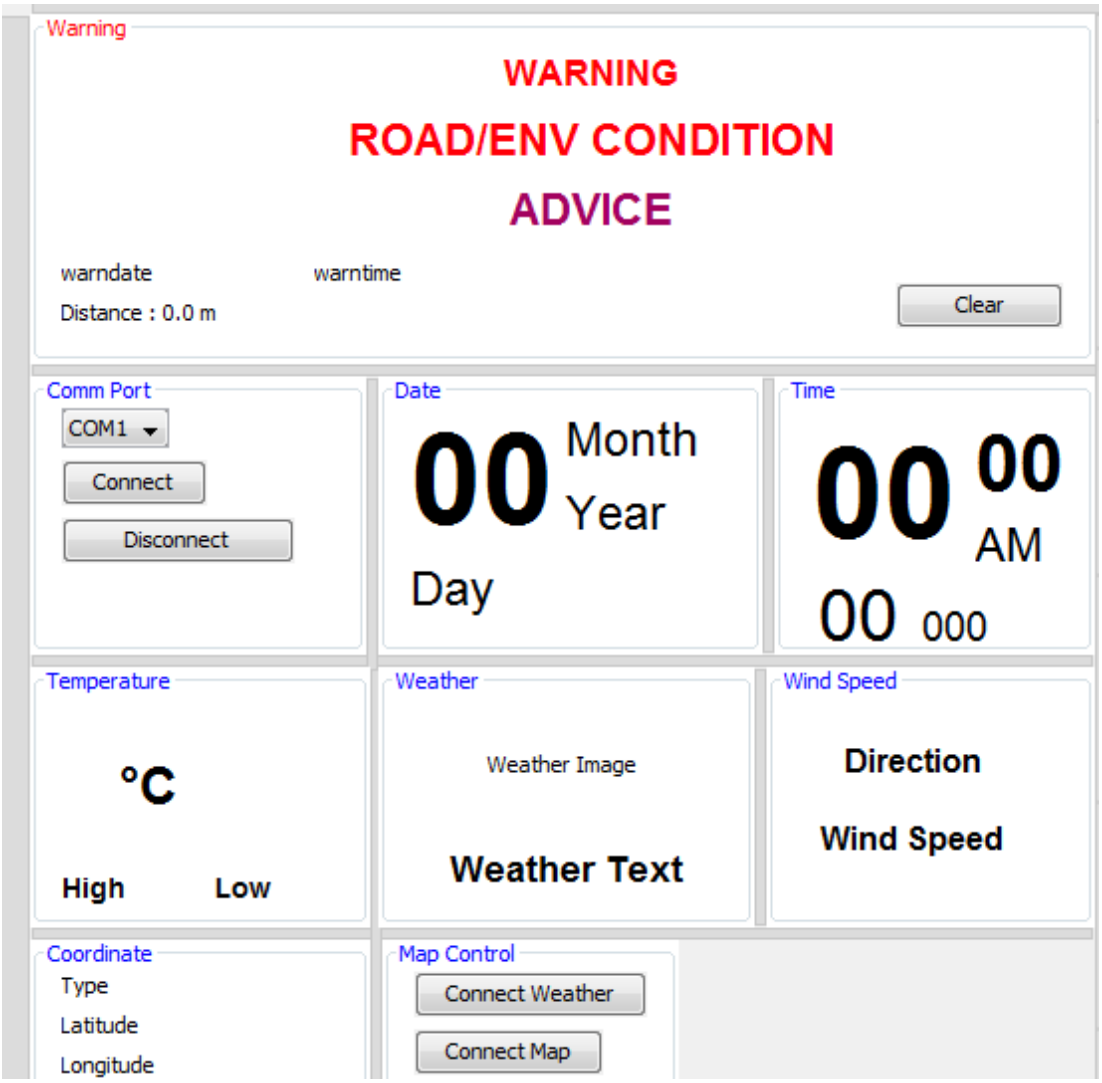

Figure 6 : Application warning system

The GUI have a few signifance part that provide information to the user about the warning system and the basic information such as time and location. The date and time section fetch data from the computer and display it on the GUI.

The temperature and weather section works by retrieving data from Google Weather API. The application send its current coordinate to get the weather and temperature of the location and display it on the program.

The coordinate section works by receiving coordinate from a GPS sensor connected to the computer via usb. The comm port section helps to connect and disconnect the GPS device

JAVA is capable to retrieve data directly from the Internet. The exact working of map retrieval processes is quite different compared with the weather information retrieval due to the difference of information formatting. This is currently under development.

GPS is used to retrieve the position of the car. The information is then processed to calculate several values such as the speed of the car. This is currently under development.

To transmit the data across a network, several protocols needed to be addressed. This is currently under development.

4.2 Software Simulation Design

Car Speed and Tyre Rotational Speed Input

For software simulation, we are using 4 ADC input to represent the rotation speed of the car. Another on ADC input is used to control all 4 others ADC input to represent as the constant speed of the moving vehicle. This is similar to getting the speed from the speedometer sensor. In all five of the ADC input, we used a variable resistor to vary the value of current to represent the changing signal of the rotation sensor and the speedometer from the vehicle.

Fog and Moisture Sensor

As for testing purposes, simple bit switch is used to represent the signal. On switch is consider as there are fog and moisture are detected.

Signal Processing

A PIC microcontroller 16F877A will be used as to received the signal and to provide output of the situation. A simple truth table is created to show the result from the rotational sensor and the speedo meter. C programming is used to processed the input and displaying our desired output.

Rotation Sensor on Suspension Line	Speedometer Circuitry	Results
0	0	Nothing Happened
0	1	Emergency Brake
1	0	Slippery Road
1	1	Loss Control of the Car

Table 4 : Truth Table on Sensor and the Results

Output Display

A simple light emitting diode is used to display the output of the circuit. A few LED is used to display the ouput Each LED is labeled as the result for every results from the combination of the table.

CHAPTER 5 : RESULT AND DISCUSSION

APPLICATION-BASED GUI WARNING SYSTEM

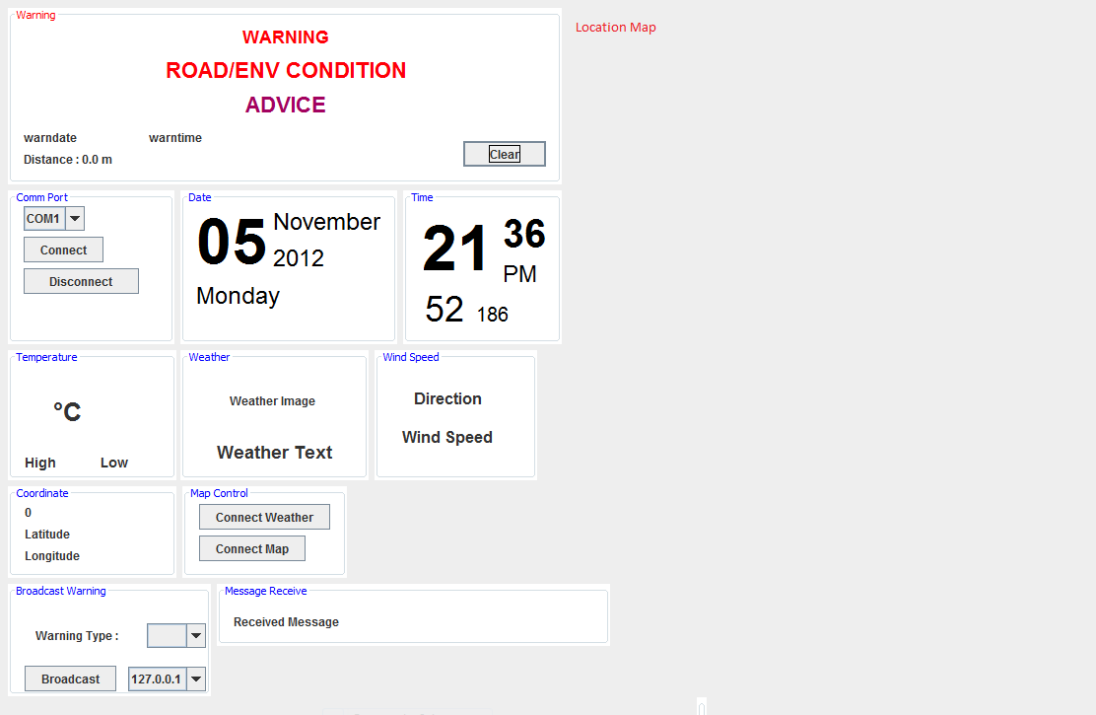

Figure 7 : Application Warning Sytem

The current development of the GUI add a significant improvement by including location map which will displayed on the right side of the interface. The map is imported online from google maps.

The table below shows the warning that will be display by the interface based on the the condition.

Road/Environment Condition	**Warning Display**
Fog	Reduced visibility
Rain	Slippery Road
Snow	Icy Road

Table 5 : Road Condition and Warning

Software Simulation Design

Circuits for the simulation are prepared but with only one analog signal to represent the speed of the cat. The analog signal is generated using a variable resistor that are change based on the speed of a car. Lower resistance will represent as lower speed while higher resistor represent higher speed. In the circuit below, the variable resistor is represent by the name RV1

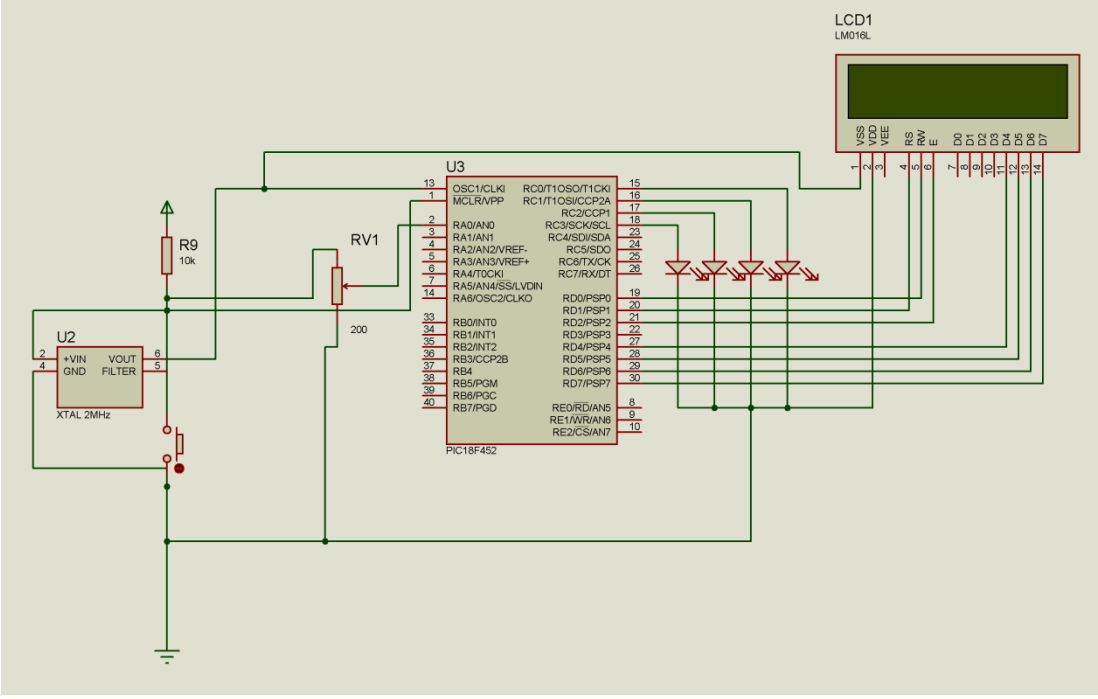

Figure 8 : Circuit of simulation

The PIC microcontroller 16F877A is used to connect the resistor value as the input and the LCD as the output. The LCD display is used to display the value of the resistor to determine the value its representing.

The programming code of the PIC is as below:

```
#include <lcd.c>
#use fast_io(d)
void main()
{
  unsigned int x,i;
  float voltage;
  setup_adc_ports(AN0_AN1_VSS_VREF);
  setup_adc(ADC_CLOCK_DIV_2);
  set_adc_channel(0);
  setup_psp(PSP_DISABLED);
  setup_spi(FALSE);
  setup_wdt(WDT_OFF);
  setup_timer_0(RTCC_INTERNAL);
  setup_timer_1(T1_DISABLED);
  setup_timer_2(T2_DISABLED,0,1);
  setup_timer_3(T3_DISABLED|T3_DIV_BY_1);
  set_tris_D(0x00);
  while(1)
  {
  for(i=0; i<=30; ++i) {
      delay_ms(30);
      x = Read_ADC();
          }
voltage = x * 0.0196;
  lcd_init();
  printf(lcd_putc,"input:%u",x);
 lcd_gotoxy(2,2);
 printf(lcd_putc,"volt:%f",voltage);
 if(x>= 192)
   {
   output_high(PIN_D4);
   output_high(PIN_D5);
   output_high(PIN_D6);
   output_high(PIN_D7);
   }
 else if (x>= 128 && x < 192)
    {
   output_high(PIN_D4);
   output_high(PIN_D5);
   output_high(PIN_D6);
   output_low(PIN_D7);
    }
 else if (x>= 64 && x < 128)
   {
   output_high(PIN_D4);
   output_high(PIN_D5);
   output_low(PIN_D6);
   output_low(PIN_D7);
    }
```

```
   else if (x>= 26 && x < 64)
      {
     output_high(PIN_D4);
     output_low(PIN_D5);
     output_low(PIN_D6);
     output_low(PIN_D7);
      }
else if ( x< 26)
     {
     output_high(PIN_D4);
     output_low(PIN_D5);
     output_low(PIN_D6);
     output_low(PIN_D7);
     delay_ms(100);
     output_low(PIN_D4);

     }



  }
}
```

CHAPTER 6 : RECOMMENDATION AND CONCLUSION

Recommendation

More input are going to be included in the Truth Table as to more sensor is needed for the project. If more sensor are used and there are more results that can be obtained we can improve the overall project effectiveness. The same PIC 16F877A can be used for sending the signal from the circuit to the application.

Conclusion

The programming of the GUI is compiled with some error. The application send the data to other device running the same application. The program is working but cannot be tested with many application running at the same time due to limited resources

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Appendix

Appendix I: PIC16F87X Datasheet

MICROCHIP

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

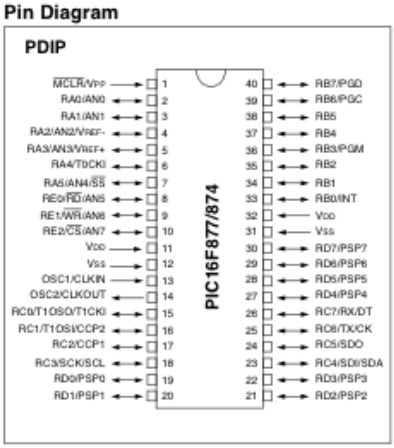
- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and
  Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low power, high speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial, Industrial and Extended temperature ranges
- Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

Pin Diagram

PDIP

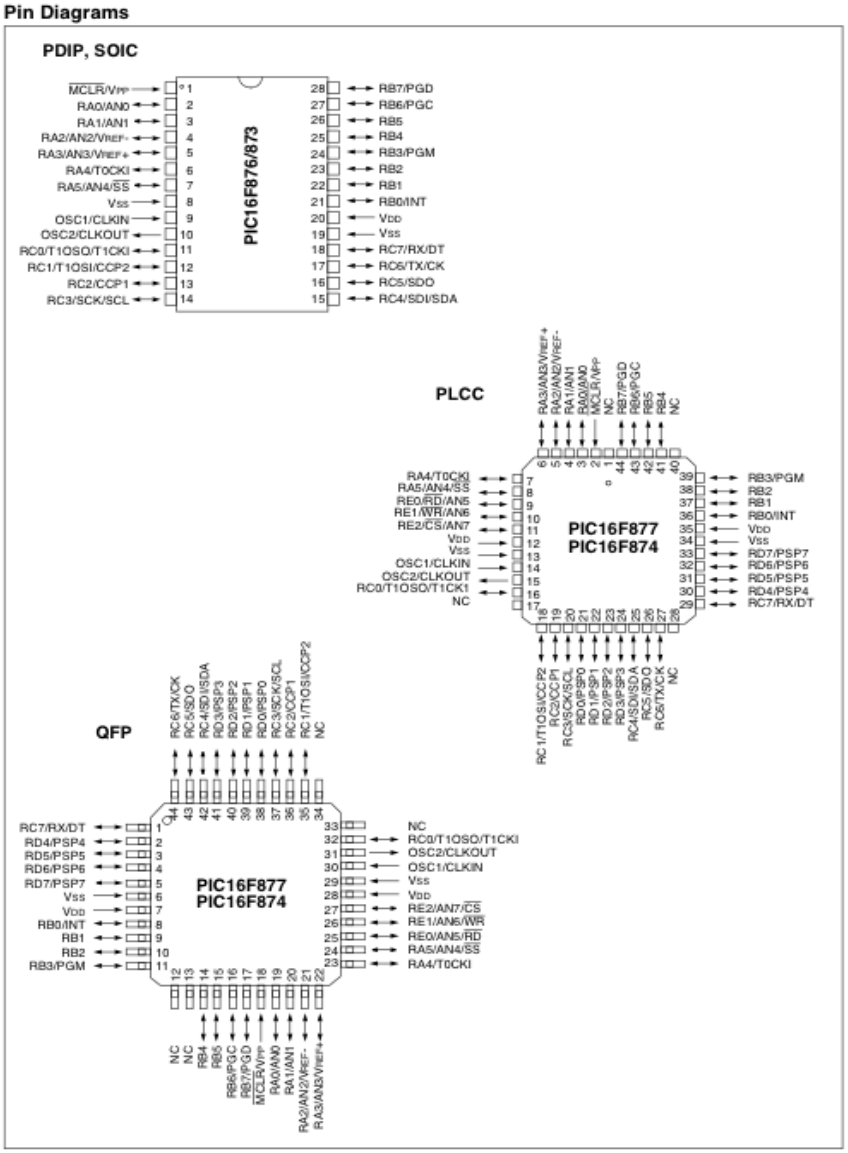


Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I²C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Source: Microchip Technology Incorporated @ 2001

Pin Diagrams



Source: Microchip Technology Incorporated @ 2001