INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 2)
Available online at: www.ijariit.com

Automation in the body control module of a car

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ABSTRACT

The number of automobile users is increasing day by day. At the same time, the number of people prone to accidents continues to rise. This is because drivers are exposed to a number of distractions. In order to reduce this, automation came into existence. Over the past two decades, the automotive industry has aggressively researched ways to exploit modern computing and electronic advances in body control modules to provide safety, reliability, comfort and entertainment technologies for users. In this paper, the automation system deals with the development of a Body Control Module (BCM) including features providing automatic control of windshield wipers, headlamps, sunroof, power window regulators with an anti-pinch feature. Developments of these features were accomplished using a PIC micro-controller 16F877A along with components like sensors, actuators, current drivers & signal conditioning circuits. The developed automation system is tested on a general purpose PCB with DC motors and LED.

Keywords— *BCM, Sunroof control, Power window, Anti-pinch, Windshield wiper, Headlight control, PIC16F877A*

1. INTRODUCTION

Automation process uses a control system like computers to monitor and handle processes and machines. They provide the advantage of improving productivity and quality, thus reducing errors, increasing safety, adding flexibility. To meet this advantage in a car, automation is done in various modules of a car such as shown in figure 1.

The BCM is an electronic device, which controls and regulates a large number of basic functions on modern vehicles. Vehicle electronic system comprises of engine control, steering control, fuel injector control, windshield wipers, power window, headlight adjustments etc, can be controlled by their respective sensors and controller unit.

Farhat Alam, Mohammed Islam and Shuva Paul [1] propose an automatic control of the vehicle headlamps based on the detection of headlights under night time road conditions. It is about to control high beam or low beam light intensity automatically thus reducing the glare effect.

Shantanu Dharmadhikari, Naeem Tamboli, Nilesh Gawali and Prof. N. N. Lokhande [2] feel that the automatic wiper system can be used to detect rainfall and activate automobile windshield wipers without driver interaction. It uses a combination of impedance and piezo-electric sensors to detect rain and its intensity and controls the operation of the windshield wipers based on those input signals.

Nithin Alex John, Mona Sherki and Sanjay A Patil [3] provides an effective solution for the anti-pinch mechanism, which releases the object safely just when it gets trapped using the ultrasonic sensor.

V Sundara Siva Kumar, P Nagesh [4] explains the automatic closing of the window by controlling a motor using the instructions given to a microcontroller based on rain moisture sensor.

Okrah.S.K, Williams E.A and Kumassah F. [5] introduce an automatic headlight dimmer which uses a Light Dependent Resistor (LDR) sensor has been designed to dim the headlight of on-coming vehicles to avoid human eye effects. This automatically switched the high beam into the low beam, therefore reducing the glare effect by sensing the light intensity value of approaching the vehicle and also eliminated the requirement of manual switching by the driver which was not done at all times.

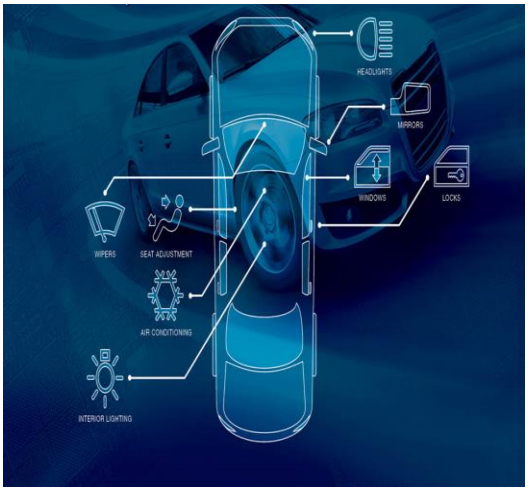

Fig. 1: BCM of a car

V. Sundara Siva Kumar and P. Nagesh [6] explain the automatic closing of the window by controlling a motor using the instructions given to a microcontroller based on rain moisture sensed by the rain sensor.

Martin Bates [7] explains details on Micro-controller hardware, programming the micro-controller, programs and configurations on memory management, configuring Inputs and outputs, handling timers and interrupts.

The objective of this paper is to automatically control the sunroof, windows, headlight brightness and wiper of a car. This will help to provide a comfortable and safe environment for the passengers inside the car by sensing the sunroof, windows, headlight brightness and windshield wiper and control them accordingly.

2. SYSTEM DESIGN

The detailed description of the system used is explained in the block diagram in figure 2.

2.1 Block diagram

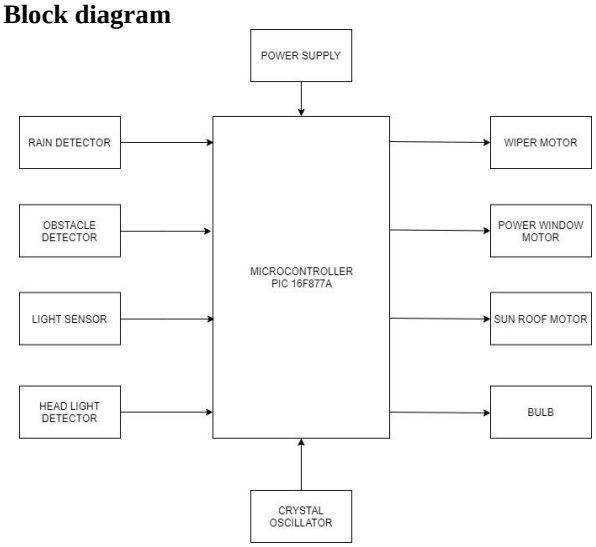

Fig. 2: Block diagram of BCM of a car

The project addresses design and development of one such Body Control Module in lower-end segment cars since BCMs are presently a standard feature in high-end cars while for middle and lower segment cars where this is either an add-on feature or is totally unavailable.

The main controller is interfaced with intelligent sensors and automatic mechanisms to control different modules such as a wiper, headlamp, windows as shown in the block diagram in figure 2.

2.1 Description

- **Power supply section**: It consists of a transformer, a bridge circuit, a filter and a regulator. The step-down transformer is used to convert 230V AC to 12V AC. The bridge circuit converts AC to DC is called rectifier. The filter is used to remove the ripples in the supply. The regulator makes the supply voltage to constant 5V DC voltage which is given to the microcontroller.
- **Infrared sensor:** It is used as an obstacle detector which is an electronic device that emits IR radiation in order to sense some aspects of the surroundings. The primary function is to recognize IR signals which are emitted from an IR transmitter. Depending on the amount of IR light falling on the photodiode, the resistances and the output voltages change in proportion to the magnitude of the IR light received.
- **Rain sensor/detector:** It is a sensor that detects when raindrop falling on the raining board and also measures rainfall intensity.
- **Light Sensor:** It generates an output signal indicating the intensity of light falling onto it. The output voltage obtained depends on the resistance value of the light sensor which varies according to the intensity of light on it.
- **Light Dependent Resistor:** It is a variable resistor whose resistance decreases with an increasing incident light intensity which is very useful in controlling the intensity of headlight.
- **PIC microcontroller:** This microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller has a processor, memory and input/output (I/O) peripherals on a single chip.
- **Window motor:** The mechanism that moves the window up and down is called the window regulator. The window motor has a special function in case of obstacle detection.
- **Wiper motor:** Windshield wipers are powered by a small electric motor, usually mounted on the firewall or under the cowl (the area under the windshield's base). The motor activates linkage that moves the wiper arms back and forth.
- **Sunroof motor:** The movement of the sunroof glass panel is achieved by the sunroof motor. It can be driven in both forward and reverse direction.
- **Crystal oscillator:** It is an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This helps to set the clock pulse for the execution of instructions of the microcontroller.

3. POWER WINDOW

Power windows are automobile windows which can be raised and lowered by depressing a button, instead of a hand-turned handle. They provide more safety compared to a simple window because if any obstacle interrupts while closing the window, there is no control to stop the window from closing in order to avoid the obstacle from getting hurt. The working of the anti-pinch power window is shown in figure 3.

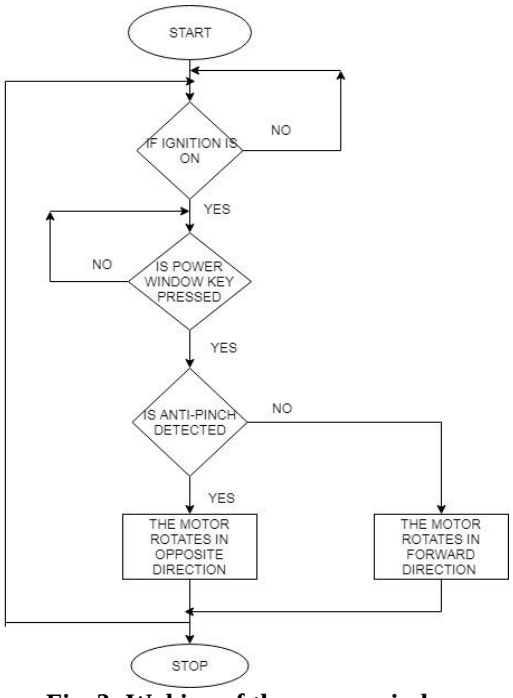

Fig. 3: Woking of the power window

To avoid this, the IR sensor is used to detect any obstacle present in between the side window of the car. If any obstacle is detected then, IR sensor input goes low which is fed to the PIC microcontroller. This indicates the presence of an obstacle while closing the window. The microcontroller is programmed in such a way to reverse the direction of rotation of window motor in order to avoid damage to the obstacle.

4. HEADLIGHT CONTROL

Automatic Headlight control system turns the lights on whenever the LDR sensor, in the instrument panel, senses dark conditions. If any vehicle comes opposite to the user, its headlight intensity of the opposite vehicle causes disturbance to the driver. The workflow of the headlight system is shown in figure 4.

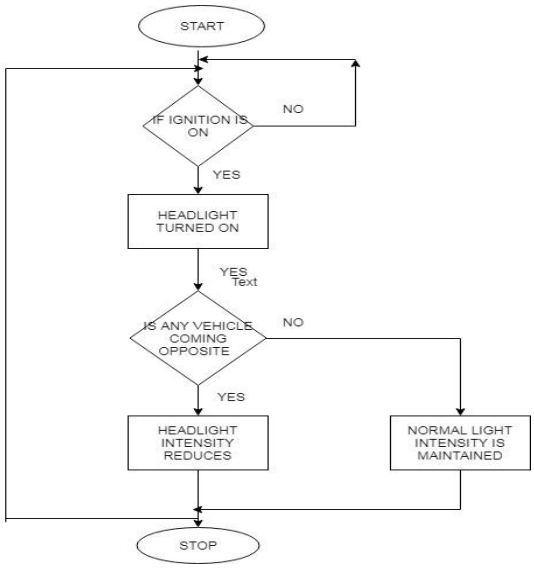

Fig. 4: Working of the headlight unit

The sensor senses its intensity and converts into an electrical signal. This is sent to the PIC microcontroller. The microcontroller is flashed with the Embedded C program that helps to adjust the intensity of the headlight so that the driver's eyes are not disturbed.

5. SUNROOF CONTROL

A Photoresistor or Light Dependent Resistor (LDR) is used as a light sensor for sensing sunroof light intensity.

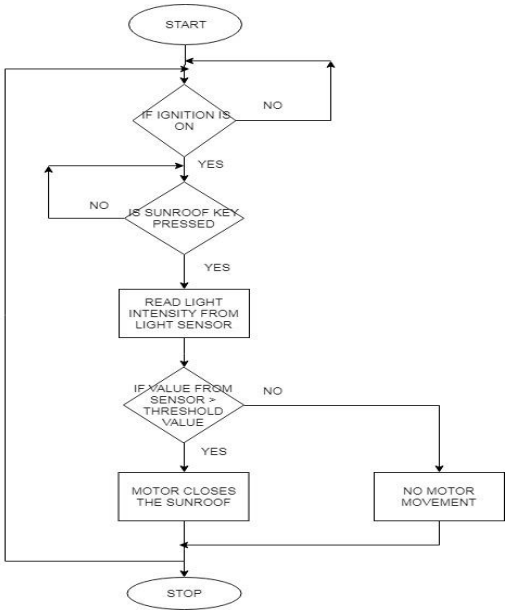

Fig. 5: Working of sunroof control

In the dark, a photoresistor can have a resistance as high as a few megaohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms. In the rooftop of the cars, based on sunlight intensity or occurrence of rain, the roof is opened or closed manually by pressing a switch. But by automation, it is possible to open or close the roof automatically by a light sensor. So, by this light sensor, if the sun's intensity is too high or if rain occurs, the roof will close automatically if it is opened is illustrated in figure 5.

6. WIPER CONTROL

The wiper control module features a rain sensing board and the control board that is separate for more convenience, power indicator LED and an adjustable sensitivity through a potentiometer. In the absence of smart wiper system, if it is rainy outside, the user has to manually switch on the wiper which might divert the attention of the driver. So, automatic rain sensing wiper system workflow shown in Figure 6 is used.

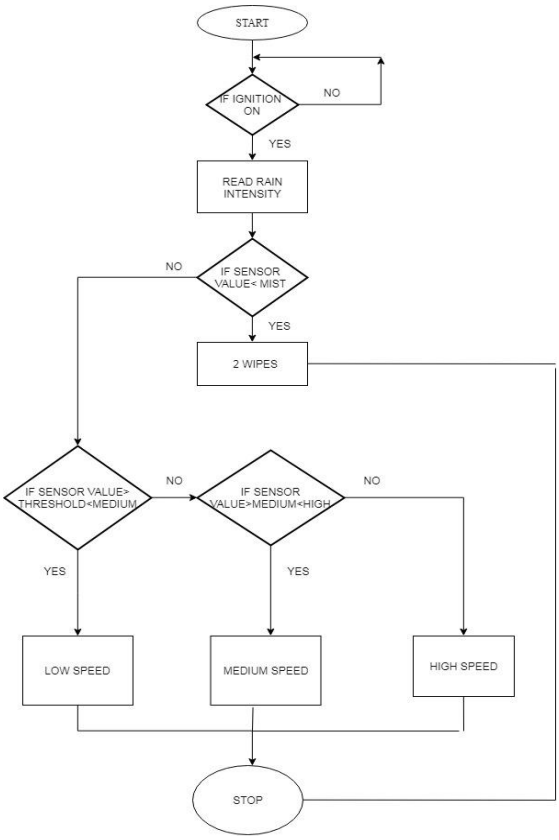

Fig. 6: Working of the wiper system

Rain sensor allows to measure moisture via analog output pins and it provides a digital output when a threshold of moisture exceeds. The rain sensor can sense the presence of rain or waterfall level and gives the control signal to the microcontroller. Here speed of wiper is adjusted by giving various levels of the speed control signal to the wiper motor according to the amount of water on the windshield and in additional moisture on the windshield is also removed.

7. EMBEDDED C

Embedded C Programming is the soul of the processor functioning inside each and every embedded system we come across in our daily life. Each processor is associated with embedded software. The first and foremost thing is the embedded software that decides the functioning of the embedded system. The programming flow of Embedded C is shown in figure 7.

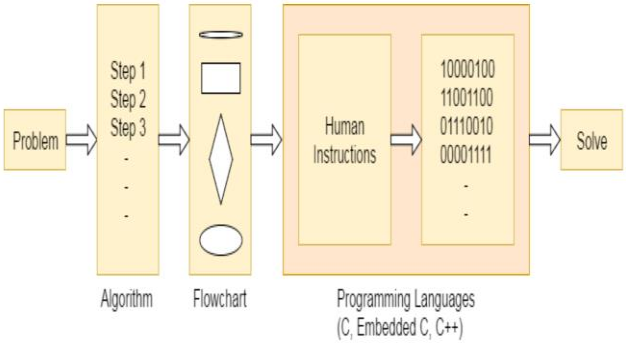

Fig. 7: Flow of Embedded C programming

Embedded C language is most frequently used to program the microcontroller. Earlier, many embedded applications were developed using assembly level programming. However, they did not provide portability. This disadvantage was overcome by the advent of various high-level languages like C.

8. MPLAB IDE

MPLAB IDE software is a freeware Integrated Development Environment (IDE) which is used in Microprocessor and Micro-controller lab for the development of embedded applications. It is developed by Microchip Technology. MPLAB supports project management, code editing, debugging and programming of Microchip 8-bit and 32- bit PIC Micro-controller.

9. CONCLUSION

The Body control Module designed will serve the purpose of controlling many actuators in a vehicle using a single centralized controller**.** As almost everything described already for this design, we would like to say there are still numerous kinds of enhancements one can implement in this project to make it even more convenient. It has a great advantage over the conventional non-automation system. This system is developed with low-cost high-performance electronic components to fit in all low-cost vehicles.

10. FUTURE SCOPE

Using more appropriate sensors we can make use of precise automation system by adding further Microcontroller-based systems. We can implement some more security features for an automobile. Similarly, other features like Bidirectional RF communication, Crash Lighting, Pathway Lights, Auto Beam Control, Remote Start Lighting, and Auto Cruise Control can also be added to the existing system. They can be introduced in Driverless cars.

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