Intelligent Windshield for Automotive Vehicles

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***Abstract*—Windshield control is a vital operation of driver during driving. The mountings fitted in the windscreen or also called windshield are essential to use for smooth driving. These can be automated by using sensors and microcontroller. A complete windshield controlling system has been developed here to increase human comfort and flexibility. The wiper has been controlled by a water level sensor which regulate the wiper motor through sensing the level of water or rain. A dust sensors has been integrated to spill some water in the windscreen and then wipe it. It senses when a certain level of dust get accumulated in the screen. The sun visor which is mounted inside the car to shade the driver's eye from sun would be easier to control by a servo motor. Here an automatic sun visor has been designed to be controlled through a light sensor which is used to measure the light intensity and send the signal to the main control unit. This project focuses on improving human comfort in the existing system so that the driver can pay full attention in driving at all weather even in dusty, rainy or summer.**

Keywords— Intelligent windshield, Smart windscreen control, Automation, Sun visor control, Wiper

I. INTRODUCTION

In recent years researchers are trying to develop automobile industry more and more for safety, reliability, flexibility and entertainment by modern computing and electronics. Consumers are expecting their car to be voice controlled, auto driven and GPS assisted visual directions for driving. Almost all consumer first go for checking electronic gadgetry before selecting a car. Bluetooth hands free, mp3 player, video/ TV players are even common phenomena for a car. These interactions with gadgetry could be very dangerous distraction for the driver. [1] Distraction or taking drivers eye off the road may cause devastating accidents. Southern part of Asian countries as well as Bangladesh has placed within 100 top accident happening countries in the world (WHO 2011). [2] The National Highway and Transportation Safety Association reports that twenty six percent of all car accidents are caused by distractions due to talking on cell phones, eating while driving, and other similar distractions that take a driver's focus off the road. The distraction considered in this project is the adjustment of wiper speed based on the intensity of precipitation falling. The number of accidents caused by distraction can be slightly reduced by eliminating the need for drivers to adjust wiper speed. The traditional wiper system requires driver constant attention in adjusting the wiper speed using manual switch. And sometimes dust particles floating in the air are covered in the windscreen during moving vehicle which could be another cause of accident. The manual adjustment of the wiper and windscreen washing spray distracts driver's attention, which may be a direct cause of accident. This project is up to minimize the drivers work by setting up automatic control system for windshield mountings which are wiper, and sun visor. With drivers exposed to an ever increasing number of accidents, automatic rain-sensing wiper system, dust cleaning system and automatic sun visor system could be an even more appealing feature, as they work to minimize the time the driver must take his/her hands off the wheel. By using rain sensing device the wiper can be automated and light sensor can be useful to regulate the sun visor without even touching it. The pivotal concern is to render more attention of the driver on the road.

II. BACKGROUND

In spite of many endeavors to develop an effective and reliable rain sensing wiper control system, it is relatively uncommon in modern vehicles. Sun visor control is not even implemented commercially. Hyundai motors have employed some sensible wiper controller by using optical sensor. [3] These sensors reflect infrared ray in the windscreen to detect presence of water. It is very vulnerable to false data due to imitation of rain by dirt or other particles in the windshield. Another possible cause to disincline towards using optical sensor is the large size, which may obtuse the aesthetic view of luxury cars. However optical sensor is used, capacitive sensors are more effective for this purpose. It covers more sensing area and not prone to be false-positive. The sensor detect and relay the presence of water in the windshield to the body control module (BCM). [4]

Once windshields were made of ordinary window glass that could be broken easily and damage the passengers during crash. Recently windscreen became a safety device as too seat belts and airbags. The installation of the glass is done with an automotive grade urethane designed specifically for automobiles. The glass is made by adjoining two curved tempered glass as a sandwich with a laminated plastic inside them. [5] The windshield has some mountings on it as wiper, water spraying system and a sun visor inside the car. A wiper generally consists of an arm, pivoting at one end and with a long rubber blade attached to the other. The blade swung to and fro over the glass, wiping water droplets from its surface. The speed can be adjusted by the regulator posited at the right side of the steering wheel. Figure1 shows a manual wiper regulator

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with the wiper at the right side of it. Most automobiles use two synchronized radial type arms, while many commercial vehicles use one or more pantograph arms.

Figure 1. Manual wiper used in the car windshield

Most cars have two sun visors, one for the driver's side and a second for the passenger's side. They can be rotated to help shedding of the driver's eye. Rotation can be done over the left/side window side. Figure2 depicts the real time image of a sun visor used in a car's inside.

Figure 2. Sun visor and its extension mounted in a car's inside

The sun visor's flap is typically made from pressboard with a piece of metal for its attachment onto a mounting bracket which is often a metal rod with a slight bend in the middle and a bracket that attaches it with screws to the sheet metal above the headliner. The bend in the rod serves to hold the visor flap in the desired position and the flap is covered with a material, most often to complement the interior of the vehicle. Padding on the sun visors became popular for the extra protection afforded to passengers.

III. PHYSICAL COMPONENTS

A. *Wiper mechanism*

Each automotive vehicle is incorporated with wiper mechanism to clean the windscreen when needed. It has multiple components linked along to serve its purpose. Such as wiper motor, cam assembly, wiper blades, joining nuts etc. Figure 3 illustrates a complete sketch of wiper mechanism used in the earlier cars (1990-2004). [6] For automatic control of the wiper some components are used to create the control system. Such as water sensor, dust sensor, microcontroller board, relays etc.

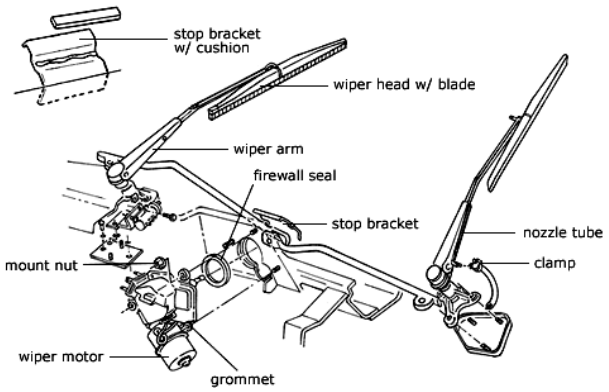

Figure 3. Sketch of wiper mechanism components [7]

B. *Microcontroller*

In this project Arduino UNO board has been used. The model is ATmega328, working voltage range is 5~12V. It contains 20 pins as 14 input output digital pins and 6 analog pins. Figure 4 shows ATmega328 microcontroller. [8]

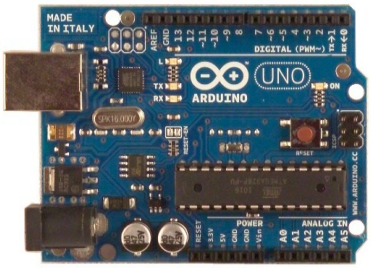

Figure 4. Arduino UNO board

C. *Sensors*

Three sensors have been used for this project.

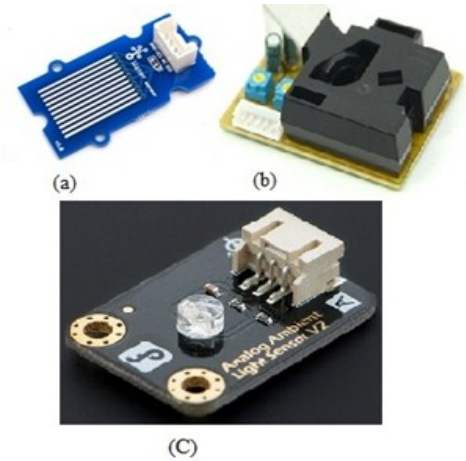

Figure 5. (a) water sensor (b) dust sensor (c) light sensor

Water sensor, dust sensor and light sensor. Figure 5 provides visual image of these sensors. The water sensor indicates whether it is dry, damp or completely immersed in water by measuring conductivity. The sensor traces have a weak pull-up resistor of 1 MΩ. This dust sensor measures the particulate matter level in air by counting the Lo Pulse Occupancy time (LPO time) in given time unit. Light sensor module help to detect the light density and reflect the analog voltage signal back to the controller Board. In this project a capacitive sensor has been used.

D. Motors

The mechanism behind the moving wiper is the windshield wiper motor, which provides the capacity to run. A linkage converts the rotational output of the windshield wiper motor into the back-and-forth motion of the wipers. A worm gear controls the force that the windshield wiper motor delivers to the drive arm by slowing down the speed of the electric motor by 50 times while multiplying the torque by 50 times. [9] Figure 6 shows both motors used in this project. 6(a) is the wiper motor specially designed for rotating the wiper arm according to the speed provided by the switch. 6(b) is the servo motor used to rotate the sun visor.

Figure 6. (a) wiper motor (b) servo motor

IV. METHODOLOGY

Automotive vehicle is mounted with a windscreen at its front. It serves its purpose as the switch gets on manually by the driver which is situated alongside the steering wheel. Its function is to keep the windscreen clean from raindrops, snow, dust etc. This project aims to develop an automatic control system for the wiper where the driver won't have to turn ON the switch manually. A control system has been developed which contains water sensor, dust sensor, light sensor, relay switches, wiper motor, servo motor and Arduino microcontroller.

A water sensor is attached with the windscreen which gives signal when even a small amount of raindrop falls. The microcontroller receives the signal through relay and act as it has been programmed. Through this process the wiper responses with the raindrop. Here a dust sensor is also attached which responses after getting a certain amount of dust in the windscreen. By the same process it open up the spray pump to spill water in the windscreen which again gives signal through the water sensor and make the wiper motor ON. It should be noted that the wiper motor speed vary with the level of immersion of the sensor.

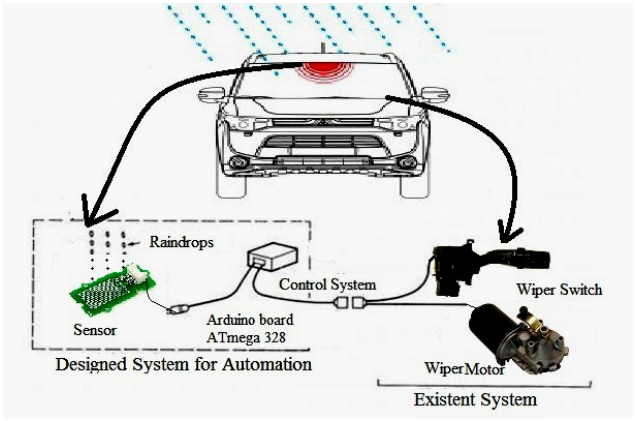

Figure 7. Schematic sketch of the developed system

Figure 7 provides a complete diagram of the automation process. For sensible turning of sun visor a light sensor could be attached in the windscreen. To rotate the sun visor to a comfortable position of the driver the shaft of the servo motor must be rotated according to the signal. When sunlight fall on the light sensor, it will measure the light intensity using reflection as well as send the signal to control board. The servo motor turns on when light intensity gets higher which may cause a distraction for the driver. Servo motor transfers the rotation to the flap of sun visor which is set at an angle for shading the eye and face. Figure 8 depict the rendered image of designed sun visor. It will rotate by the power given to it according to the program uploaded in the microcontroller.

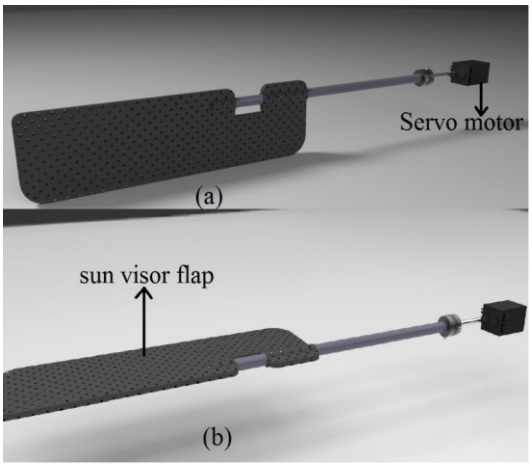

Figure 8. (a) Open flap (b) Closed flap of sun visor

V. DESIGN AND MODELLING

A. Design

As water sensor can detect the quantity of water using its contacting surface, it can be read as analog input to control the wiper motor speed at different speed. Other sensors have been connected as analog input pins in order to design variable speed for motors. All outputs are connected to the

microcontroller by digital pins. Three LED is used to investigate the sensor activity as they are working or not. A 5mm blue LED is used for water sensor and red one is used for Dust sensor. When the sensors sense the water, dust and light the LED will be turned ON. The main purpose of these LED is to notify whether the sensors are working or not. So that any malfunction can be detected very easily. Figure 9 illustrates the complete block diagram of the control system. Three LED are used which turned on when sensors provide some signal to the microcontroller.

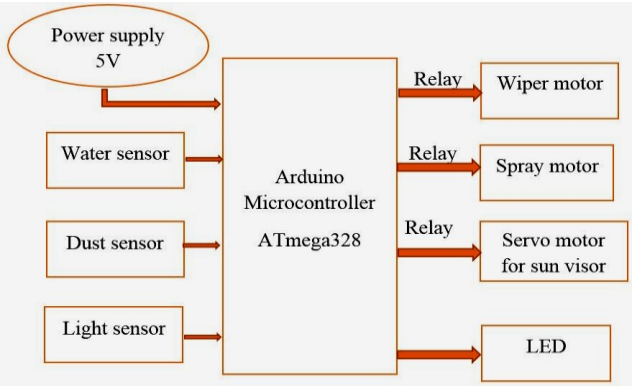

Figure 9. Block diagram of the control system

B. *Modelling*

The program is uploaded to the Arduino to run the system according to the desire. The program is based on the flow chart shown in Figure 10. In the flow chart sensors are used as the decision variable for the program. When water sensor sense water the voltage changes. When water intensity increases the motor speed need to be increased also. So when voltage increases motor speed automatically increases by sensing the water immersion level. The LED becomes ON when sensors work perfectly. A new system has been designed and developed using servo motor to use as a sun visor. It only opens when high sun light is perceived. Closing has been kept manual to minimize the mimicking of low sunlight. That is why the logic is not shown in the flow chart at Figure 10. The Arduino integrated development environment (IDE) is a cross-platform application written in Java, and derives from the IDE for the Processing programming language and the Wiring projects. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and is also capable of compiling and uploading programs to the board with a single click. A program or code written for Arduino is called a sketch. Arduino programs are written in C or C++. The Arduino IDE comes with a software library called "Wiring" from the original Wiring project, which makes many common input/output operations much easier.

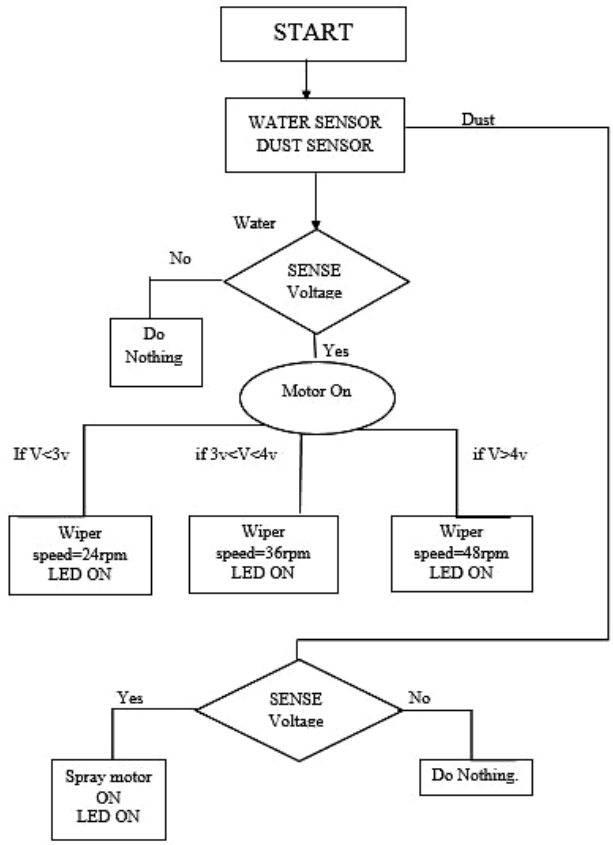

Figure 10. Flow chart as a logical expression of the Arduino program to control the wiper

VI. RESULT AND DISCUSSION

A. *Result*

For wiper top motor speed= 2400rpm;

The worm gear in wiper mechanism reduce the speed 50 times and increase torque 50 times.

So the wiper top speed will be=2400/50=48 rpm

Using this we can vary speed of motor using various voltage level of sensor at 1800 rpm and 1200 rpm which will give the wiper speed 36 rpm and 48 rpm.

This variation of wiper speed is satisfactory for our requirement.

Given, servo motor rotational time= .12sec/60 degree

For requirement at an angle 110-125 degree,

Time required= (110/60*0.12) to (125/60*0.12)=.22sec to .25sec. If we want to have a required angle servo motor have to rotate for .22sec or .25 sec.

B. *Discussion*

The basic control unit of the hardware comprises of power supply unit, control switch, servo motor, wiper motor, water sensor, dust sensor, light sensor and the most important of all Arduino microcontroller board. The supply current has been delivered from the lead-acid battery used in each vehicle which maintains the continuous power to the

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controller, servo motor and the wiper motor. Motor driver circuit is linked with the wiper motor and the controller in wiper and servo motor circuit is adjusted with the controller. It responses with the controller either drive the motor or switch it OFF. Rain detection sensor detects the amount of water level on the windscreen and accordingly sends the signal to the controller. And dust sensor sense the dust and the controller switch of washer pump is connected to the controller which turns it ON or OFF. The water sensor is placed in such place in the windscreen so that it can detect rain drop and also sprayed washer fluid which is very important factor of this project. As before light sensor can measure the light intensity falling on its surface using reflection method and placed in the top side of the windscreen. Sometimes, as the sensors could not work properly and sensors area are small, 5mm LEDs are used to detect that the sensors are working properly or not. And so it can detect the problem so that necessary replacement can be done easily.

VII. CONCLUSION

This developed project is an improved version of intermittent wiper system and manual sun visor. This system reduces manual cleaning of windscreen and improved the driver's level of comfort to an extent. It can render a new dimension of comfort and aid to the drivers who work at night and traffic prone areas in all seasons where they already have to concentrate on brake and clutch. The automation of wiping and dust cleaning of windshield during rain will provide them much ease and help them concentrate on the basic ABC (accelerator, brake and clutch) of driving. Our further concern is to automate and develop the sun visor using a motor by speed reducing mechanism and provide maximum level of comfort for driver in over sunlight which will fully automatize the whole windscreen components. In a nutshell, our system features high accuracy, high sensitivity and reliability during cleaning. The system can also be used as a component of home automation system as too it can detect a sudden rain and dust on glass and notify people in the house or can shut off windows automatically.

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