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Design and Implementation of Data Logger for Vehicle Safety

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Abstract:

As the rising of transportation system design, so many data logger design was developed for safety. In our country, there are many accidents on highways. Both driver's faults and road construction cause accidents. To reduce these condition some safety system such as obstacle detection system, vehicle declination alarm system, temperature and smoke level display unit, signboard warning on road sides should be used for both driver and passengers. In addition data logger system for whole vehicle must be equipped for safety. With the implementation of PIC microcontroller as an Embedded device, this logger design was constructed with many sensors and C# service-based database. Using Arduino boards, vehicle detection sensing circuit, Check point radio signal sensing circuit for dangerous road sector, hall-effect magnetic wheel revolution sensing circuit were designed to be connected with main PIC microcontroller and Personal Computer. Real time result was displayed on C# Graphical User Interface and Vehicle data log could be easily exported to Microsoft Excel report.

Keywords -**Arduino, alarm and alert system,C# service-based database, PC based control system, Vehicle data logger.**

I. INTRODUCTION

The vehicle accident is a major public problem in many countries, particularly Myanmar. Despite awareness campaign, this problem is still increasing due to driver's poor behaviours such as speed driving, drunk driving, driving without sufficient sleep, etc. The numbers of death and disability are very high because of late assistance to people who got the accident. These cause huge social and economic burden stop people involved. Therefore, several research group and major vehicle manufacturers have developed safety devices to protect drivers and passengers from accidental injuries. However, good safety device for vehicles is difficult to implement and very expensive. On the roadway driver usually keep a safety distance from one another. On the other hand, due to the driver's interruption, long-time driving tiredness, or a sudden break applied by another car, a serious collision may occur. Even though the driver is in a conscious mind, he cannot respond immediately to control his/her vehicle. Sometimes crash may occurs due to bad weather situations as mist, vapour, fog and so on. Many cases remain pending due to unknown reason of an accident [1].For vehicle safety and safety for passengers in vehicle is an important parameter. Most of the vehicles get accident because no proper safety measures are taken especially at curves and hair pin bends humps and any obstacles in front of the vehicle [2].Vehicle is the first place where safety starts. Hence we must try to equip it with the latest technologies and measures to make it a safe machine and also to keep our self and our loved ones safe. Always remember that safety starts and ends with the person who drives the vehicle. The cars and trucks found today have high range of inbuilt safety accessories to protect their passengers. Before it used to be just seatbelts, but now more features have been included which are more advanced and efficient than seatbelts. Warning alerts and alarms are other security systems incorporated in the cars and trucks to alert us about various factors like exceeding speed limit or smoke alarms. These are designed to make the passengers aware of crossing the limitations which is important in most of the time and in most cases. In the same way here an

embedded system has been designed to make the journey of the passengers inside a vehicle safe and secure with various recently found safety and security measures [3].

There are different types of vehicle control systems that have no flexibility over choosing the types and number of sensors used. These systems are rebuilt devices with a limited number of sensors, with a limited area of coverage and with a limited capacity to control the electronic devices. Therefore the idea of vehicle control system was proposed, to overcome the limitations of the system already available. The user can choose the number of sensors, type of sensors, the area of coverage of the system along with the number and types of electronic devices to be controlled. The cost of the system can be determined by the user as the cost depends on the hardware in the system.

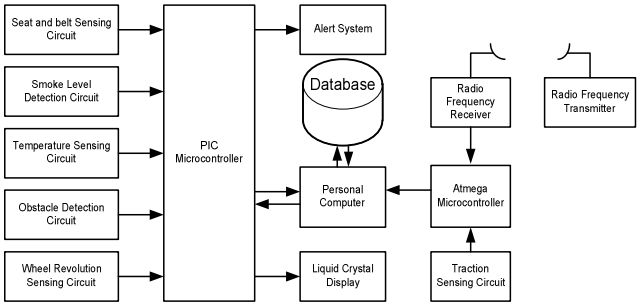


Fig.1. Block Diagram of Vehicle ControlSystem

The block diagram of vehicle control system shown in Fig.1 is for overall design of safety system for bus. In this block diagram seat and belt sensing circuit, smoke level detection circuit, temperature sensing circuit, obstacle detection circuit, wheel revolution sensing circuit, traction sensing circuit, radio frequency receiver, radio frequency transmitter, alert system, personal computer, C# service-based database and liquid crystal display are shown.

Traction Sensing Circuit gives the declination angle of the bus and the driver can know it easily. Wheel Revolution Sensing Circuit gives also the actual distance travelled. Obstacle Detector is used for front and back section. Alert system is added too for dangerous conditions. The radio frequency module, the bus will get specific signal from the transmitter placed on dangerous checkpoint. Important record such as record time, engine temperature, engine smoke level, back obstacle detection status, front obstacle detection status, mile travelled and declination angles. The system was implemented using MPLAB software with Hi-tech C compiler and C# programming based on PIC18F4550 as USB HID. It was tested for stability and satisfactory operation.

II. COMPONENTS OF THE SYSTEM

The data logger system is considered with the following implementation of:

- Design for Radio Transmitter and Receiver section
- Design for Traction Sensing section
- Design for Wheel Revolution Sensing section
- Design for Obstacle Sensing section
- Design for main control section between C# programming language and USBHID PIC microcontroller
- Design for Graphical User Interface section
- Design for Database section.

A. Radio Transmitter and Receiver Circuit Design

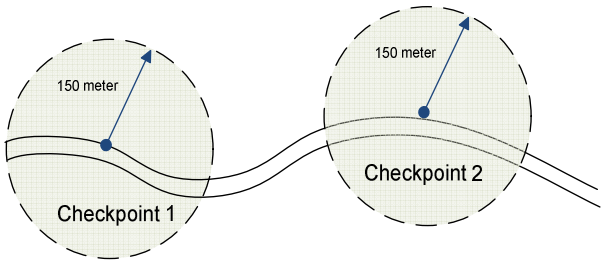


Fig.2. Checkpoint Placement on Highway

The block diagram of bus safety system shown in Fig.3 is to design the safety system for transmitter section. In this block diagram solar panel with battery charger, battery and 5V regulator, microcontroller and radio transmitter are shown. Each radio transmitter on each dangerous checkpoint on highway should transmit different signal so that receiver on bus can distinguish

specific checkpoint. Acceptable baud rate for RF module KST-TX01 is 1200. The lunch distance of that module is 150 meter shown in Fig.2. So the minimum distance between two checkpoints should be greater than 300 meter.

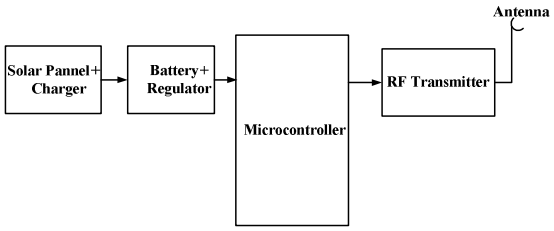


Fig.3. Block Diagram of Checkpoint Transmitter Section

Each checkpoint covers whole circle of 150 meter radius. The transmit signal uses 8 bits wide so number of checkpoints can be extended up to 255 according ASCII code table. Solar panel generates up to 12 Volts, and the battery will store and recharge power to regulator circuit. The 7805 regulator IC circuit will drive microcontroller and RF module with 5 Volts. Necessary circuit diagram is shown in Fig.4.

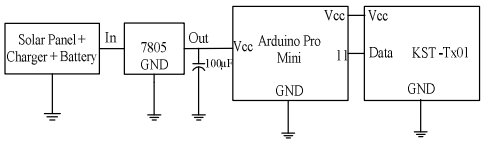


Fig.4. Circuit Diagram of Checkpoint Transmitter Section

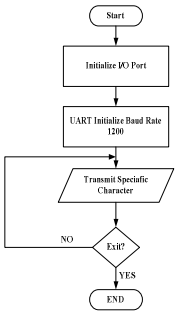


Fig.5. Flowchart of Checkpoint Transmitter Section

The flowchart shown in Fig.5 is for the operation of checkpoint transmitter. Firstly the microcontroller will initialize input/output ports. And then baud rate 1200 is set up and specific signal for its checkpoint will be generated. Until the program is restarted, the signal will be generated repeatedly.

B. Traction Sensing Circuit Design

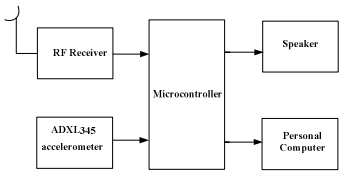


Fig.6. Block Diagram of ADXL345 Accelerometer and RF Receiver Section

The block diagram of vehicle safety system, RF receiver, microcontroller, ADXL345 accelerometer and speaker are shown in Fig.6.

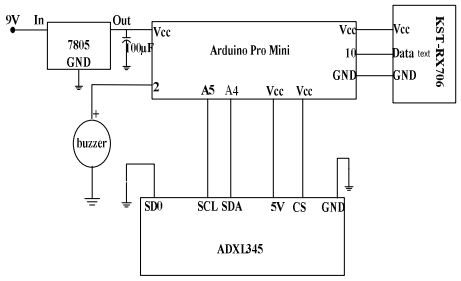


Fig.7. Circuit Diagram of ADXL345 Accelerometer and RF Radio Receiver

USB to RS232 module is used to communicate Arduino with PC. For traction sensing circuit, Arduino pro mini is used with ADXL345 (3 axis) sensor so that the dangerous declination angle of the bus will be sent back to PC. The receiver needs to check incoming signal from road-side checkpoint towers placed on dangerous zone. It needs to check the listed or predefined checkpoints. According to check routine the buzzer will make sound. PC display will be updated with checkpoint number. Each radio receiver on bus should distinguish incoming signal whether bus reach dangerous zone or not. Necessary circuit diagram is shown in Fig.7.

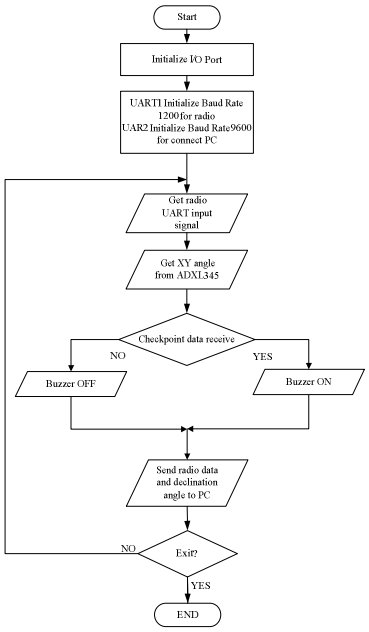


Fig.8. Flowchart for ADXL345 and RF Receiver System

The flowchart represents loop function of traction sensing and radio receiver shown in Fig. 8. Typically baud rate 9600 is used for communication between microcontroller and PC. Another UART communication of 1200 baud rate is used as software serial for radio receiving part. Whenever checkpoint data receive, buzzer will be energizing as beat of alarm signal.

C. Wheel Revolution Circuit Design

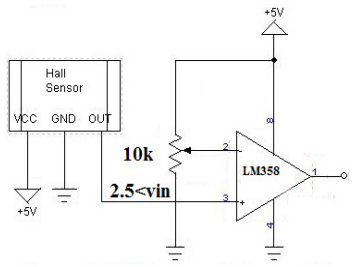


Fig.9. Wheel Revolution Sensing Circuit

Hall sensor is used for wheel revolution counter is shown in Fig. 9. is added and total mile travelled will be displayed on LCD display. The sensor generates 2.5V normally but when magnet on wheel approaches near to sensor, it will generate greater or less than 2.5V. In above design by turning polarity magnet is placed so that sensor generates over 2.5V. Variable resistor can be adjusted to meet required intensity. LM358 Op Amp is used for compare positive terminal and negative terminal. The output terminal of Op Amp is connected to Arduino digital input pin.

D. Distance Sensing Circuit Design

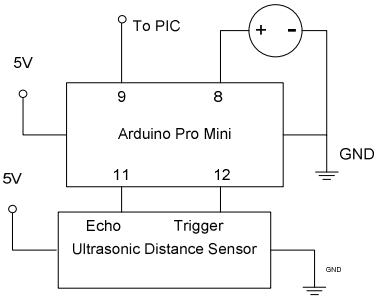


Fig.10. Block Diagram of Obstacle Detection Circuit

In Fig. 10, an ultrasonic distance sensor is mounted in front and back of the vehicle to detect the obstacles up to 13ft apart. Ultrasonic signal transmission and receiving are performed by Arduino Pro Mini board. If nearby obstacles are detected, Arduino will send signal to PIC microcontroller.

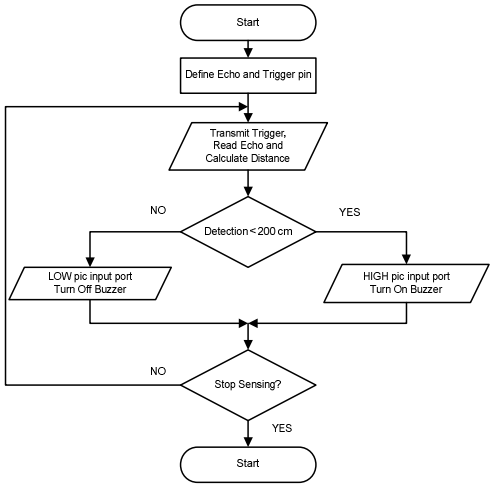


Fig.11. Flowchart for Obstacle Detection System

Above flow chart shows how ultrasonic distance sensing works. When sensed distance is less than 200 cm, Arduino pin for buzzer will be high and output pin to PIC will be activated. When the

distance is greater than 200 cm, Buzzer will be stopped and output pin to PIC will be deactivated. Until program stop, the routine will be repeated infinitely.

E. Main Control Section

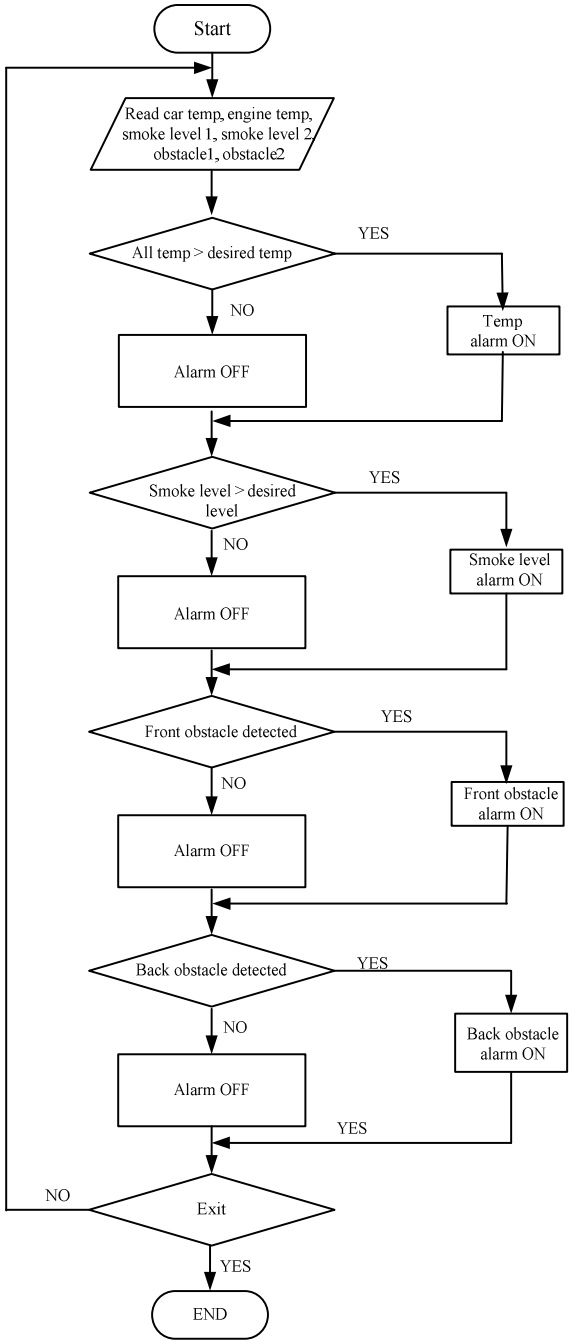


Fig.12. Flowchart for Alarm and Alert Control

When program start, it will send bus temperature, engine temperature, bus smoke level, front obstacle detector and back obstacle detector. If all temperature is exceeded desired temperature, temperature alarm will be ON. If not, temperature alarm will be OFF. And then, smoke level is exceeded desired smoke level, smoke level alarm will be ON. If not, smoke level alarm will be OFF. Therefore, if there is something front and back of the car, obstacles are detected, obstacle alarm will be ON. If not, obstacles alarm will be OFF.

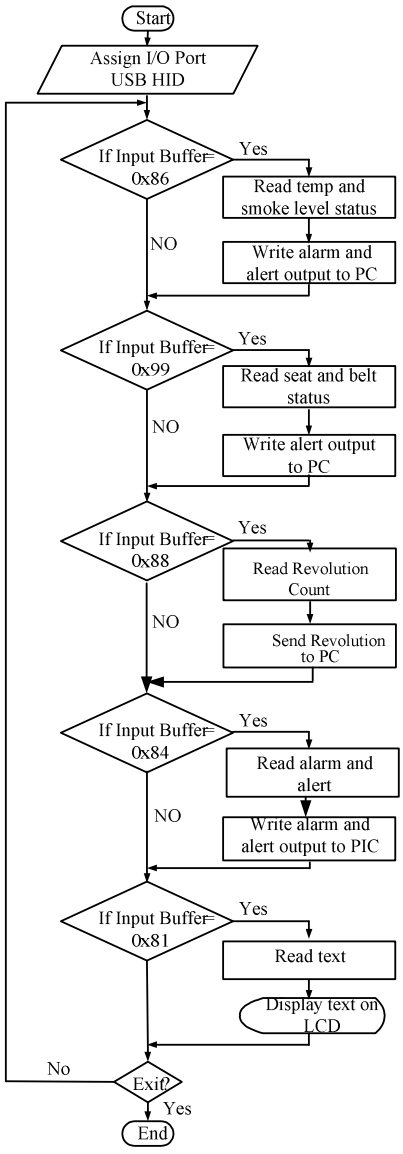


Fig.13. Flowchart for PIC Microcontroller in Vehicle System

When input buffer started with 0x86address is received from PC, the microcontroller reads ADC values at its analog pins and then sends the values as array of hexadecimal value to PC.

When input buffer started with 0x99 address is received from PC, the microcontroller reads pin status at its digital pins and then sends the values as array of hexadecimal value to PC.

When input buffer started with 0x88address is received from PC, the microcontroller reads clock pulse at its digital pins and then sends the values as array of hexadecimal value to PC.

When input buffer started with 0x84address is received from PC, the microcontroller reads incoming data from and then drives its digital pins.

When input buffer started with 0x81 address is received from PC, the microcontroller reads incoming data string in message and then displays on LCD display.

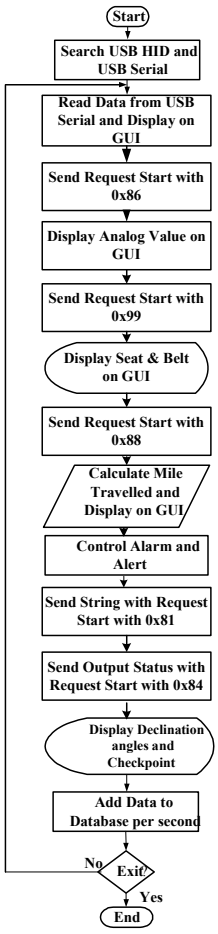


Fig.14. Flow Chart for C# Program Control for Vehicle System

When program starts, it will search USB HID device according to their ID and also lists the serial COM port of traction control circuit. As the frequently repeat request it will send command started with 0x86 addresses. And then program will accept incoming data and will display and record analog sensor measurement values. It will send request started with 0x99 address for seat and belt GUI representation. For distance travelled measurement option, it will send command address 0x88.

According to the desired temperature, alarm and alert will be operated and it will write data to PIC with address command 0x84. For display option program will collect bus information and will send to PIC with command address 0x81 for display option. Using one second counter , some important input data will be recorded in database.

Program will collect serial RS232 signal with baud rate 9600.Arduino pro mini using ADXL345 library is used for displaying X,Y,Z axis declination angle reading and checkpoint indicating.

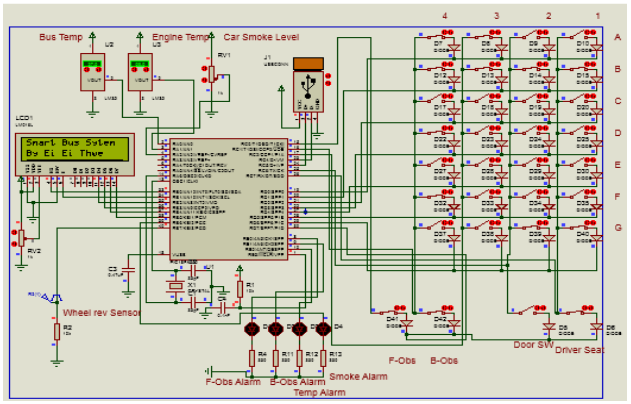


Fig.15. Main controller Circuit Diagram

USB interface of microcontroller was used to connect C# GUI of personal computer. USB HID (universal serial bus human interface device) was implemented with MPLAB software with Hi-TechC compiler so that no more USB driver is needed. LCD Display can be updated easily from GUI control. So any other messages can be applied to all passengers.

III. GUI IMPLEMENTATION AND TESTING

Fig.16. Real Time Control C# GUI

The GUI was implemented not only for monitoring system but also for dynamic control in the alarm and alert session. Driver can also easily repair message signal on LCD display to passengers.

In the running condition shown in Fig.16 software system, passengers are already sat and buckled the signal will be alert is green. If not, the signal will not be alert green (one person or two person etc.) is absent. And then, alarm system is added on the bus. Therefore, also added front obstacle alarm, back obstacle alarm, temperature alarm (engine temperature and car temperature) and smoke level alarm. If there is something front of the car, alarm will ring and front obstacle switch will show red signal. Similarity, if there is something back of the car, also alarm will ring and back obstacle button will show red signal.

When the input temperature for vehicle and engine is increased over desired limit, the alarm system will start and this condition will be displayed on LCD. It will repeat and check until program stops. The desired limits for temperature sensing can be easily updated while program executing.

IV. DATABASE DESIGN IMPLEMENTATION AND TESTING

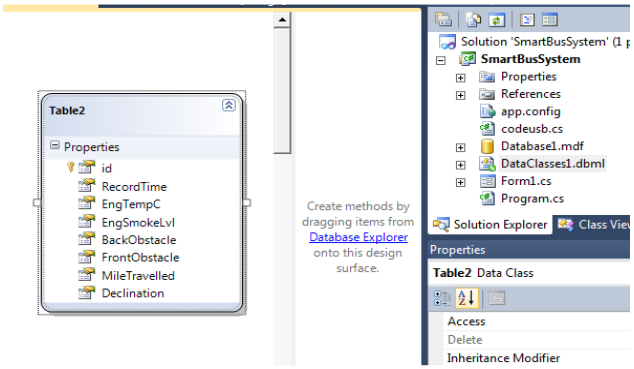


Fig.17. Database Table Design

By using C# service-based database feature, above table is constructed with seven types of vehicle information. In every second, program will store not only record time but also temperature and smoke level of vehicle engine, Front and Back Obstacle detection status, travelled length and vehicle declination. The database file is placed at the specific place on hard-drive.

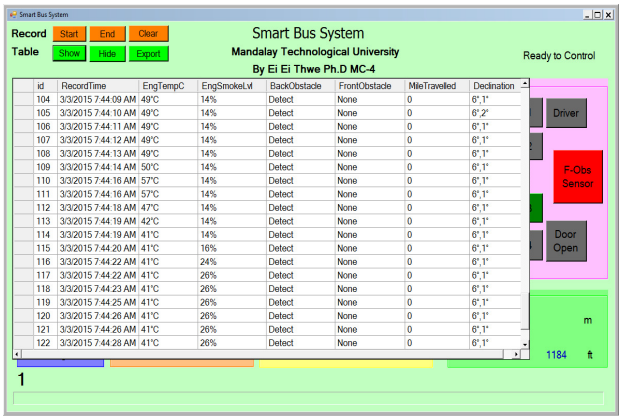
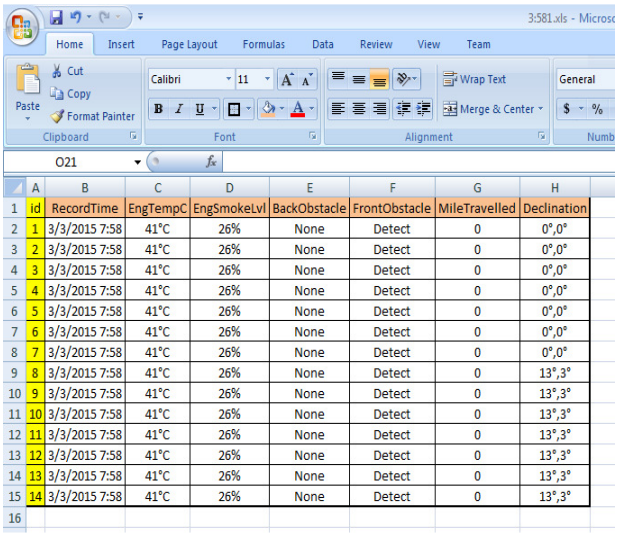


Fig.18. Recorded Log in every second

With GUI implementation, "start" and "end" button were created for start and end of storing data. "Clear" button stands for Database clear option. For user friendly, "Show" and "Hide" button were created for show and hide for data grid view. User can easily check back vehicle status for every second. Sample of recorded data table was shown in above figure.



id	RecordTime	EngTempC	EngSmokeLvl	BackObstacle	FrontObstacle	MileTravelled	Declination
1	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
2	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
3	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
4	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
5	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
6	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
7	3/3/2015 7:58	41°C	26%	None	Detect	0	0°,0°
8	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°
9	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°
10	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°
11	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°
12	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°
13	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°
14	3/3/2015 7:58	41°C	26%	None	Detect	0	13°,3°

Fig.19. Exported data in Microsoft Excel format

"Export" button was created for export data to MicroSoft Excel so that data can be saved as MSOFFICE format. For security reason, "start" and "end" button were locked with administrator password.

V.SOFTWARE REQUIREMENTS AND SYSTEM WORKING

While PIC18F4550 is connected with PC, no more USB driver is needed because it is programmed as USB HID device. But while using Arduino Pro Min as a USB compatible, USB to TTL (Prolific) module and driver are needed. Developed Program (.exe) will work on most of windows such as window7 32-bit and 64 bit, window xp 32-bit and 64-bit because it is compiled with "any CPU" option.

VI. CONCLUSIONS

This vehicle control system is effectively achieved by using graphical user interface, visual C# programming language. The interface between the computer and the vehicle control system is controlled by USB HID. In this system, GUI is developed to monitor and control the system. Hardware of vehicle system is designed with the prototype. The operation is tested by interfacing with GUI. It can be monitored from computer. The logged data in every second can be reviewed not only in developed program but also in Microsoft excel. The disadvantage is that system can only detect obstacle within 13ft range by using ultrasonic sensor. There are other type of sensors which can detect more range. As advantage, there can be reduction of occurring accidents, safety and comfortable of passengers by using this system. It is possible to use as not only an automated alert system but also good data logger, it also saves time and cost.

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