Design of Adaptive Headlights for Automobiles

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Abstract: The highest fatal traffic accident rate occurs on curved roads at nighttime. Night time driving with conventional headlamps is particularly unsafe. Only 25% of the driving is done at night but 55% of the driving accidents occur during this period. The existing conventional light systems do not provide illumination in the right direction on curve roads. Due to this constrain, a need to understand an alternative technology solution. The aim is to improve visibility for driver and so achieve a significant increase in safety and driving comfort. This calls for a flexible front light for automobiles to illuminate road ahead in the night at corner. Adaptive front lighting system (AFS) helps improve driver's visibility at night time hence achieving enhance safety. AFS (adaptive front-lighting system) used to detect information about corner in advance with help of sensor which detect the information send it to motor to adjust headlamps to get the lighting beam which was suitable for the corner. Through this way, it could avoid "blind spot" caused by the fixed lighting area when coming into the corner, and improve driving safety.

Keywords: *AFS (adaptive front-lighting system) ,headlamps, Sensor ,Automobiles.*

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I.INTRODUCTION

Because the static headlamp just provides certain illuminating fields for drivers in the nighttime and is insufficient to serve for curved roads and intersection, Advanced Front-lighting System (AFS), has been proposed by many researchers and is catching increasing interest [1].

Over 80 percent of all road traffic accidents occur in darkness and bad weather – a compelling reason to put efforts into developing the next generation of intelligent lighting systems with multi-functional swiveling headlamps. The aim is to improve visibility for the driver, thereby achieving a significant increase in road safety and driving comfort. Various studies on swivel-beam headlamps have shown up to a 30% increase in the illumination of the driver's gaze point as the vehicle turns into a corner. The additional corner illumination results in a 58% increase in the driver's ability to recognize an obstacle [1].

The current static headlamp provides illumination in tangent direction of the headlamp without any consideration towards the turning angle of road and the distance between incoming vehicle and subject vehicle. The driver is therefore subjected to insufficient illumination and unreliable or incomplete view of the road. It is therefore imperative to study new technology. Adaptive front light system (AFS) is an innovative technology and is being studied by researchers across the globe. The AFS controls the aiming direction and lighting distribution of the low beams according to turn during cornering or turning and distance between the incoming and subject vehicle [1-5].

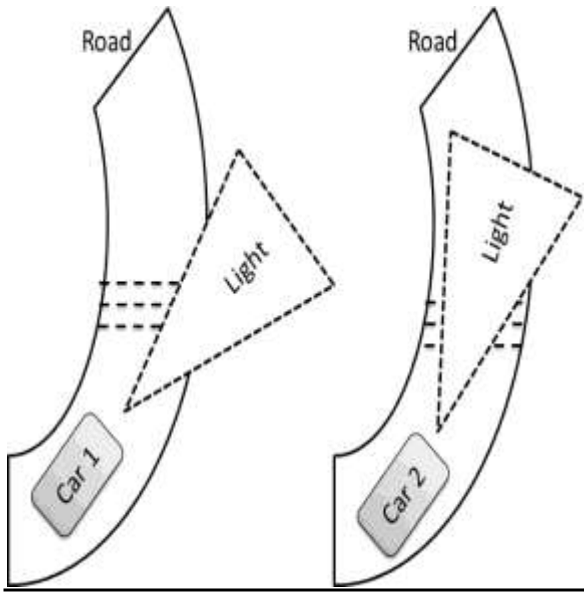

Figure 1: Car 1 without AFS and Car 2 with AFS

When driving on the curve road, Adaptive front light system (AFS) will change the lighting pattern to compensate for the curvature of the road to help enhance night visibility. Fig 1 shows car1 without AFS and car2 with AFS system. AFS therefore improves 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. [6]

Newly developed an adaptive front-lighting system based on CCD which was better than the traditional one. This new kind of AFS uses CCD image recognition technology to collect corner information from a certain distance. And then it adjusts different angles of dipped headlights in advance according to the corner information collected. After that it will fulfill the pre-regulation of headlamps to ensure light coverage area when coming into a corner and avoid appearance of lighting visual "blind spot". This way, it can adapt to corner condition in advance through CCD [8].

A. General Problem:

The general problem is to design a system which can amylase road conditions to identify situations in which adaptive road illumination system could enhance visibility, and thereby substantially improve safety and/or comfort for road users. The main goal of this proposed project is to discuss ways in which the present, static vehicle illumination systems could be improved by making them dynamic more adaptable to the ever changing road conditions.

B. Specific Issues:

Standard headlights shine straight ahead, no matter in which direction the car is moving. When going around curves, they illuminate the side of the road more than the road itself. it is proposed design a system to achieve horizontal movement of the headlamp in accordance turning angle of road thereby illuminating in the proper direction and to achieve vertical movement of the headlamp in accordance to the distance from the incoming vehicle or any object , thereby increase drivers' visibility and reduce glare to oncoming vehicles in various traffic scenarios.

Figure 2. shows the conventional headlight which illuminate more side area rather than road while the adaptive headlight illuminates road area more.

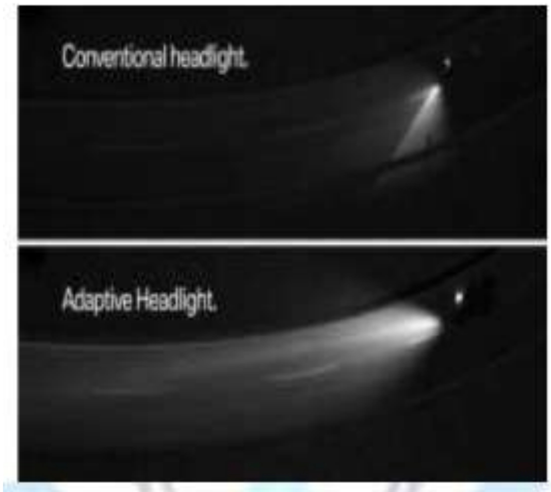

Figure 2:Conventional Vs adaptive headlight system

II.METHODOLOGY

A. Proposed Design:

Designing a system which can detect the rotation for headlights with high sensitivity and then processing the output of the sensor using microcontroller and then directing the motors attached to the head light.

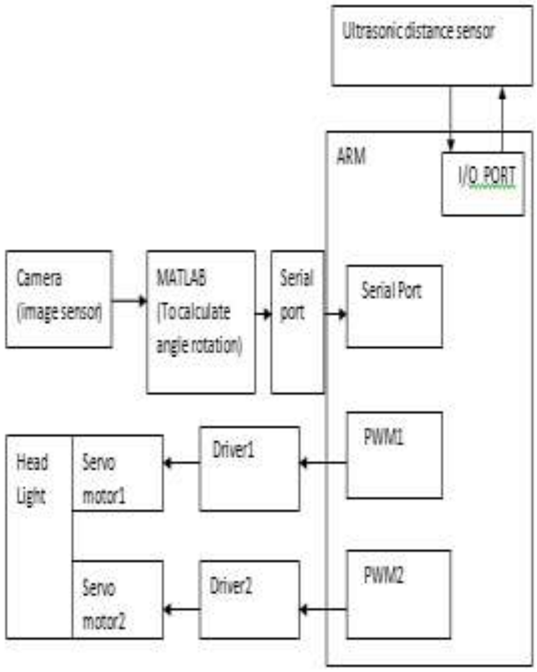

Figure 3: Block Diagram of proposed design

The block diagram of the proposed Adaptive Front Light System is shown in Figure1. To get clear visual on road and obstacles on road at night time along curved road, it is necessary to turn headlight along that direction In this system Camera (image sensor) is used to detect information about the corner and that RGB image is converted into HSV plane and from that image we are going to calculate angle of rotation for headlamp which acts as angle sensor. This information is send to the controller and controller unit processes the input and updates the PWM width. The output is feed to the servo motor and servo motor helps to rotate headlight horizontally.

Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor.

Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object and achieve vertical movement of the headlamp in accordance to the distance from the incoming vehicle or object.

B. Hardware And Software Requirement :

1. PC with MATLAB
2. KEIL
3. Ultrasonic distance sensor

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4. ARM Controller
5 .Servo motor

C. Principle Of Operation :

C.1 .Vertical turning of light in response to distance obtained:

Ultrasonic sensor has two signal pins. One is trigger and second is echo. Ultrasonic module needs trigger pulse of 10μs to initiate its operation. In response to the pulse an echo pulse will be generated with width proportional to the distance between the vehicles. A pulse will be received on echo pin. ON width of this signal is proportional to distance of obstacle. If distance decreases speed has to be decreased. So program will reduce ON width of PWM proportionally to distance from obstacle. The output if feed to the controller and the controller will update PWM width to rotate headlight vertically

vertical_servo_pwm = 18000 + (150 - (ultrasonic_cnt - 50)) * 60;

PWM waveform for vertical servo motor depends upon ultrasonic count. Ultrasonic sensor gives minimum width of 50 and maximum of 200. We have shifted down the lower limit to 0 by subtracting 50 from all the values. Now the range becomes 0 to 150. To preserve the relation that when object is at far distance headlight angle is up and if the object is nearer then headlight should be lowered, obtained count is subtracted from 150. Multiplication of 60 brings this count in the range of thousands and ensures full vertical span of motor is covered. 18000 count brings motor to lowermost point and any addition of remaining factor brings it to upper angle by some proportional amount.

C.2.Camera with servo for horizontal turning of front lights:

The controller unit processes the input from camera and updates the PWM width. The output is feed to the servo motor. This in turn helps to rotate headlight horizontally. Servo motor needs PWM pulse of 20ms period, min on time of 1ms and max of 2ms. As per ON width of pwm servo motor will have rotation angle mentioned in fig4.

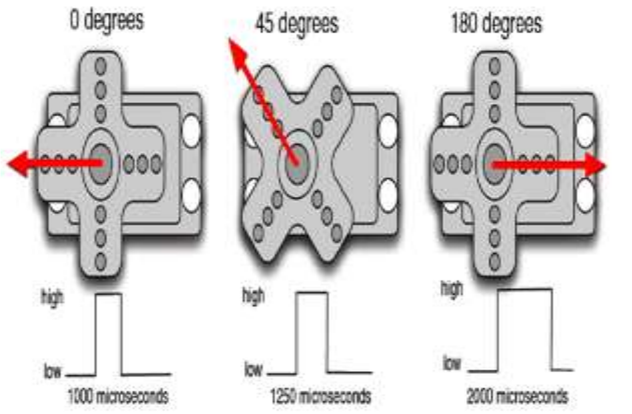


Figure.4 : PWM (Pulse Width Modulation)

Figure 5 shows four different PWM signals. One is PWM output at a 25% duty cycle. That is, the signal is on for 25% of the period and off the other 75%. Next shows PWM output at 50%, 75% and 100% duty cycles, respectively. These three PWM outputs encode three different analog signal values, at 10%, 50%, and 90% of the full strength

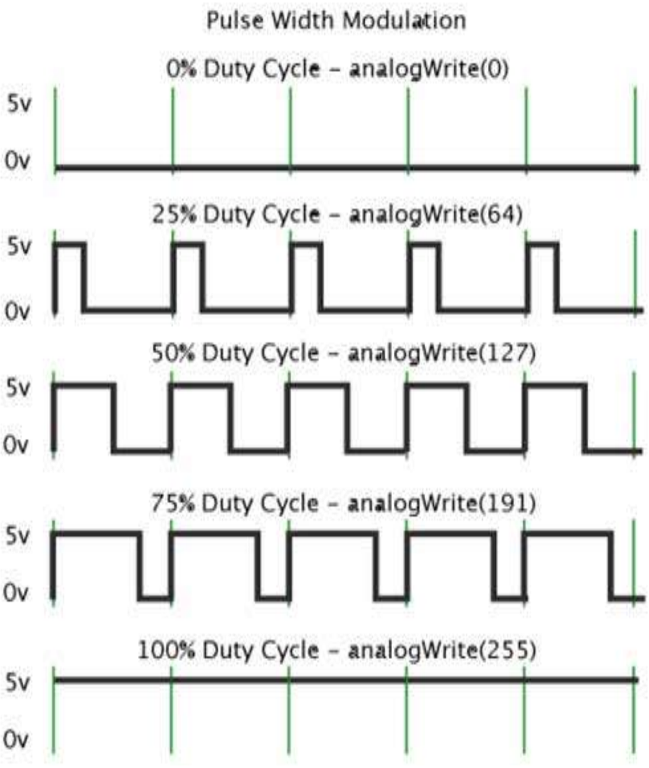
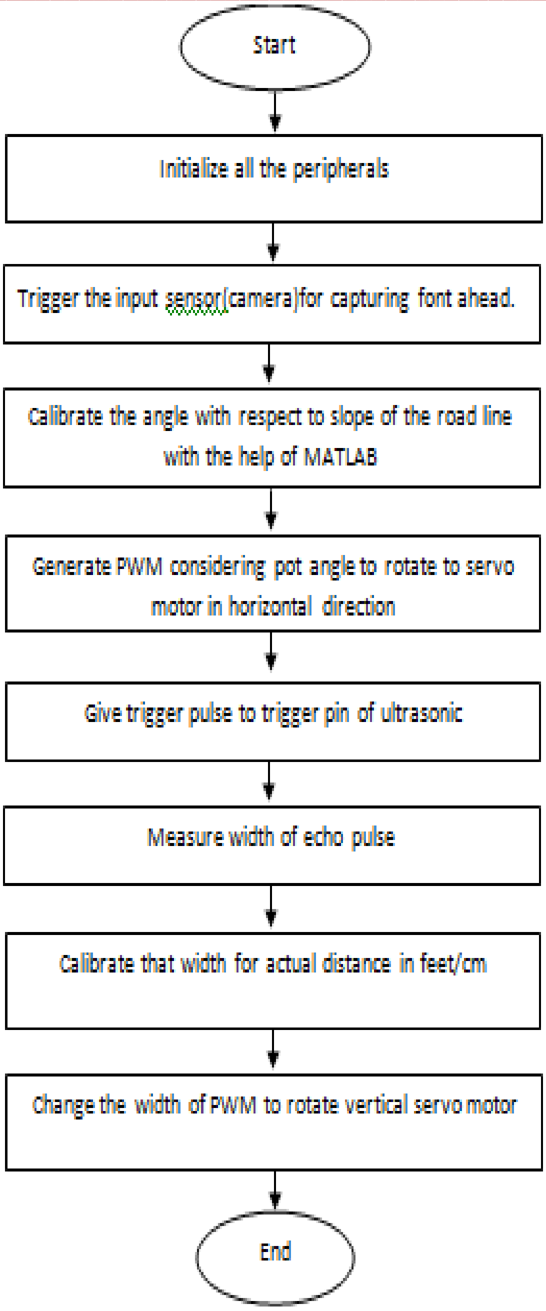


Figure 5 :PWM Outputs

C. Software Flowchart

Philips flash utility software allows uploading and execution of code. Keil tool by ARM (For ARM7 (LPC2148) μVision4 software is used for compilation purpose.Fig.6 shows the software flowchart of proposed system.



III.RESULTS

A.PWM Waveform Results

Figure 7: PWM waveform with 1ms + width

Figure.7 shows the signal period is always 20ms. PWM waveform with 1ms + width (ON time) shows that servo motor is rotating at 0 degree. In this case off time is 19ms.

Figure 8: PWM waveform with 2ms + width

In Figure.8, PWM waveform with 2ms + width shows that servo motor is rotating at 90 degree. Off time in this case is 18ms.

IV.CONCLUSION

The existing conventional light systems do not provide illumination in the right direction on curve roads. Due to this constrain, a need to understand an alternative technology solution. This paper propose the new system which is based on camera as input sensor to adjust the horizontal rotation of headlamp and this newly proposed Adaptive front lighting system (AFS) helps to improve driver's visibility at night time hence achieving enhance safety. The future work mainly concentrates on to invent a comprehensive AFS system which can be suitable for complex road conditions including related to this paper. road surface water, corner, highway, rural road and urban road and so on.

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