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Adaptive Front Light Control System for Every Vehicle

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***Abstract*– Major Road mishaps occur at night on account of curve roads and glare caused from the headlights of incoming vehicles. 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 system does not provide illumination in the right direction and at the precise angle. Due to this constrain, a need to understand an alternative technology solution. Adaptive front lighting systems helps improve driver's visibility at night time hence achieving enhance safety. The objective of this work is to design and build an Adaptive Front Light Control System Prototype. From the results, it is concluded that the headlamp swings in horizontal direction by sensing steering angle and vertical by sensing distance between subject vehicle and next vehicle. Accuracy, reliability and availability of the components were few considerations during the conceptualization stage.**

Keywords—Adaptive Front Light Control System, Conventional Light System, Steering Angle, Sensing distance.

I. INTRODUCTION

In our college, there was a big event held by the Traffic police about "Traffic Awareness" on 25th July, 2014. In that event they inspires and aware us about the traffic safety. They told us that the Major road mishaps occur at night on account of curve roads and glare caused from the headlights of incoming vehicles.

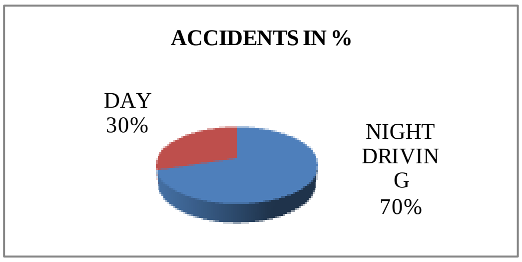

Figure 1: Graphical survey of accidents in percentage

Road accidents are human tragedy. They involve high human suffering and monetary cost in terms of untimely deaths, injuries and loss of potential income. Road safety is an issue of national concern, considering its magnitude and gravity and the consequent negative impacts on the economy, public health and the general welfare of the people.

Approximately 70% of vehicle to pedestrian accident occurred in night time

The current static headlamp provides illumination in tangent direction of the headlamp without any consideration towards the steering shaft angle 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 the amount of turn applied to the steering wheel during cornering or turning and distance between the incoming and subject vehicle.

II. METHODOLOGY

AFS will modify its lightning pattern while travelling turning of road or curvature of road. It will enhance the night visibility for drivers in night time.

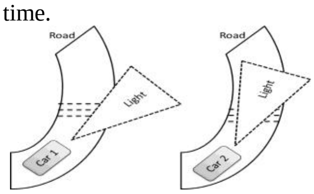

Figure 2: Car 1 without Adaptive Front Light Control System and Car 2 with Adaptive Front Light Control System

AFS therefore improves driver's visibility during night driving by automatically turning the headlamp in the direction of travel according to steering wheel angle and the distance between two vehicles.

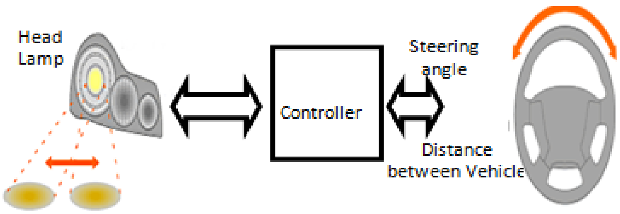

Figure 3: AFS Working

The aim is to improve visibility for the driver, thereby achieving a significant increase in road safety and driving comfort. The concept of this system is that while turning of the road the headlamp beam turns to follow the direction which was sensed by the steering angle sensor. Here, we are sensing angle using a POT for demonstration purpose. Good illumination results in a 58% increase in the driver's ability to recognize an obstacle.

III. OBJECTIVE OF PROJECT

To design and implement "Adaptive Front Light Control System for every vehicle" the following steps can be used:

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a) Achieve horizontal movement of the headlamp in accordance to steering shaft angle, thereby illuminating in the right direction with flashing of Strobe Light while turning the vehicle.

b) Achieve vertical movement of the headlamp in accordance to the distance between the incoming vehicle and the subject vehicle, thereby increase driver's visibility and reduce glare to oncoming vehicles in various traffic scenarios.

c) ARM is used to achieve system integration and to reduce chip count as well as cost.

IV. SYSTEM ARCHITECTURE

The developed System block diagram of Figure 4 shows that the system first collects inputs, processes them, and then moves the Servo motors as output.

LPC2148 an ARM7 series microcontroller is used to control the motor. The LPC2148 uses 16/32-Bit and has 512KB of internal flash and 32+8K RAM. It has inbuilt 14 channel 10 bit ADC, 6 channel 10 bit PWM and high speed of 60 MHz The choice of controller is determined by easy availability, affordable price, reliability and the fact that it permits the use of C language for its programming.

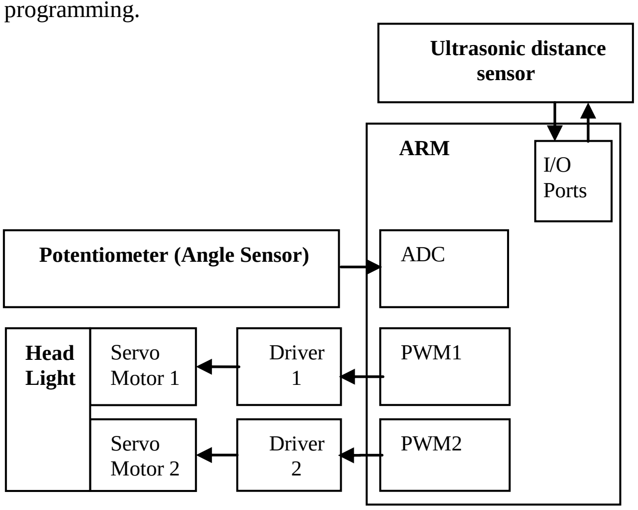


Figure 4: System Block Diagram

The position of the headlights is dependent on the direction of the vehicle so the input to the headlight system is attached to the vehicle's steering shaft. A simple geared mechanism is attached to a low-power type potentiometer that can then feed directly into the microcontroller. Potentiometer axle was turned as the steering shaft rotates at corners and therefore varies the voltage input. The voltage input that varies from 0-5 volts is converted into digital input via the A/D channel of the microcontroller. For example, if the headlight is set at the center with an initial voltage of 2.5V, if the voltage increases as the potentiometer turns, the microcontroller reads this voltage increment and will turn the motor as programmed.

V. WORKING

5.1 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

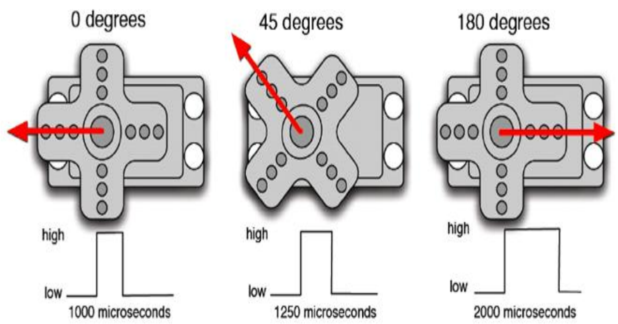
5.2 Steering Angle with Servo for Horizontal Turning of Front Lights

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. A 10K potentiometer is coupled to steering shaft. Potentiometer will generate varying analog voltage according to turning of steering. This voltage is fed to ADC and then is read by controller. The controller unit processes the input 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 **figure 12.**

5.3 PWM (Pulse Width Modulation)

PWM controls the analog circuits, it gives a digital output. It has various applications from communication to measurement and



controlling power and converting power.

Figure 5: PWM (Pulse Width Modulation)

5.4 Interfacing PWM:

Figure 6 suggests us that the 4 positions of PWM with duty cycles of 25%, 50%, 75% and 100%. 25% of duty cycle means the signal is on for 25% of period of time. These 50%, 75% and 100% duty cycles are encodes the different analog signals.

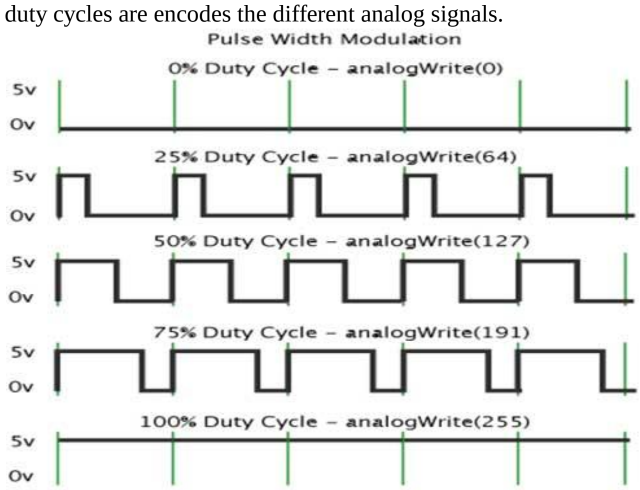


Figure 6: PWM Outputs

5.5 Interfacing PWM with LPC2148

PWM can be generated on LPC2148 board at a particular frequency. PWM is a technique of getting the analog signals in digital form. Digital means, we get a square wave with HIGH (on) and LOW (off). This is achieved by changing the pulse width.

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5.6 Formula Used in Program for Calculating Required PWM Width

$$vertical_{servo_{pwm}} = 18000 + (150 - (ultrasonic_{cnt} - 50)) * 60$$

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 counts bring motor to lowermost point and any addition of remaining factor brings it to upper angle by some proportional amount.

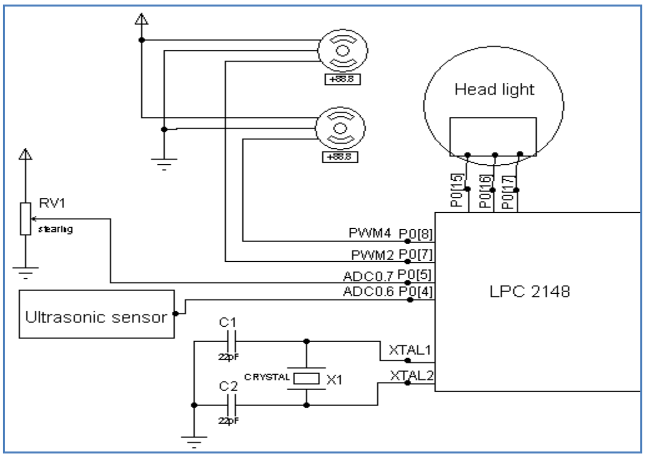
$$horizontal_{servo_{pwm}} = (1024 - adc_{read(0,3)}) * \left(\frac{1024}{280}\right)$$

ADC being of 10 bit gives number 1024 corresponding to 3.3v input. Potentiometer is used for angle measurement and potentiometer rotates from 0 degree to 280 degrees. The factor (1024/280) converts maximum range of 1024 to 280. Here potentiometer is interfaced to channel 3 of ADC0. ADC value subtracted from 1024 ensures correct direction of rotation of servo motor with respect to direction of turning of steering.

VI. SOFTWARE CONFIGURATION

6.1 Software Flowchart

ARM IDE tool allows uploading and execution of code. Program can write in the C language or Assembly language.



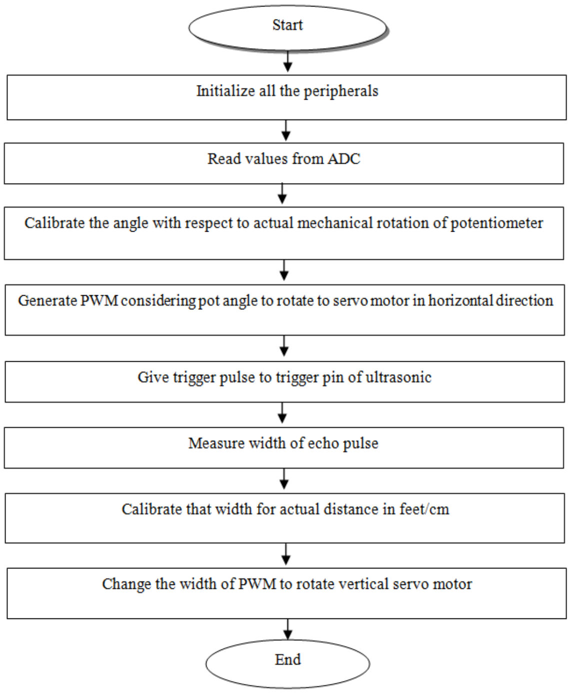


Figure 7: Software Flowchart

6.2 Main Circuit Diagram

Figure 8 shows the interfacing connections between ARM LPC2148, Ultrasonic sensor, Servo motors (Horizontal and vertical movement), Head Light.

Figure 8: Main interfacing Circuit schematic.

VII. DISCUSSION

7.1 Application

- User Friendly.
- Can used in small and big scale vehicles.

7.2 Advantage

- Fully automated front lightening control takes place.
- Accidents at night time may get reduced.
- Safety provided to the pedestrian, cyclists

7.3 Future Scope

This system relies on information obtained from various sensors and considers only a next vehicle. A step forward can be achieved by adding computer vision based image processing algorithms. Instead of only fixed ultrasonic module we can add radar type mechanism to scan the vehicle coming from all directions. With this consideration, a neighboring and backside vehicle can also be traced. A second dimension may also use external input from satellite positioning (GPS or Galileo) to determine current road environment in order to control desired light distribution. The current system tested has no user interface allowing system parameters to be set or overridden by the driver. Accordingly the learning process is different form a user controlled interface, e.g.

Adaptive Cruise Control, were the user controls and learns to set system parameters according to his/her preferences. According to suppliers the current automatic AFS system matches user preference for desired light distribution in 90% of the driving situations.

The AFS system should thus alleviate the driver in choice of light distribution choices, provide safety profits in terms of enhanced perception of the night-time environment reduce accident risk, driver workload and increase driver comfort and possibly exhibit positive effects on traffic flow

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VIII. RESULT

After interfaced the POT with ARM DEVELOPMENT BOARD and measured the steering angle which was from 0 to 255.Middle constant position can be nearly value of 128.

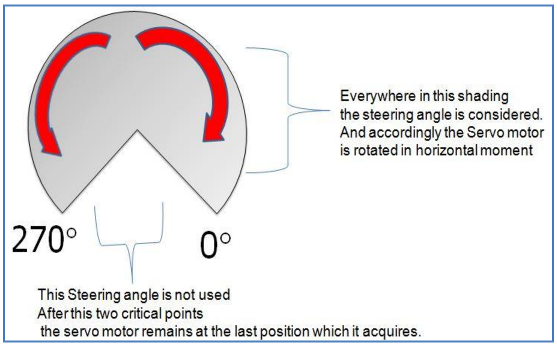

Figure 9: Result from POT movement

Results which are observed are shown in figure 9, with steering angle changes, results in change of the direction of headlamp. There are two cases:

- Everywhere in this shading the steering angle is considered. And accordingly the Servo motor is rotated in horizontal moment.
- This Steering angle from 270° to 360° is not to be used. After these two critical points the servo motor remains at the last position which it acquires.

IX. CONCLUSION

The Adaptive Front Lighting System is a system which regulates automatically the light distribution of a vehicle. A specific control algorithm is developed for different driving conditions – curve roads and incoming vehicle's. AFS can be formally defined as maintaining a presumptively desired light distribution adapted to the above road environment. The system tested does so by way of input from in-vehicle parameters like steering wheel angle and distance between incoming vehicle and subject vehicle etc.

The horizontal headlight movement through movement of steering shaft and vertical movement of headlamp due to distance between the two vehicles is achieved by the means of AFS system architecture. Few critical design factors considered during inception stage were ease of availability, affordability and reliability of the components use. It is also observed that the system can be accommodated in the current low cost models without major changes.

AFS appears to offer potential for a favorable night driving behavior potentially reducing accident risk, compared to standard headlights.

X. REFERENCES

[1] Meftah Hrairi and Anwar B. Abu Bakar "Development of an Adaptive Headlamp Systems" International Conference on Computer and Communication Engineering (ICCCE 2010), 11-13 May 2010, Kuala Lumpur, Malaysia

[2] Weifeng Wang, Qing Wu, Zhiyong Lu, Xiumin Chu , "Control Model and Simulation for Adaptive Front light System of Vehicle on Curve Roads"2010.

[3] T. Aoki, H. Kitamura, K. Miyagawa, and M. Kaneda, (1997). "Development of active headlight system," (SAE Technical Paper Series No. 970650). Warrendale, PA: Society of Automotive Engineers, 1997.

[4] H. Hogrefe and R. Neumann, "Adaptive Light Pattern – A new way to improve Light Quality," SAE 970644, 1997

[5] Dr Joachim Damasky, Dr Arn Hosemann, "The Influence of the Light Distribution of Headlamps on Drivers Fixation Behaviour at Night", SAE 980319, 1998.

[6] C.K. Chan, K.W.E. Cheng and S.L.Ho, "Development of packaging and Electrical Interfacing for Electrical Vehicles", Proc PESA '06, pp.234-24-.Nov 2006.

[7] Varghese, Cherian; Shankar, Umesh (May 2007)."Passenger Vehicle Occupant Fatalities by Day and Night – A Contrast". Traffic Safety Facts, Research Note (DOT HS 810 637) (NHTSA's National Center for Statistics and Analysis). Retrieved 2010-12-30

[8] "EUREKA AFS task force". Memagazine.org. Retrieved 2012-01-31 July 03, 2012 Status Report of HLDI. HLDI is a nonprofit research organization that publishes insurance loss statistics on most car, SUV, pickup truck and motorcycle models on U.S. road.

[9] Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958. Addendum 122: Regulation No. 123 6-Dec 2012. http://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2013/R123r1am3e.pdf

[10] Source: FARS Encyclopedia, Public Roads. C. Falcon, "Stepper Motors Assist Adaptive Headlights," Retrieved August 5, 2007, from http://www.automotivedesignline.com/.

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