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FPGA based Adaptive Front Light System (AFLS)

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Abstract-Road accidents are human catastrophe. They involve high human pain and cost in terms of untimely deaths, injuries and loss of potential income. Road safety is an issue of countrywide concern, considering its amount and importance and the consequent negative impacts on the financial system, community health and the universal welfare of the people. Driving in the hours of darkness has its reward, such as lesser traffic levels and cooler temperatures (FPGA climates) but many riders choose not to do it because they feel unsafe enough. This has a lot to do with the straightforward reality that basic vehicle headlights are not good enough to illuminate the road ahead to match the speed the driver wants to travel at. in addition, a lack of adjustment often means that the headlight cannot compensate for changes to driving and load conditions, and ends up glowing in a straight line towards approaching traffic rather than assisting the driver„s vision. Another key drawback for many drivers is that, quite simply, they cannot see far enough into corners, as traditional permanent headlights cast their beam straight ahead only. As well as blinding other road users in bends, this also leaves the driver„s area of the road in darkness, which can compromise safety. 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 swivelling headlamps.

Keywords- Adaptive Front Lighting System, Conventional Light System FPGA, Steering Angle, Sensing distance.

1. INTRODUCTION

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 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.

AFS therefore improves drivers 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. The aim of this project is to build a cost effective. Adaptive Front Light System‟ that will help achieve increases safety, comfortless and reliability. The new design and build should modify and fit into an existing fixed headlamp with a very close eye on cost and reliability. Use of existing headlamps will also allow the AFS addition to maintain the vehicles conformity to existing vehicle aesthetics as well as government

regulation. The objectives to achieve of this project are Achieve horizontal movement of the headlamp in related to angle of steering shaft, thereby focusing in the right direction andAchieve vertical movement of the headlamp in accordance to the distance between the subject vehicle and the incoming vehicle, thereby enhances drivers‟ visibility and reduce glare to oncoming vehicles in various traffic scenarios.
In combination with discharge headlamp, the scheme illuminates a better distance and more brightly compared to halogen headlamp, refining the driver's pitch of vision and visibility around curves and at intersections during night-time driving. Coupled with the auto-adjusting function, the scheme offers a steady delivery of light unaffected by the vehicle's position. Preserving the illumination axis, the scheme helps to prevent drivers of approaching vehicles from getting blinded when many people or a lot of luggage weighs down the back of the car, or when the vehicle location changes going over a bump or driving up a slope.

II. BLOCK DIAGRAM

The intention here is to disassemble the conventional headlight and adapt the projector light for beam rotation. In order to manage system expenses and complication, a simple framework was laid out for the developed adaptive front light system. The system consists of three chief components: input sensors, a FPGA as the head of the system, and a motor for rotating the headlights.

2.1. Sensor Block

The sensors used are ultrasonic distance sensor and potentiometer as steering angle sensor. It is expected that the position of the headlight will change in accordance with the steering shaft. Therefore the potentiometer, attached with the steering shaft, takes input from steering shaft sends analog signal to the ADC. This helps in horizontal movement of the headlamp. Correspondingly the vertical movement of the headlight is achieved through ultrasonic distance sensor.

Figur1.Basic block diagram

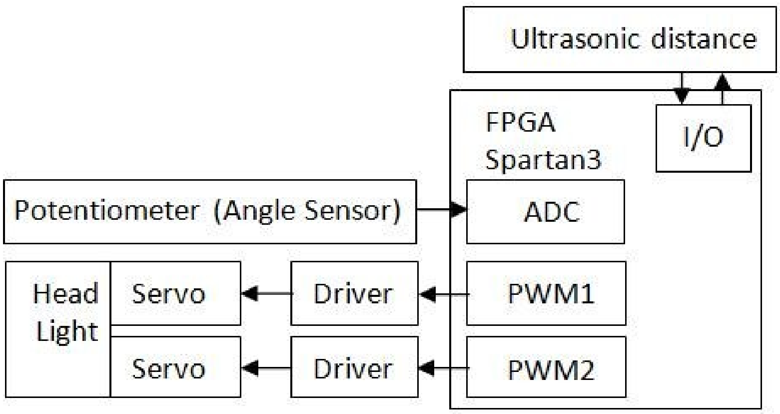

Figure2.System Block Diagram

2.1.1. Potentiometer (as steering angle sensor)

A potentiometer is a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used variable resistor.A potentiometer measuring instrument is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same standard, hence its name is potentiometer.

Figure3.Potentiometer

Figure4. Ultrasonic Sensor

2.1.2. Ultrasonic sensor

This sensors work on a principle just like measuring instrument that evaluates attributes of a goal by decoding the echoes from radio waves or sound waves severally. It generates high frequency sound waves and evaluates the echo that is received back by the device. Sensors calculate the fundamental measure between causing the signal and receiving the echo to determine the space to an object.

2.2. FPGA

It act as controller of whole project and it is fully assembled with Xilinx Spartan 3E and 4Mbit SPI Flash Memory. It provides an easy introduction to FPGA, Digital electronics and SOC design. USB Connection with two channels for JTAG and Serial communication.

2.3. Actuators

To make easy the movement of the headlamp depends on steering shaft, the headlamp is located on motors. The servo motorsis used as actuator a for horizontal movement. The rotating angle for servo motor for horizontal is 0-180 degree. It requires power source of 4.5–6 V.

Figure5. Servo Motor

2.4. Servo Motor

From the above table we conclude that servomotor was seemed to be more suitable for the adaptive front light system design since motor positioning is the most important criteria and servomotors usually come with a closed loop circuit that facilitates design.

Table1. Comparison between Stepper and Servomotor

Parameter	Stepper motor	Servomotor
Drive circuit	Simple. The user can fabricate it.	Since the design is very complicated, it is not possible to fabricate your own driving circuit.
Noise and vibration	Significant	Very little
Speed	Slow (1000 to 2000 rpm maximum)	Faster (3000 to 5000 rpm maximum)
Out-of-step condition	Possible (will not run if too heavy a load is applied)	Not possible (will rotate even if a heavier load is applied)
Control method	Open loop (no encoder)	Closed loop (uses an encoder)

2.5. PWM (Pulse Width Modulation)

PWM is a technique for controlling analog circuits with a processor's digital outputs. PWM is working in a wide variety of applications, ranging from communications and measurement to power control and conversion.

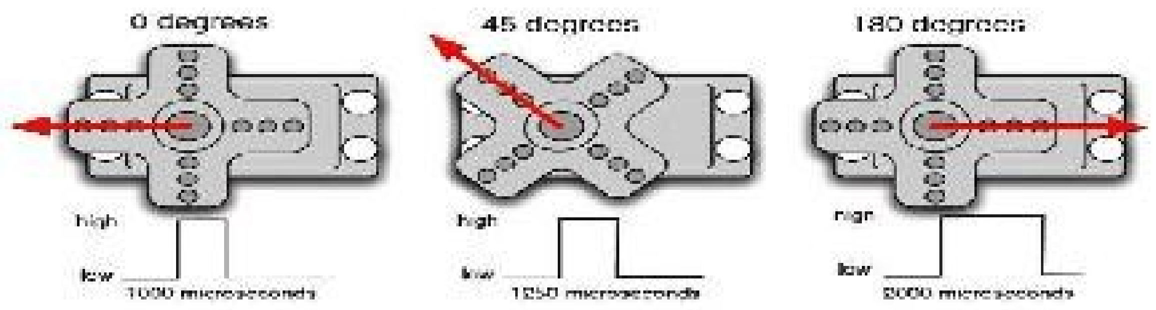

Figure7.PWM (Pulse Width Modulation)

III. FORMULA USED IN PROGRAM FOR CALCULATING REQUIRED PWM WIDTH

vertical_servo_pwm = 18000 + (150 - (ultrasonic_cnt - 50)) * 60 (1)

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 countsbring 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)) *(1024/280) (2)

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.

V.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 vehicles. 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. 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.

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