Adaptive Headlights System for Vehicle using Arduino

S. Sanjay Kumar[1], E. Santhiya[2], S. Sivasakthi[3], H. Rabiyul Fahim[4], G. Madhusudanan[5]

[1,2,3,4]UG Student, Valliammai Engineering College, Chennai, Tamil Nadu, India
[5]Assistant Professor(Sel.G), Valliammai Engineering College, Chennai, Tamil Nadu, India

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Abstract - *The purpose of this project was done to focus on the design and working of an Arduino based Adaptive Headlight System (AHS) for automobile safety. The highest fatal accidents occur on the curved road at night time. In maximum cases, the recognition of objects in the traffic zone plays an important role. These facts point to the necessity of the role of automobile adaptive headlight systems [1]. The dazzling headlights also contribute to recognition of objects due to temporary vision loss. Components that are easily available in the market are suitable for adaptive headlight system. The system is designed to receive input from the sensors and manipulate the data which drives the motor connected to the headlights. Also, the headlights brightness is automatically varied to prevent glare on other drivers.*

Key Words*: *Adaptive Headlight System; Arduino; Curved road; Night driving; Reaction time; Servo Motor; Ultrasonic Sensor;

1. INTRODUCTION

A large number of fatal injuries occur after nightfall. A sound physiological explanation for this is advanced based on the poor temporal characteristics of rod photoreceptors. It is argued that processing information based on low brightness, dull targets is much slower than that for high contrast bright targets [2]. The main aim of this project is to develop an Adaptive Headlight System (AHS) also called an Adaptive Front-lighting System (AFS), to provide better illumination in the roads having steep turns and curved roads, particularly during night time. Adaptive headlights are an active safety feature designed to make driving in the dark or in low-light conditions safer by increasing visibility around curves and over hills. When driving around a curve within the road, normal headlights continue to shine straight ahead, illuminating the facet of the road and the actual path remains dark. Adaptive headlights, on the other hand, swivel their beams according to your steering input so the vehicle's actual path is lit up [3-4]. Figure 1 shows car A without AFS and car B with the AFS system. AFS therefore improves the driver's visibility during night driving by automatically turning the headlamp in the direction of travel according to curve road and the distance between two vehicles [5].

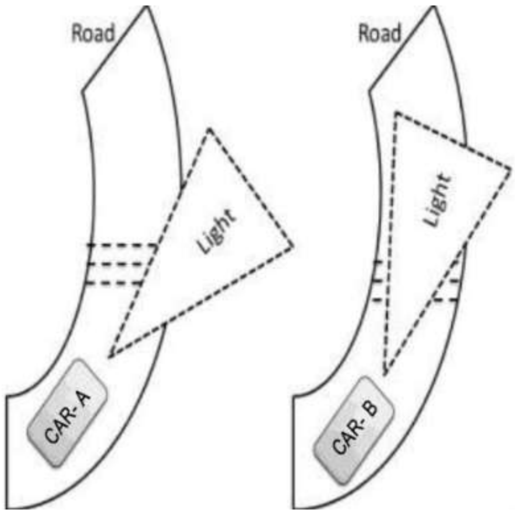

Figure 1. Car A without AHS and Car B with AHS

Momentary loss of vision of the driver will occur because of the dazzling of headlamps. Dazzling happens once when the headlights of the vehicle coming in the opposite direction fall directly into the eyes of the driver. This result in the driver being blinded momentarily and which results in an increase in the chance of accidents. This problem is more frequent when the road is curved. A vehicle with traditional headlights sends the light rays tangential to the curve of the road. Thus, the probability of dazzling lights in the eyes of the driver of the vehicle coming in the opposite direction is very high. This driver, along with his eyes momentarily blinded, can go off the curve and off the road and make a significant accident, hence, killing him and et al on the road [6].

Thus, there should be an economical mechanism to handle the issues of blind spots, dazzling of headlights and low visibility. In this paper, the planned system is one such solution that helps in preventing the associated accident by providing correct visibility to drivers by illuminating curves and bent paths such that the driver can be cautioned before he hits a life or an object.

2. SYSTEM ARCHIETECTURE

When driving on the curve road, an adaptive headlight system will change the lighting pattern to compensate for the curvature of the road to help enhance night visibility [5]. This is achieved by using a potentiometer to sense the steering wheel position and to detect the direction of rotation of the wheel. The readings of the potentiometer are read by the Arduino micro-controller and give the proper pulse width modulated (PWM) signal to the servo motors. The servo motors mechanically coupled to the headlights, thus illumination of curved roads is achieved.

The antiglare is achieved using HC-SR04 ultrasonic sensors which detects the presence of vehicles in front of our vehicle or oncoming vehicles. The Arduino reads these two sensors and processed to vary the intensity of the headlights, i.e. when a vehicle is close to our vehicle or a vehicle is coming towards us, the light intensity of high beam drops in order to prevent dazzling lights to the other drivers without sacrificing good illumination of the roads.

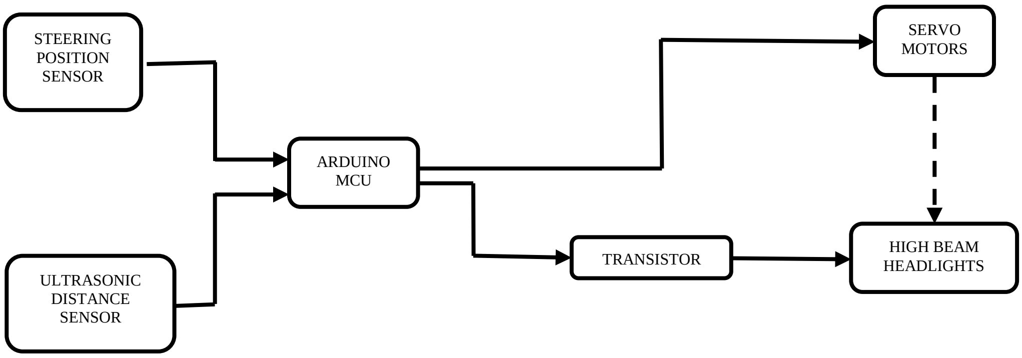

Figure 2. Block Diagram for AHS

2.1 Microcontroller

The main controller unit used is the Arduino Uno R3 as shown in Figure 3, which is interfaced with the ultrasonic sensor (HC-SR04), servo motor and the potentiometer. The Arduino consist of ATMEL Atmega328P is an 8-bit microcontroller with 32kB flash memory and speed of16MHz. The Arduino is selected because of its availability, low prices, reliability and uses C/C++ for programming [7-8].

Figure 3. Arduino Uno R3

2.2 Ultrasonic Sensor (HC-SR04)

It consists of a pair of ultrasonic sensors to detect the vehicles in front of our vehicle up to the range of 400cm. The microcontroller processes the data from the sensor and provides a signal to control the illumination intensity of the headlamp.

Figure 4. Ultrasonic Sensor (HC-SR04)

2.3 Servo motor (Tower Pro – MG995)

It consists of a pair of servo motors connected to each headlamp on either side of the vehicle as shown in Figure 5. The angular position of the servo motor is controlled by the PWM signal from the Arduino. The angular position of the steering wheel is determined by the potentiometer which acts as the sensor.

Figure 5. Servo motor (Tower Pro MG995)

2.4 Potentiometer

The potentiometer also called as pot, used is as the steering position sensor. The steering wheel can rotate up to 720° and for this purpose multi-turn potentiometer consisting of 3 or 5 turns is used. A simple geared mechanism attached to low power potentiometer is used to vary the output voltage. The potentiometer is initially set to a neutral position with the output voltage of 2.5V. The multi-turn potentiometer is shown in Figure 7.

Figure 7. Multi-turn precision potentiometer

3. ASSEMBLING AND OPERATION

The potentiometer is used as the steering wheel input the potentiometer will vary the voltage in the Arduino which is from 0V to 5V. The pot gives an analog voltage corresponding to the position of the steering wheel, and therefore Arduino needs to convert it into digital output via ADC. The Arduino board has a built-in 10-bit ADC converter and a full-scale maximum input voltage of 5V [7-8]. The conversion factor is given by the following formula:

$$\frac{V_{in}}{V_{full-scale}} = \frac{X}{2^n - 1}$$

Where X is the digital output and n is the number of bits. Another important factor is the resolution which is given as follows:

$$V_{resolution} = \frac{V_{full-scale}}{2^n - 1}$$

Therefore, the finest voltage increment which can be measured is 5mV. The actuator used in the TowerPro-MG995 servo motor. Again, the servo consists of 3 wires: red, brown, and orange. The red and brown are the positive and negative power supplies respectively, whereas the orange is for signalling. The signalling is actually a varying time signal, which in this case ranges from 1mS to 2mS for 180° rotation. This signal is called Pulse Width Modulation (PWM).

As mentioned previously the antiglare is achieved using the ultrasonic sensor. The sensor is activated by the 10μS pulse to the trigger pin. The module internally issued eight 40KHz cycle level and detect an echo. Once the echo wave is detected the sensor generates an echo signal with pulse width proportional to the measured distance. Figure 9 shows the timing diagram of the sensor.

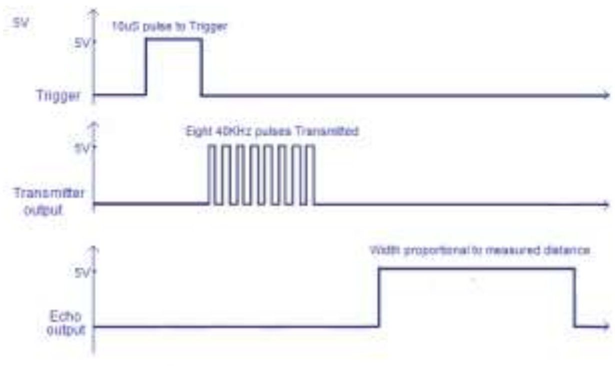

Figure 8. Ultrasonic Sensor timing diagram

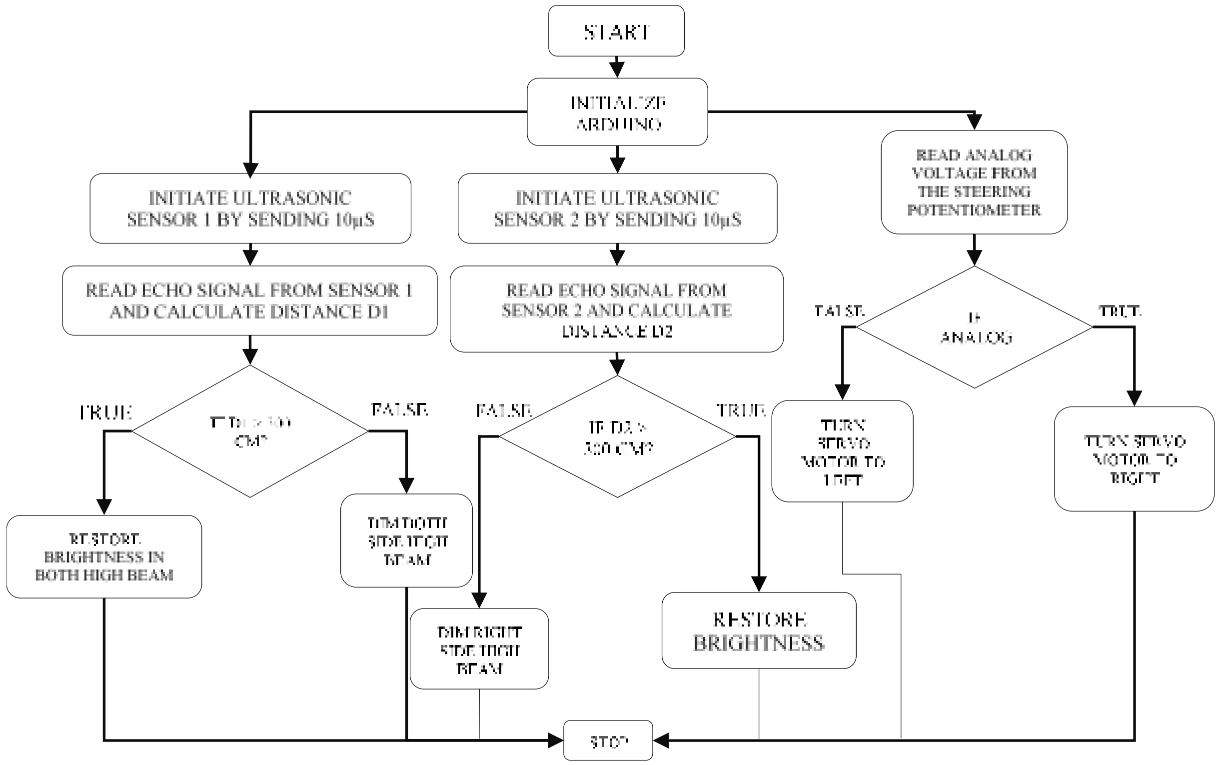

Figure 9. Software flowchart of the AHS

Figure 9 shows the basic software flowchart of the proposed AHS system. The headlights turn along with the servo motor when the output voltage of potentiometer rises above or falls below the median value (i.e. when the steering column is turned left or right).

The headlight is dimmed when the ultrasonic sensor detects the obstacles in front. There are two ultrasonic sensors, one to govern the vehicle moving in front of our vehicle and other to govern the on-coming vehicle.

When ultrasonic sensor 1 detects the vehicle is in front of our vehicle, the Arduino dims both the high beam headlights while the ultrasonic sensor 2 detects the on-coming vehicle, the Arduino dims the high beam headlights on the right side of the vehicle. When no vehicle is detected the normal brightness of the headlights is restored. The time taken by the pulse is actually for to and from travel of ultrasonic signal, while we need to take only half of this.

We know that Distance = ½ × Speed × Time and

Sound of speed at sea level = 343 m/s or 34300 cm/s.

Thus, Distance = 17150 × Time cm.

Finally, the Arduino will receive voltage signal from the potentiometer and the distance data from the ultrasonic sensor, which is then manipulated so that it will produce the required PWM signal for the control of the servo motor and the headlights.

4. RESULT AND DISCUSSION

To put this whole system into practical use, there is a critical function that need to be analysed, which is to determine maximum turning angle of the car, which ranges from 32° to 36° for either side. As the steering wheel angle is limited to 36° per side, the headlights which are mounted on the shafts of the servo motor and it rotates along with the turns of the servo motor for turn angle of 20° per side.

The theoretical results have been compared with the experimental results as shown in Figure 10. In this experimental test, the input voltage variable is measured by a multimeter and the motor position is measured using a protractor [11].

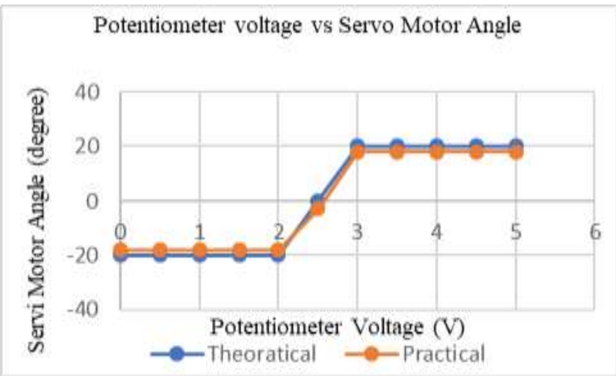

Figure 10. Potentiometer Voltage vs Servo motor angle plot.

The proteus simulation of our project is displayed in Figure 11. And Figure 12 shows the simulation of rotation of servo motor with various position of the servo motor.

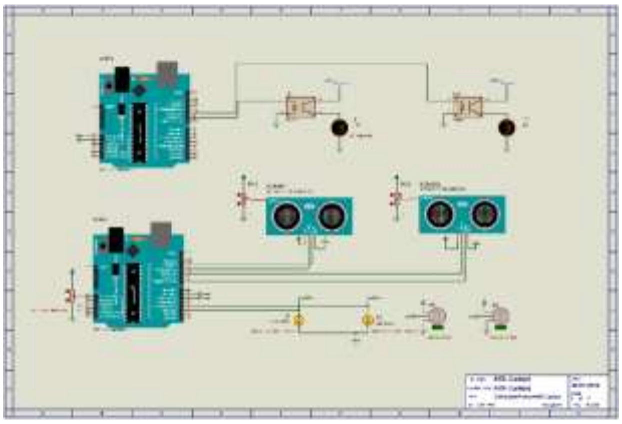

Figure 11. Proteus Simulation

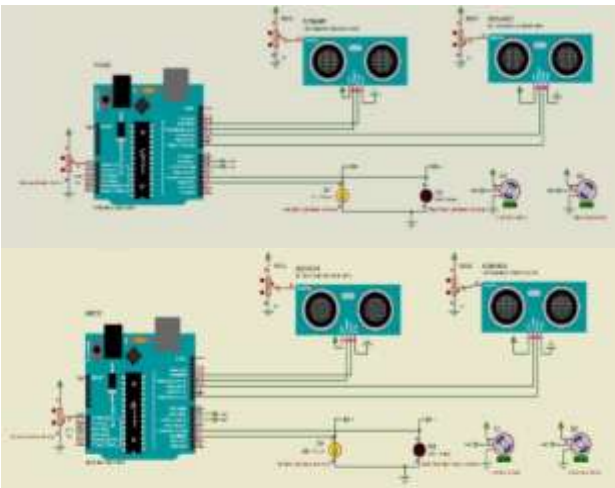

Figure 12. Servo motor rotation in simulation

Similarly, the ultrasonic sensor used for the distance measurement, mentioned above has a maximum range of 4.36m. Hence, the threshold is maintained at 3.25m below which the headlamp brightness is reduced and above which the normal brightness is restored. The ultrasonic sensor 1, governs the vehicles moving in front of our vehicle, and controls the brightness of both headlights, while the ultrasonic sensor 2, governs the on-coming vehicles, and controls the headlights on the right side only. Figure 13 shows the simulation result of ultrasonic sensors, in which the distance can be varied using a potentiometer in the simulation software.

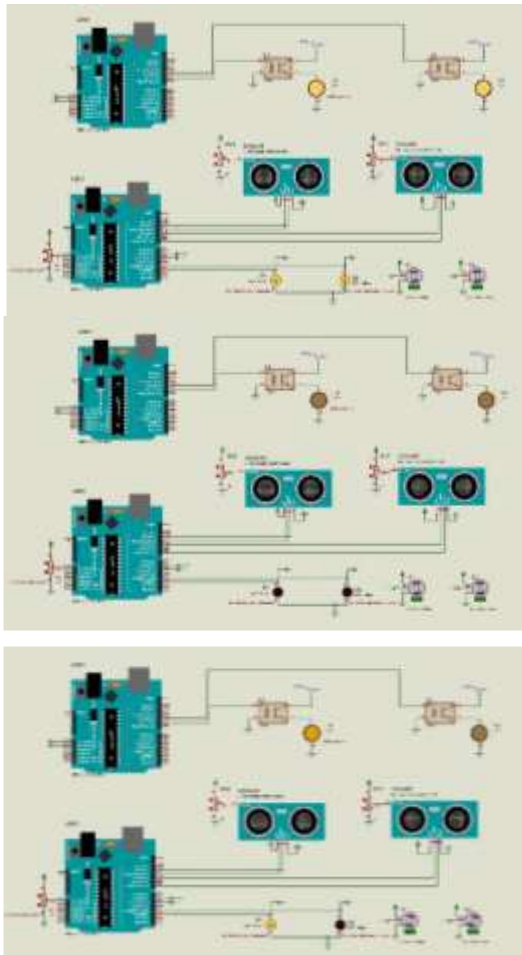

Figure 13(a). Simulation of ultrasonic sensors

5. CONCLUSIONS

The design and build of steerable headlights from standard static headlamps are achieved. Moving the headlights from left to right or vice versa continuously corresponding to a steering sensor is achieved. And the design and build of antiglare headlights using ultrasonic distance sensor are achieved. The main advantage of the headlamp system is to improve the visibility of the drivers particularly during the night, thereby avoiding accidents more efficiently.

Furthermore, the system is of inexpensive, simple and dependable assembly.

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