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Design of AFS system in automobiles on FPGA

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Abstract:- **AFS system or Automatic front light system is an add on feature in the modern vehicles which improved the safety of vehicle drivers and passengers travelling at night. FPGA is considered as a boon for the design engineers and is better considered now in many military applications because of its sustainability and efficiency to work in harsh environments. In this paper we have designed a AFS system on FPGA keeping the conventional light pattern to improve illumination at night and the safety of the users. This system uses DPWM technique with high resolution which provides us with better control over beam patterns and intensity of the headlamps.**

Keywords:- AFS, DPWM, beam pattern

I. INTRODUCTION

Headlamps are an important part in an auto-mobile vehicle which ensures the safety of the user at night providing adequate visibility. Better illumination reduces driver's fatigue while driving at night since he doesn't have to strain so much to see the road. Usually when a car takes a turn the lights to the turning side will be light creating more strain on the driver since he cannot see the road properly.

Fig 1: (a)car without AFS system (b) Fig 2: car with AFS system

AFS or Automatic Front Lighting system provides an adequate solution for this problem. When the car is taking a turn the AFS system allows the light to follow the turn with the help of stepper motors added to the headlamps which turns the lamp to the turning direction.

This system provides better visibility to the driver at turns ensuring the safety of the passengers and pedestrians. The AFS systems has also features like adjusting the light pattern according to the roads where we are driving which makes it more efficient at night time driving as shown in Fig 1. It can also adjust with the scenarios which we are driving as shown in fig 2. This is achieved by determining the speed of the car.

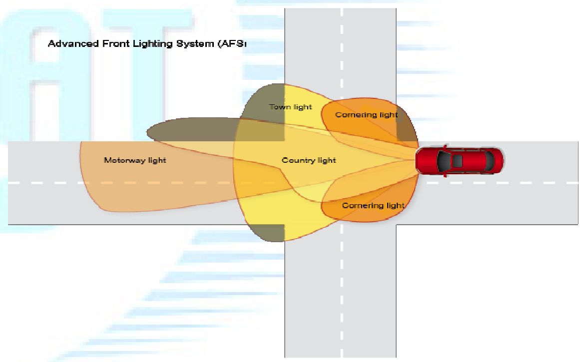

Fig 2: light pattern of AFS system at each scenario

The drawback of current AFS system is that it has no straight beam light ie, the conventional lighting and also confuses the other driver coming from the opposite direction while taking a turn which is crucial at huge turns because these straight beams ensure that the other vehicle coming from the opposite side sees the light of our car and be alert about our car at the time of the turn.

Fig 3: light to be seen at the turnings by our car

Most designs of AFS design consist of micro controllers [1] and these takes much computation. Fpga has proved to be much faster for providing parallel output. In this paper we are implementing the AFS system on the FPGA and by keeping the conventional lighting method and making use of two beam bulbs instead of one. The low beam lamp will work with the AFS system and high beam lamp is kept as it is. When the car is running in dim mode and is taking a turn the high beam lamps ensure the lighting assistance needed for the low beam lamps.

II. AFS DESIGN

A. Proposed design

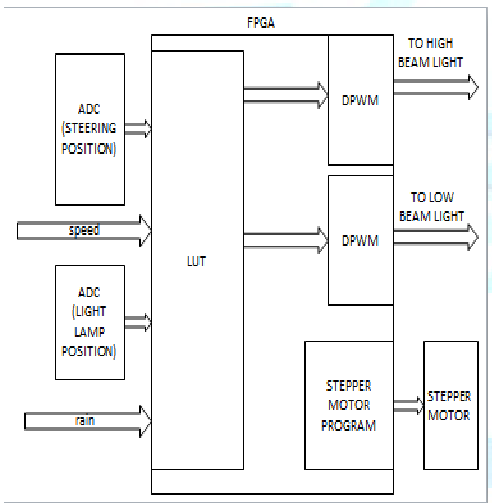

Fig 4: basic block diagram of the proposed design

The design is based on a two head light system as shown in fig 5(b). The low beam lamps are connected with the steeper motor and will turn with the steering according to the requirement and head lamp is set in a constant position to keep the conventional lighting style. The lighting pattern aiming to be achieved is shown in fig 5(a).

Fig 5: a) light pattern aiming to achieve (b) head lamps to be used in proposed design

The block diagram of the proposed design is shown in Fig 4. The ADC's to convert the output from the sensors at the steering and headlamps to digital data. The FPGA takes the input from the ADC and generate the PWM signal needed for the voltage control for the head lamps at each stage and drives the stepper motor for turning the head lamps to the required position.

B. ADC CIRCUIT

Fig 6 shows the simulation of an ADC circuit. The potentiometer in the circuit is used to determine the steering position. When we turn the steering the potentiometer will change the Vin connected to the ADC generating the 8 bit data which we use to give as input to the FPGA.

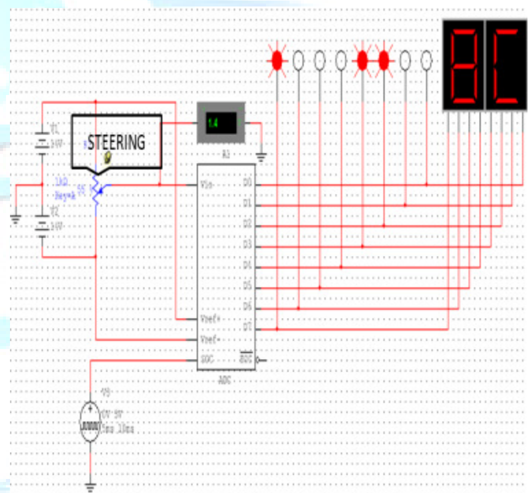

Fig 6: ADC simulation

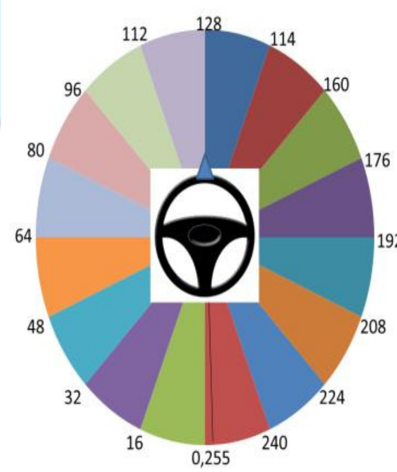

Fig 7: Steering position denoted by the ADC

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Fig 7 shows the decimal number of the 8 bit data to be produced. E.g.: when the steering position is at 128 then the ADC will give an output bit 10000000. The same technique is used to determine headlamp position also as shown in Fig 8.

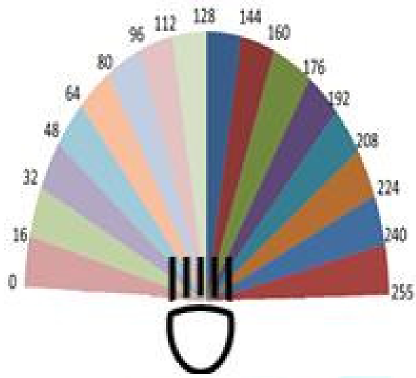

Fig 8: head lamp position denoted by the ADC

C. THE CONTROLLER BLOCK

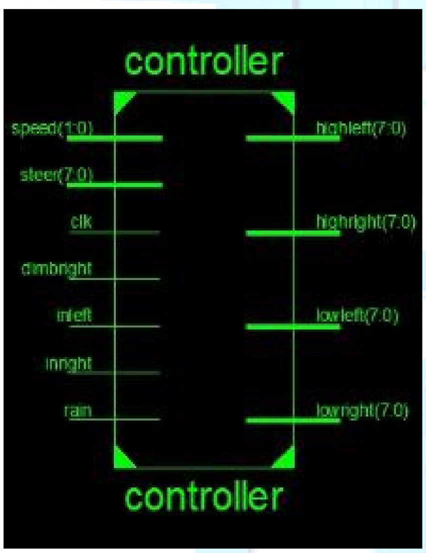

Fig 9: synthesized block of the LUT/controller

The controller block determines the input bits given to the DPWM block. The controller block decides the bits to generate the PWM signal for each lamp by considering the steering position, speed. It also considers whether hazards like rain which reduces the visibility of the road for the driver at night. It also has features like adjusting light with its surrounding by determining the speed as shown in fig2.

Motorway light mode is activated when the vehicle is travelling above 80km/hr, country light mode is activated when the vehicle is above 40 km/hr and below that town light mode is activated. The cornering mode is activated when the indicators are on(in the above design inleft and inright). When the vehicle is in dim mode which is determined by the input dimbright in fig 12 and fig13 and when we take a turn the low beam light will turn with it and at this stage we will give a PWM signal to the high beam light to compensate for the conventional lighting style. When the vehicle is running above 80km/hr we activate both the headlamps to its maximum capacity to improve the maximum visibility to the drivers and at this stage if the dim mode is activated the right high beam head lamp will be given only 50% capacity which will reduce the glare problem for the vehicle coming from the opposite side.

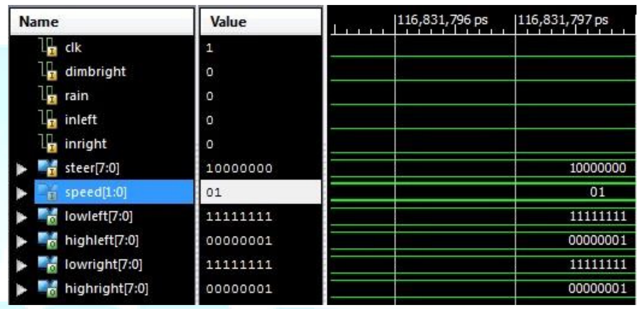

Fig 10: waveform showing vehicle running in dim mode

The Waveforms in fig 10 and 11 shows how the controller acts when the vehicle is running in as straight road with dim mode and bright mode. The design also considers whether hazards like rain and when the sensor goes on at bright mode maximum intensity is provided to the lights and in dim mode the right hand side high beam lamp is turned off as shown in fig 12 and 13.

Fig 11: waveform showing vehicle running in bright mode

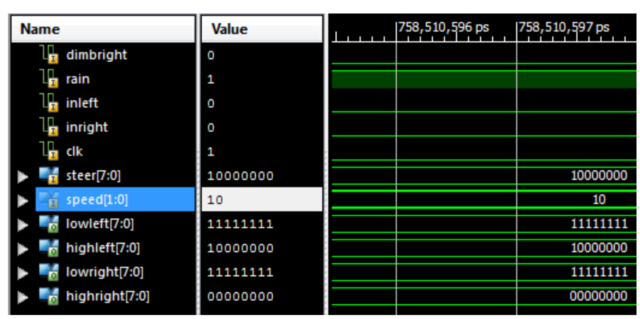

Fig 12: waveform showing vehicle running in rain at dim mode

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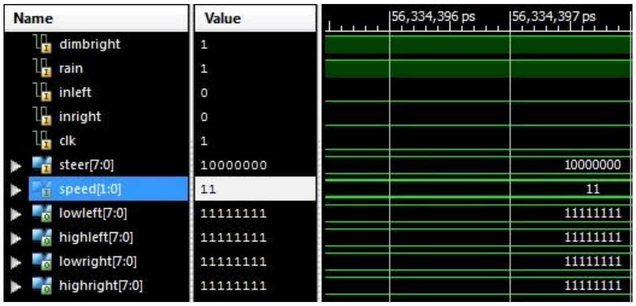

Fig 13: waveform showing vehicle running in rain at bright mode

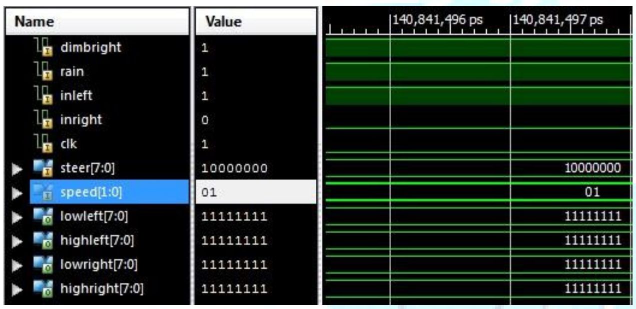

Fig 14: waveform showing vehicle is taking turn in bright mode

The waveform in fig 14 shows how the controller acts when the vehicle is taking a turn. In this scenario when we activate an indicator ie, any one of the inputs inleft or inright goes on and the speed is less than 40km/hr the low beam lights turn to the require direction providing maximum illumination. If the speed is above 40km/hr then the design will act normally as explained above.

D. DPWM TECHNIQUE USED

A. High resolution DCM based DPWM design

DPWM techniques are mainly used in power converter application due to its advantages in better control over signals both logically and in terms of voltage too[2]-[4]. In this design the clock signal is phase shifted and synthesized with the help of DCM modules to generate clock signals with different frequency and phase shift needed for the PWM signal generation. The input bits are divided into msb(dc1) and lsb(dc2). When the counter gets the clock signal its starts counting and when the output of the counter matches the input of the 1st comparator (zeros) a set signal is given to the SR latch. And when the output of the counter matches with the input of the 2nd comparator (dc1)a clear signal is activated and this output signal is given to the D flip-flops and depending on the multiplexer input(dc2) the output of a D flip-flop is send as a reset. Since the phase shift and frequency of the clock signals given for the flip-flops are different we will get a proper reset signal depending on the input given to the multiplexer.

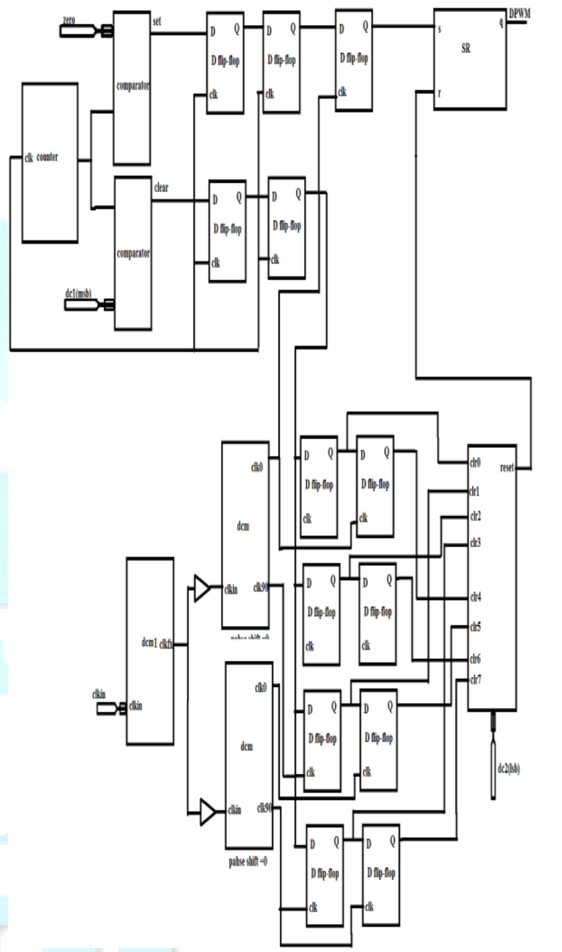

Fig:15 high resolution DPWM architecture based on DCM module

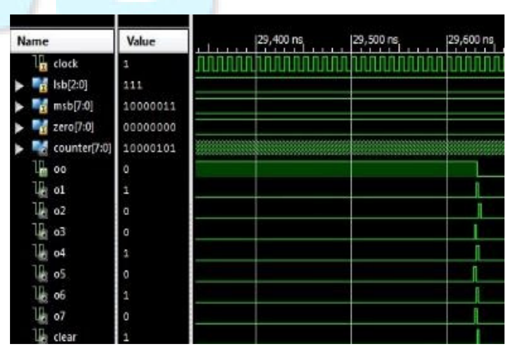

Fig:16 output waveform of DCM based DPWM technique

E. STEPPER MOTOR LOGIC

The stepper motor logic in this design is based on comparing steering position and headlamp position. If steering position is less than headlamp position the motor will rotate anti-clockwise and if the steering position is higher than the headlamp position then the motor will rotate clockwise direction and when both position matches the motor will stop rotating.

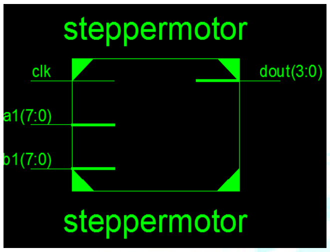

Fig 17: synthesized block

In the above figure a1(7:0) is connected to the steering ADC and b1(7:0) is connected to the headlamp position ADC. The waveform in fig 18, fig 19 and fig 20 shows how the logic works when the steering position and headlamp position matches, when steering position is larger than headlamp position and when it is less than headlamp position.

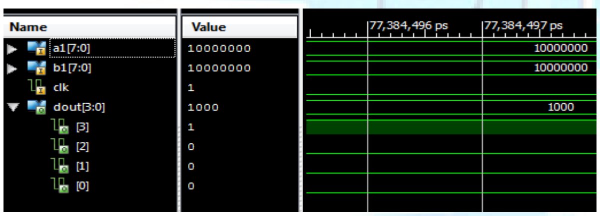

Fig 18: Stepper motor not running

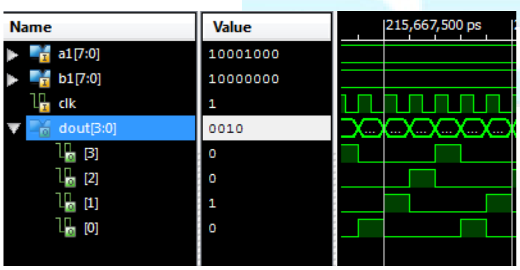

Fig 19: Stepper motor running in anti-clockwise direction

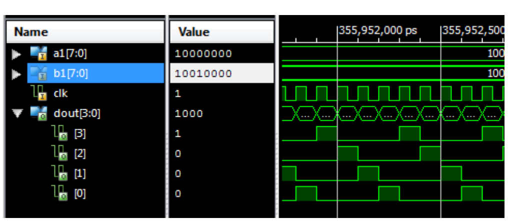

Fig 20: Stepper motor running in clockwise direction

III. SIMULATION AND ANALYSIS OF THE DESIGNED AFS BLOCK

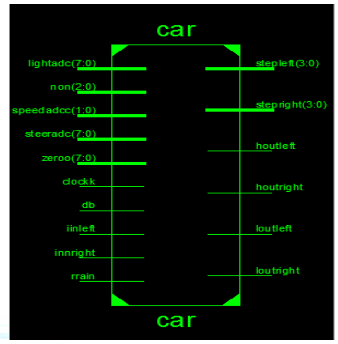

Fig 21 : Synthesized block

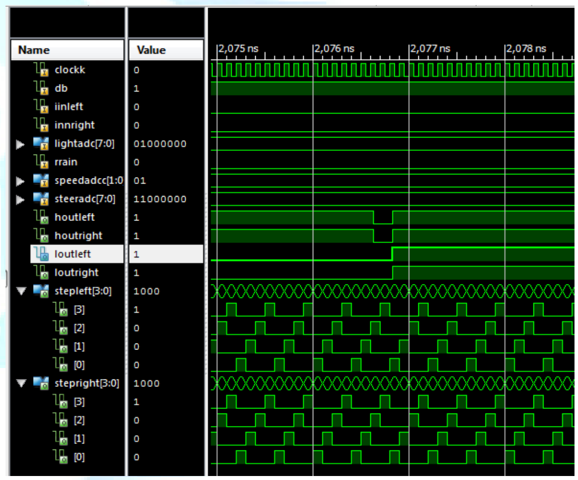

Fig 22 : complete waveform of the AFS system designed

Fig 22 shows the wave form when all the blocks are combined together. Here it shows a stage when the vehicle is taking a turn and at that scenario how the head lamps will respond. In the design the aiming beam pattern can be achieved.

CONCLUSION

The designed AFS system is working according to the design specification explained before with a delay of 1.864 micro second. The design exhibits faster response to the input given and since the design is fully synchronous which an advantage is in this system. The above deign is just a proposal how we can design an AFS system in a car because as the implementation is concerned we have to take care about the dynamics of the car and beam pattern of the head amps so we can reduce the glare caused by our car to other vehicles and pedestrians. There are also automobile light standards to follow when we implement an AFS system in a car. Most of the new FPGA's have on board processors to handle computing more easily. The simplicity and features of FPGA has bought it a long way and FPAA and FPAADD [5] has proven promising development in this field.

REFERENCE

[1] Study of adaptive front-lighting system of automobile based on microcontroller," Transportation, Mechanical, and Electrical Engineering (TMEE), 2011 International Conference n., vol. 23, no. 6, pp. 1281-1284,ISBN 978-1-4577-1700-0.

[2] Synchronous FPGA-Based High-Resolution Implementations of Digital Pulse-Width Modulators Denis Navarro, O´ scar Luc´ıa, Member, IEEE, Luis Angel Barraga´n, Jose´ Ignacio Artigas, Isidro Urriza, and O´ scar Jime´nez, Student Member, IEEE. IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 27, NO. 5, MAY 2012

[3] A. Mohammed, "Digital control of power converters," IEEE Applied Power Electronics Conference and Exposition, Professional Education Seminars Workbook, Austin, TX, 2008.

[4] A. Prodic, D. Maksimovic, and R. W. Erickson, "Design and implementation of digital PWM controller for a high-frequency switching dc–dc power converter," in *Proc. IEEE Annu. Conf. Ind. Electron. Soc.*, 2001, pp. 893–898.

[5] Floating Gate-Based Field Programmable Mixed-Signal Array Richard B. Wunderlich, Farhan Adil, and Paul Hasler, Senior Member, IEEE. IEEE TRANSACTIONS ON VERY LARGE SCALE INTEGRATION (VLSI) SYSTEMS, 2012 IEEE