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LabVIEW Based Hill Assist and Black Box in Four Wheelers with Battery Management

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Abstract:

At the present, the vehicle operation research on slope sections in mountainous areas mainly use statistical analysis to describe the correlations between operating speed and road alignment, which could not explain the vehicle's driving risks with different dynamic characteristics on slope sections. Based on vehicle dynamic analysis, a basic operating speed of a passenger car is achieved by the dynamic model, then the model amended by road factors is acquired to predict the operating speed. The operating speed of passenger cars on some of the slope sections were carried out by LABVIEW programming and GUI visualization. The comparison of observation speed with operating one shows that the accuracy of operating speed of the forecast model is higher and has a good applicability.Mostly Battery efficiency will reduce in lower temperature. So travelling to hill stations through E-Vehicles becomes a serious issue. Hence a battery management system is needed and it is achieved through a BMS. This project utilizes a Battery Management System (BMS) to manage battery cells in Electric Vehicles (EVs). Battery Management System is an automated control system which is employed to prevent batteries in the e-vehicle from explosion and failure. The battery management system can be integrated with the monitoring structure which is capable of both managing, monitoring and logging the data to an online database. This system monitors the battery parameters like voltage, temperature and status of charging and discharging. These parameters are then sent and stored in a database via internet which is then shown to the user by means of an android app.

Keywords: AFS, Automatic braking, LabVIEW, Hill safety, Driving Assist, cruising control, tracking control, hybrid dynamical system, GPS,GSM.

1.INTRODUCTION

The technical level of mountainous highways is relatively low. Due to the terrain limit, there are plenty of gradient sections and long slope, road safety issues become more and more prominent. The reason is that the vehicle's operating speed and design is inconsistent. The most important reason is that the area of irradiation of the front light is not at the proper position which causes low visibility and leads to accidents. Because of this, a new technology of enhancing vehicle driving safety appears which is called Adaptive Front light System (AFS). AFS is a driving safety enhancing system which can adjust front light dynamically based on the angle of the vehicle’s steering wheel, the velocity of the vehicle, the pitching and lateral roll angle of the vehicle, to make sure the best illumination to the front road the research on AFS is gradually being carried out around the world. The vehicle black box system VBBS, The VBBS can contribute to constructing safer vehicles, improving the treatment of crash victims, helping insurance companies with their vehicle crash investigations, and enhancing road status in order to decrease the death rate. Mostly Battery efficiency will reduce in lower temperature. So travelling to hill stations through E-Vehicles becomes a serious issue. Hence a battery management system is needed and it is achieved through a BMS. This project utilizes a Battery Management System (BMS) to manage battery cells in Electric Vehicles (EVs). Battery Management System is an automated control system which is employed to prevent batteries in the e-vehicle from explosion and failure. The battery management system can be integrated with the monitoring structure which is capable of both managing, monitoring and logging the data to an online database. This system monitors the battery parameters like voltage, temperature and status of charging and discharging. These parameters are then sent and stored in a database via internet which is then shown to the user by means of an android app.

From this paper was focused on control model and simulation for Adaptive Front light System(AFS) of vehicles on curve roads. Because vehicles’ movement was related to complex dynamics, firstly linear two-degrees-freedom turning model and lateral role model of vehicles were studied. On the basis of these models, this paper put forward control algorithm of adaptive frontlight on curve roads [1].

Prototype of the Vehicle Black Box System VBBS there can be installed into any vehicle all over the world. This prototype can be designed with minimum number of circuits. The VBBS can contribute to constructing safer vehicles, improving the treatment of crash victims, helping insurance companies with their vehicle crash investigations, and enhancing road status in order to decrease the death rate [2].

Accident detection and collision is optimised using traffic signals and effective traffic management using vehicle class information. From this paper, we infer systematic approach to the above problem statement, outline the drawback of existing models and explain the need of effective traffic management in hairpin curves [3].

A system is developed to warn drivers about the approaching traffic in hill curves using ultrasonic sensors placed on both the sides of the road. The output of the ultrasonic sensor is interfaced. When a vehicle is detected by ultrasonic sensor, Processor triggers the camera to capture the image of the vehicle. The image of the vehicle is then compared with the images already uploaded in the database. The match is found and the data is send to the receiver side through Bluetooth. The output is displayed as "Two wheeler" or "Four wheeler" in the Liquid Crystal Display (LCD) [4].

Speed of a vehicle depending on the distance to an obstacle and also can initiate emergency braking automatically if needed. From this project report, the implementation of a Smart Automatic Braking System is introduced. The system has also speed control features. It will reduce or increase the speed of the vehicle depending on the obstacle distance from the moving vehicle to minimize the damage or collision of an accident [5].

In this charging strategy was discussed deeply through a Photovoltaic (PV)-based Battery Switch Station, which is one of typical integration systems to implement solar-to-vehicle. . From this paper, we have studied a novel charging strategy for the PV-based BSS considering the service availability and self-consumption of the PV energy [6].

Here inferred about (SPEV), it is supported with a charging cable that plugs in to the vehicle and into a 230v wall socket. The electric vehicle have a built in features like security system, drive guidance system, route detection, android app support, Wi-Fi, Battery Update [7].

From this paper, we inferred about how to avoid overloading a EV battery transformer (DT) in a insular area through the means of a new smart electric vehicle (EV) charging scheduler [8].

2. BLOCK DIAGRAM

The Block diagram of LabVIEW Based Hill Assist And Black Box In Four Wheelers with Battery Management shown below.

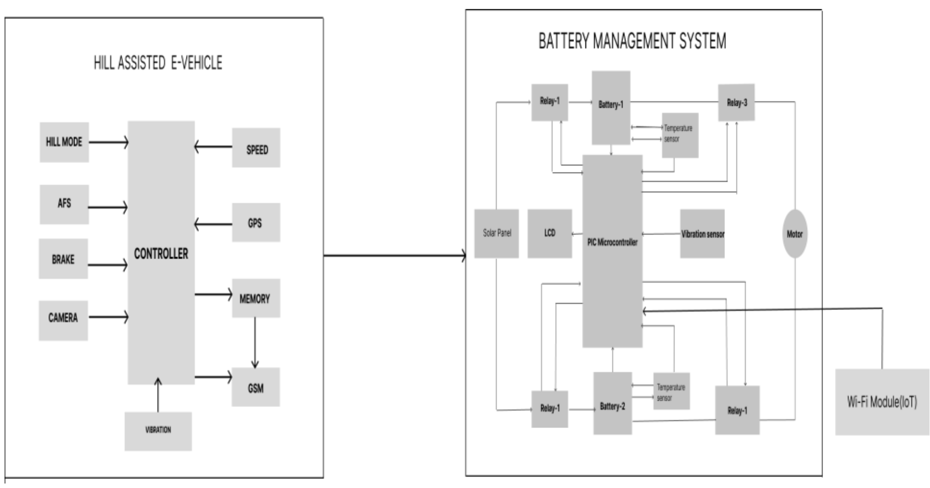


Figure 1 Block diagram of the system

3.HARDWARE DESCRIPTION

3.1 myRIO:

myRIO is a portable device and students can easily use it for the design and control of robots and may other systems quite efficiently. It operates on the frequency 667 MHzmyRIO has dual core ARM cortex A9 programmable processor. It has a Xilinx Field Programmable Gate Array (FPGA). FPGA support in myRIO helps the students to design real life developing systems and to solve real problems quite faster as compared to the other micro controllers. Using FPGA support we can avoid the complicated syntax used in C language and in many others. We just have to create logic instead of writing the complicated code with the proper syntax. So, it has reduced the student's difficulties while designing complicated systems. It is student friendly device and is very easy to use. The processing speed of myRIO is quite higher than the standard micro controllers. So, it can be used t solve real life problems and it can be easily used in efficient systems which need a quick output response. It supports different languages e.g. C, C++ and graphical language (FPGA). The further detail about NI myRIO will be provided later in this article.

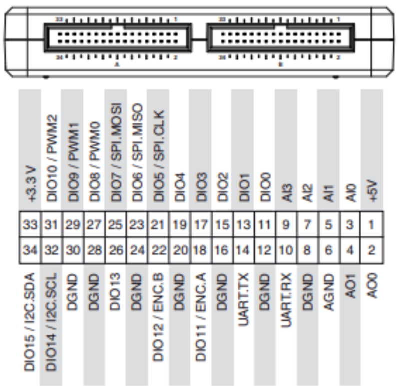


Figure.2 myRIO pin out Diagram

MyRio Control and Apparatus: -

1. NI myRIO-1900
2 .myRIO Expansion Port (MXP) Breakouts (One Included in Kit)
3. Power Input Cable
4. USB Device Cable
5. USB Host Cable (Not Included in Kit)
6. LEDs
7. Mini System Port (MSP) Screw-Terminal
8. Audio In/Out Cables (One Included in Kit)
9. Button 0

3.2. Black Box

In science, computing, and engineering, a black box is a device, system, or object which produces useful information without revealing any information about its internal workings. The explanations for its conclusions remain opaque or “black. “Financial analysts, hedge fund managers, and investors may use software that is based on a black-box model in order to transform data into a useful investment strategy. Advances in computing power, artificial Intelligence and machine learning capabilities are causing a proliferation of black box models in many professions, and are adding to the mystique surrounding them. Black box models are eyed warily by potential users in many professions. As one physician writes in a paper about their uses in cardiology: "Black box is shorthand for models that are sufficiently complex that they are not straight forwardly interpretable to humans.

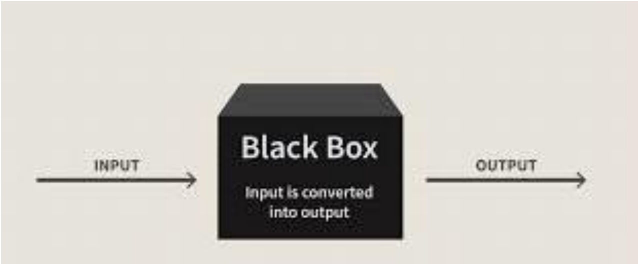


Figure.3 Black box block diagram

3.3. Adaptive Front Light System:

Dangerous traffic accidents happen when vehicles move on curved roads at night. The main reason is conventional front lights do not provide sufficient and reasonable illumination for night-time visibility to be adapted to curves. In that situation, this paper was focused on the control model and simulation for Adaptive Front light System (AFS) of vehicles on curve roads. Because vehicles' movement was related to complex dynamics, firstly linear two-degrees-freedom turning models and lateral role models of vehicles were studied. Based on these models, this paper put forward the control algorithm of adaptive front light on curve roads. From the research, it was concluded that horizontal swing angles of vehicles' front light on curve roads were adjusted according to drivers' visual angle change with velocity change, front wheels' swing angle and side-slip angle, and vertical swing angles of vehicles' front light on curve roads was adjusted according to lateral roll angle of the vehicle' body, and longitudinal irradiation distance of vehicles' front light on curve roads was controlled by safe stopping distance of vehicles. LIN (Local Interconnect Network) based systems may alter the dynamic behaviour of a vehicle. The vehicle's motion directly influences the lighting direction of AFS (Adaptive Front-lighting System), and the effect of the vehicle dynamics on the swivelling headlamp can be simulated.

3.4. GPS:

Global positioning system (GPS) it provides users with positioning, navigation and timing (PNT) services. This system consists of three segments "SPACE SEGMENT, CONTROL SEGMENT, and USER SEGMENT". It provides geo location and time information to a GPS receiver anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. Using GPS, we can position the vehicle where accident took place with the co-ordinates, we can act accordingly.

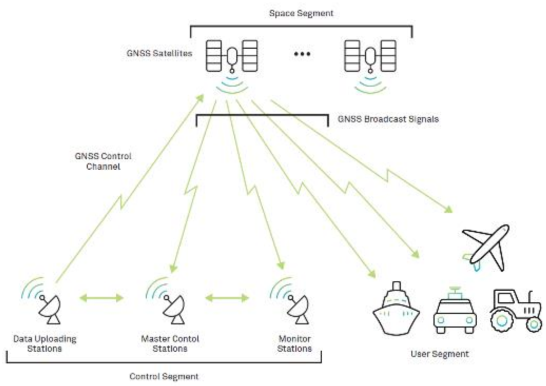


Figure.4 GPS working model

3.5. GSM:

The Global System for Mobile Communications (GSM) is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile devices such as mobile phones and tablets.The GSM standard originally described a digital, circuit-switched network optimized for full duplex voice telephony.Cell horizontal radius varies – depending on antenna height, antenna gain, and propagation conditions – from a couple of hundred meters to several tens of kilometers.Using GSM interfacing it with GPS we can send the coordinates to the destination device that records the coordinates and passes the information to connected devices.

3.6. Camera:

Dashboard camera records everything in front of the car. Some high-end dash cams even capture the rear-view with the help of a rear-facing lens. Installing a dash cam for your car is a simple and effective way to capture your drive. The recording quality, the size of the camera's SD card capacity, and other factors can all affect how long a dash cam records for. However, with a high-quality recording (1080p), you can expect the camera to record for about this long: 8 GB – 55 minutes. 16 GB – 110 minutes (1.8 hours).Two Folder One Of The footage Contain Five Minutes Of Pre-accident Content Meanwhile The Folder Contain The Five Minutes Of Post -Accident Footage.

3.7. PIC 16F877A:

This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC architecture into an 40 package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART).

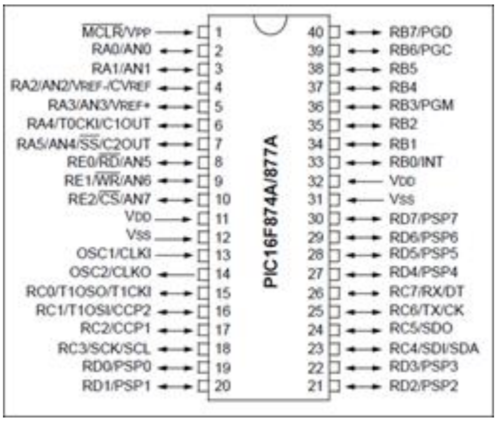


Figure.5 Pin Configuration of PIC16F877A

- PIC16F877a is a 40-pin PIC Microcontroller, designed using RISC architecture, manufactured by Microchip and is used in Embedded Project.
- It has five Ports on it, starting from Port A to Port E.
- It has three Timers in it, two of which are 8-bit Timers while 1 is of 16 Bit.
- It supports many communication protocols like:

  i. Serial Protocol.
  ii. Parallel Protocol.
  iii. I2C Protocol.

- It supports both hardware pin interrupts and timer interrupts**.**

3.8. LM35:

LM35 is a temperature sensor that outputs an analog signal which is proportional to the instantaneous temperature. The output voltage can easily be interpreted to obtain a temperature reading in Celsius. The advantage of lm35 over thermistor is it does not require any external calibration.

The coating also protects it from self-heating. Low cost (approximately $0.95) and greater accuracy make it popular among hobbyists, DIY circuit makers, and students. Many low-end products take advantage of low cost, greater accuracy and used LM35 in their products. It's approximately 15+ years to its first release but the sensor is still surviving and is used in any products.

LM35 Temperature sensor Features:

- Calibrated Directly in Celsius (Centigrade)
- Linear + 10-mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at 25°C)
- Rated for Full −55°C to 150°C Range
- Suitable for Remote Applications

Figure.6 Temperature Sensor LM35

3.9. Vibration Sensor:

Vibration sensor module SW-420 based on the vibration sensor SW-420 and Comparator LM393 to detect if there is any vibration that beyond the threshold. The threshold can adjust using an onboard potentiometer. When this no vibration, this module output logic LOW the signal indicates LED light, and vice versa. If the module does not vibrate, the vibration switch was on the close state, the output of low output, the green indicator light. The product vibrates, vibration switches momentary disconnect, the output is driven high, the green light does not shine. The output can connect to the microcontroller, which to detect high and low level; so as to detect whether the environment exists vibration, play a role in the alarm.

Figure.7 Vibration Sensor SW-420

4. SOFTWARE DESCRIPTION

4.1 LABVIEW:

LabVIEW (**Lab**oratory **V**irtual **I**nstrument **E**ngineering **W**orkbench) is a graphical programming environment which has become prevalent throughout research labs, academia, and industry. It is a powerful and versatile analysis and instrumentation software system for measurement and automation.Its graphical programming language called G programming is performed using a graphical block diagram that compiles into machine code and eliminates a lot of the syntactical details.LabVIEW offers more flexibility than standard laboratory instruments because it is software-based. Using LabVIEW, the user can originate exactly the type of virtual instrument needed and programmers can easily view and modify data or control inputs. The popularity of the National Instruments LabVIEW graphical dataflow software for beginners and experienced programmers in so many different engineering applications and industries can be attributed to the software's intuitive graphical programming language used for automating measurement and control systems.

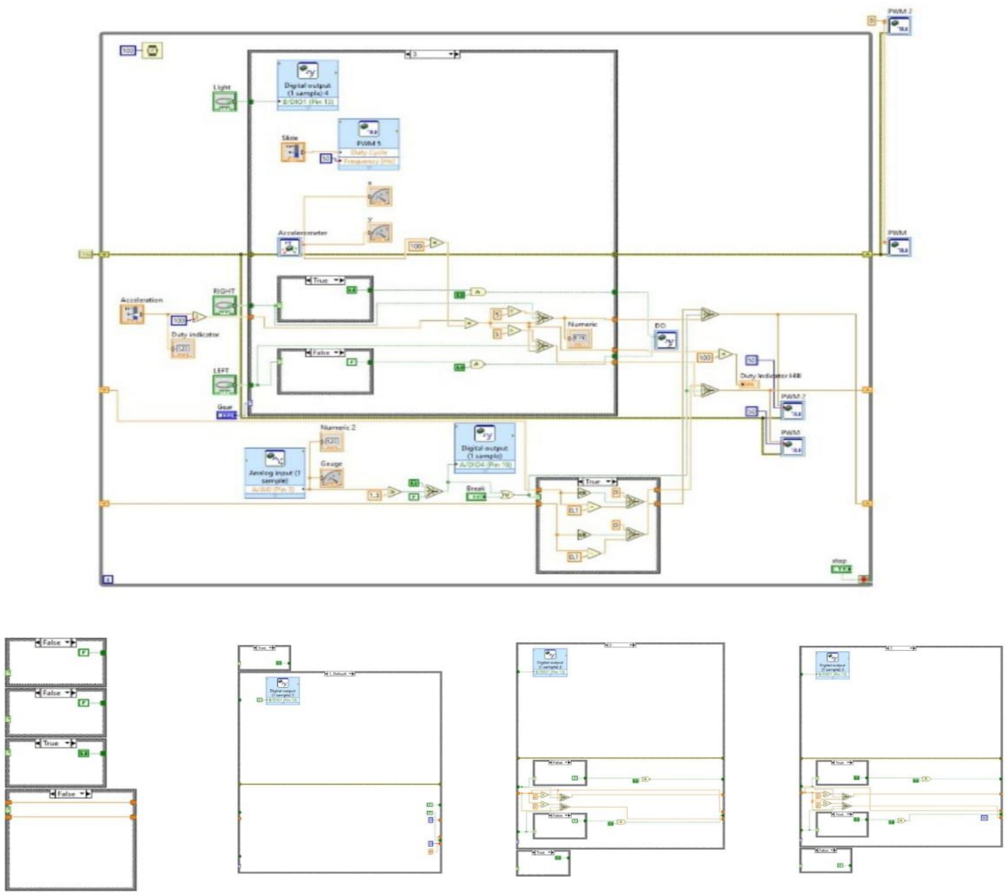


Figure.8 LABVIEW Block Panel of Hill Assist and Black Box in Four Wheelers

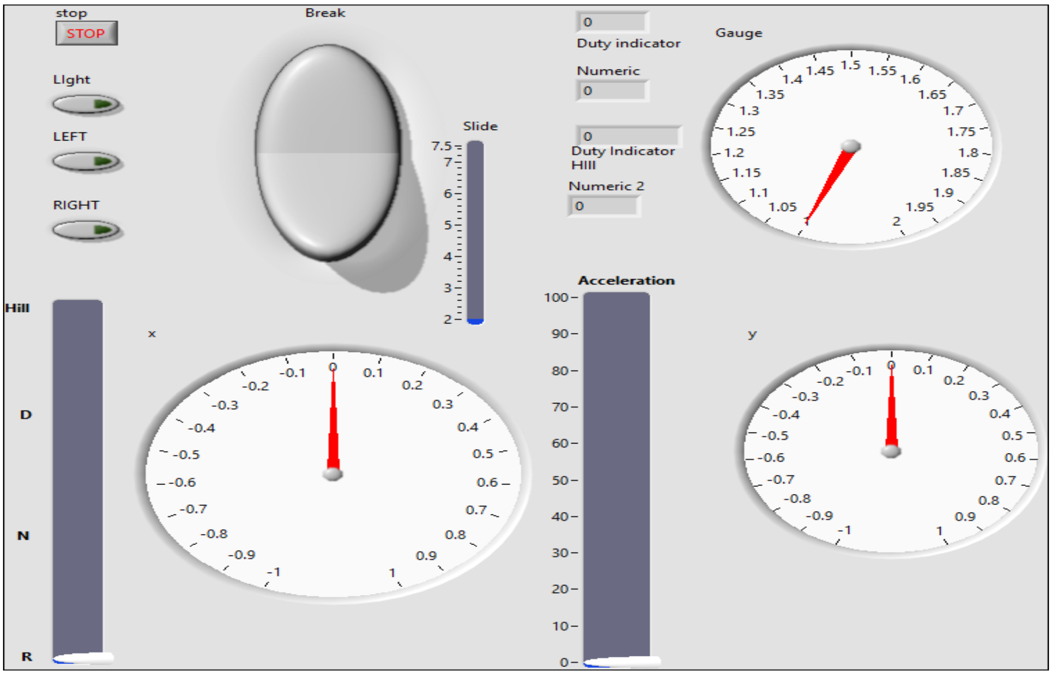


Figure.9 LABVIEW Front Panel of Hill Assist and Black Box in Four Wheelers

4.2 MP LAB IDE:

MPLAB IDE is a free, integrated toolset for the development of embedded applications on Microchip's PIC and dsPIC microcontrollers. MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging. MPLAB IDE also serves as a single, unified graphical user interface for additional Microchip and third party software and hardware development tools. Moving between tools is a snap, and upgrading from the free software simulator to hardware debug and programming tools is done in a flash because MPLAB IDE has the same user interface for all tools.

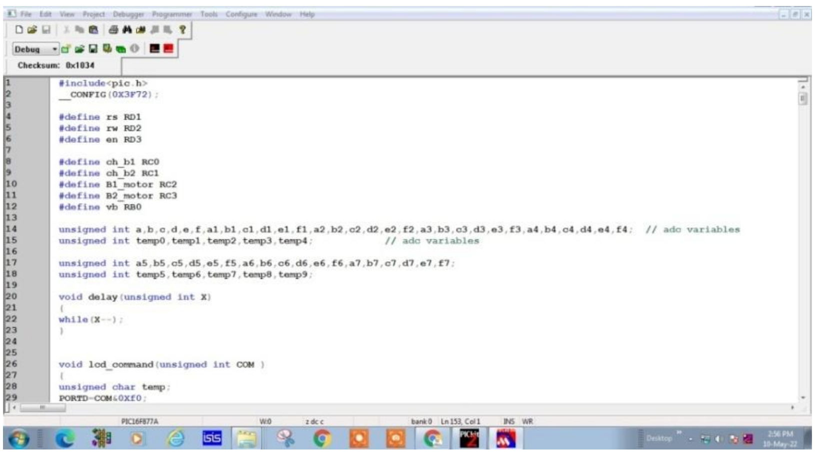


Figure.10 MP LAB IDE

5. EXPERIMENTAL SETUP/HARDWARE PROTOTYPE

The below figure depicts the hardware prototype that has been developed to realize the proposed methodology. The tests were conducted using the below experimental setup.

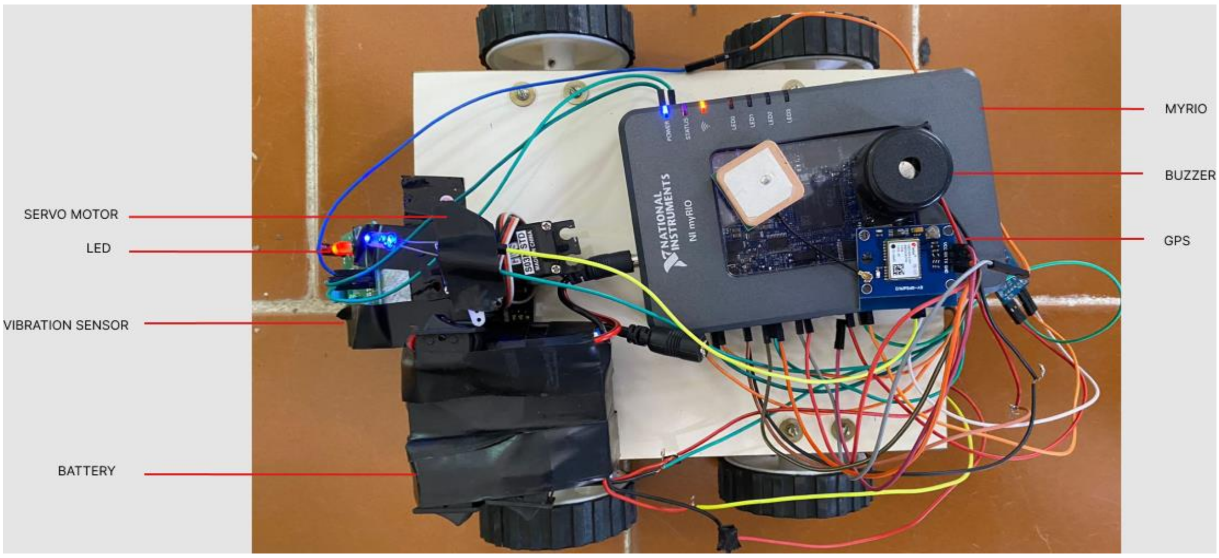


Figure.11 Experimental Setup of labVIEW Hill Assist

6. PROCESS DESCRIPTION

The Process Starts With The Power Supply And Input Command. Engine On Checks For The Door Status If All Four Doors Are Closed The Processor Enables The Engine, Elsean Indication Is Shown To Close All The Doors.

Idle Works With Basic Working Of The Car Gets Starts Based On The Pre-Defined Conditions.

Gear Has Four Cases in This State
1. Neutral
2. Drive
3. Reverse
4. Hill Mode

Neutral -This Mode The Vehicle Is In Static Position (Zero Acceleration) And The Breaks Are Enabled.

- Drive-In this Mode the Car Engine's Motor Is Activated and Controlled by the User/Driver Based on the Acceleration in Forward Direction as per User's Acceleration.
- Right-In this State The Speed Of The Right Motor Is Reduced Three Times The Actual Speed And Reversed. The Direction Of Vehicle Is Manipulated To Right Side.

- Left-In this State The Speed Of The Left Motor Is Reduced Three Times The Actual Speed And Reversed. The Direction Of Vehicle Is Manipulated To Left Side.
- Reverse-In this Mode the Car Engine's Motor Is Activated and Controlled by the User/Driver Based on the Acceleration in Reverse Direction as per User's Acceleration. Negative Pulse Is Given To The Motor By The Processor To Reverse The Direction Of Vehicle.
- Right-In this State The Speed Of The Right Motor Is Reduced Three Times The Actual Speed And Reversed. The Direction Of Vehicle Is Manipulated To Right Side.
- Left-In this State the Speed of the Left Motor Is Reduced Three Times the Actual Speed andreversed. The Direction Of Vehicle Is Manipulated To Left Side.
- Hill Mode (Up-Hill)-In this Mode Is Used To Assist While Driving In Inclined Surface By Controlling The Acceleration And Break Based On The Gyroscope's Input I.E., The Inclination Is Sensed With The Help Of Inbuilt Gyroscope Sensor In myRIO.To Increase The Acceleration During Uphill Drive An Additional Impulse Is Given To The Motor As Per Pre-Set Value.
- Forward-In this Mode the Car Engine's Motor Is Activated and Controlled by the Processor Based on the Acceleration in Forward Direction as per User's Call I.E. Based on the Angle of Inclination Provided by the Gyroscope.
- Right-In This State the Speed of the Right Motor Is Reduced Two Times the Actual Speed andreversed. The Direction Of Vehicle Is Manipulated To Right Side.
- Left-In This State the Speed of the Left Motor Is Reduced Two Times the Actual Speed andreversed. The Direction Of Vehicle Is Manipulated To Left Side.
- Reverse- In this Mode the Car Engine's Motor Is Activated and Controlled by the Processor Based on the Gyroscope's Input and Acceleration in Reverse Direction as per User's Call and Controlled by Processor Based on Change in Angle of Inclination.
- RightThis State The Speed Of The Right Motor Is Reduced Two Times The Actual Speed And Reversed. The Direction Of Vehicle Is Manipulated To Right Side.
- LeftThis State The Speed Of The Left Motor Is Reduced Two Times The Actual Speed And Reversed. The Direction Of Vehicle Is Manipulated To Left Side.
- Hill Mode (Down-Hill)This Mode To Increase The Safety Of The Vehicle During Down Hill Drive Break And Acceleration Is Controlled Using The Processor And Gyroscope.To Increase The Safety The Vehicle Speed Is Reduced As Per The Angle Of Inclination Also Maximum Speed Is Also Pre-Set.
- ForwardThis Mode the Car Engine's Motor Is Activated and Controlled by the Processor Based on the Acceleration in Forward Direction as per User's Call and the Value Is Maintained within the Pre-Set Value I.E. Based on the Angle of Declination Provided by theGyroscope.
- RightThis State The Speed Of The Right Motor Is Reduced Two Times The Actual Speed (Down-Hill Speed) And Reversed. The Direction Of Vehicle Is Manipulated To Right Side.
- LeftThis State The Speed Of The Left Motor Is Reduced Two Times The Actual Speed(Down-Hill Speed) And Reversed.The Direction Of Vehicle Is Manipulated To Left Side.

- ReverseThis Mode the Car Engine's Motor Is Activated and Controlled by the Processor Based on the Gyroscope's Input and Acceleration in Reverse Direction as per User's Call and Controlled by Processor Based on Change in Angle of Declination.An Alert Indication Is Also Enabled During Down-Hill Reverse Condition.

- RightThis State The Speed Of The Right Motor Is Reduced Two Times The Actual Speed(Down-Hill Speed) And Reversed.The Direction Of Vehicle Is Manipulated To Right Side.
- LeftThis State The Speed Of The Left Motor Is Reduced Two Times The Actual Speed(Down-Hill Speed) And Reversed.The Direction Of Vehicle Is Manipulated To Left Side.

AFS (Adaptive Front Light System)

- Adaptive Front Light System (AFS), Here Using Accelerometer's X-Axis the Servo Motor Turns the Head Light Accordingly. Adaptive Headlights Are Headlights That Actively Respond To Change In Direction Of Vehicle. Their Goal Is to Provide Drivers with Wide Range of Visibility and More Time to React to Conditions ahead.AFS Servo Motor Is Controlled with the Help of Gyroscope, Where the Processor Calculates the Better Visibility Angle.

Vibration (Accident)

- To Support The Emergency Response Team The Accident Is Detected Using Vibration Sensor And The Damage Intensity Is Sensed, Also The Co-Ordinates (GPS) Of The Accident Location Is Shared Via GSM.Here The Accident Is Detected With The Help Of Vibration As Per Pre-Set Value. If The Vibration Detected Above The Pre-Set Value The Speed Of The Vehicle Is Slowed Down. As Soon As The Pre-Set.

6.1 Operation of Battery Management System:

Generally we can classify the operation of this Battery Management System into three categories. As we discussed earlier in this paper, the ultimate objective is to protect and prevent the batteries of the electric vehicles from explosion. This could be achieved by analyzing the parameters causing the battery explosion and failure. When we sort out the parameters by impact created, the temperature would be at the top, followed by the overloading of the battery and some explosion can also takes place during an accident. The operation is continuous monitoring all these parameters and taking necessary control actions through the controller.

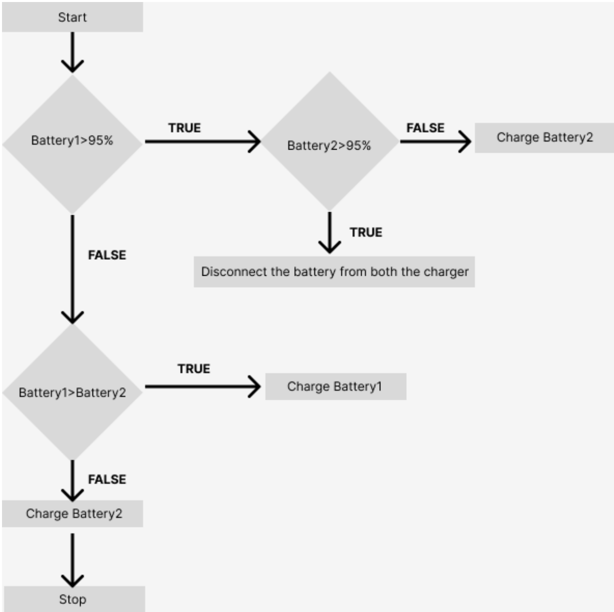


Figure.12 Flowchart of BSM

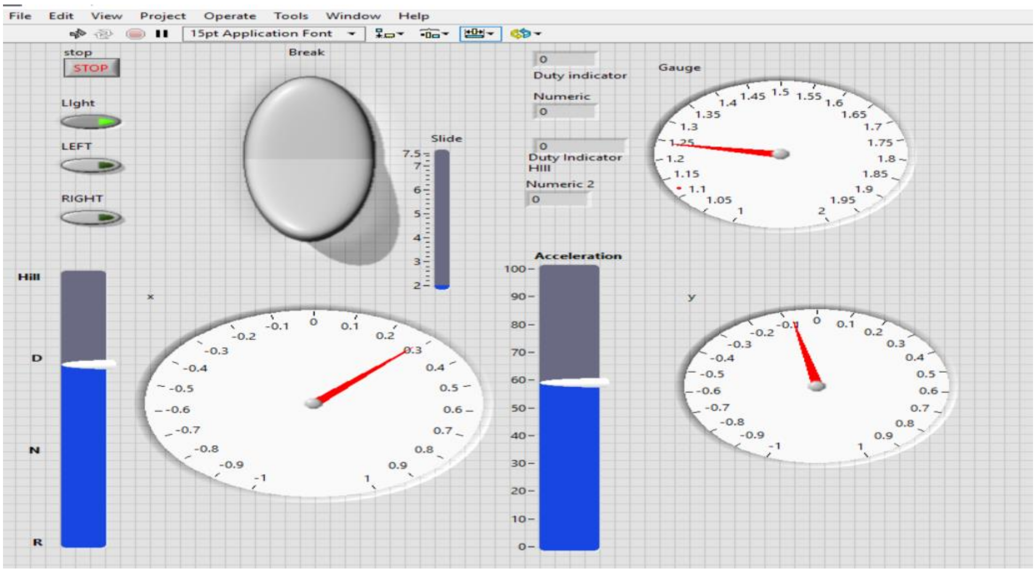
Temperature Monitoring:

As the temperature is the primary concern in the battery explosion, it should be monitored continuously. The temperature sensor (LM35) is three terminal linear temperature sensor from National semiconductors. It can measure temperature from-55 degree celsius to +150 degree celsius. The voltage output of the LM35 increases 10mV per degree Celsius rise in temperature. LM35 can be operated from a 5V supply and the stand by current is less than 60uA. This sensor is well-known for measuring the surrounding temperature with a wide range. The sensor will be mounted in a way which near enough to measure the temperature of the battery. It should be interfaced with the controller which will display the temperature in the LCD screen. For example, BT1 TEMP : 34, and the controller will also uploads the data to the cloud through the wifi-module. If the temperature exceeds the threshold, the controller will send the alert message to the LCD screen as “High Temp Detected Reduce the Speed-limit”, and will also boost up the default cooling system installed for the battery.

Battery Switching Mechanism:

Battery Switching Mechanism (BSM) is a simple switching technique implemented in order to prevent the over-loading of the battery. Over-loading the battery beyond the limit will also be a factor for the explosion. When a battery is charging for a longer period of time, high current will flow through the battery which causes the affects the battery performance. This could be prevented through this BSM technique, initially the battery should be divided into two as battery1 and battery2, if battery1 is charging, then the vehicle will run through the battery2 and vice-versa. When the system gets on, the controller will start comparing the voltage level of the two battery.

7. RESULT



The result of the IoT connected Battery Management System is shown below.

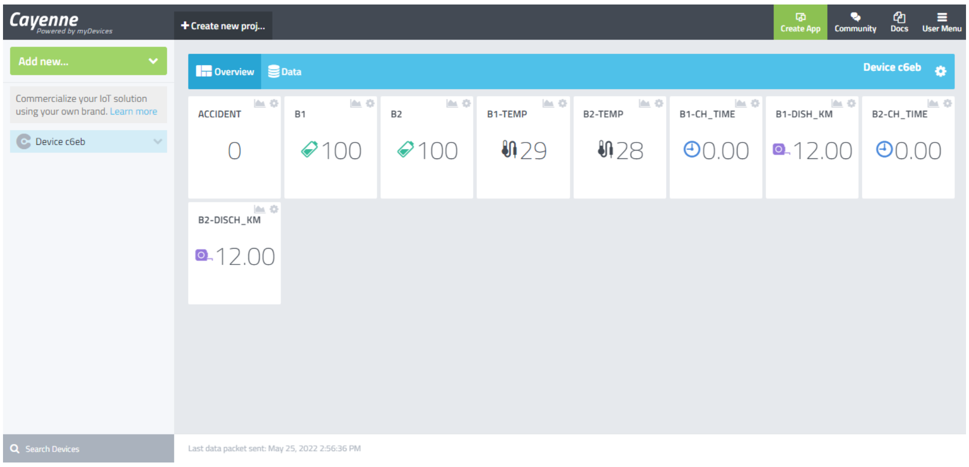


Figure. 13 Front panel of the cayenne web application

8. CONCLUSION

This set up gives us most safety and better driving experience in hill stations and assists the emergency response team with location and impact intensity. This also has improved the field of vision in wide range of vehicles so that it can be very useful while driving in sharp bends. The total vehicle can be monitored through IOT. The hill hold feature itself has proven to be very beneficial to manual transmission drives that find themselves on grades that would normally make driving difficult. In addition to manual transmission vehicles, the driving experience of vehicles with automatic transmissions can be enhanced. When implemented correctly, the functionality of the hill hold feature seamlessly matches the driver's normal driving habits and instincts. By using this feature we can drive vehicle easily.

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