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A Retrofit for Controlling the Brightness of an Automotive Headlight to Reduce Glare by using Embedded C Program on a PIC Microcontroller

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Abstract: In an automotive, the headlights are the most needed equipment to help the drivers to get a proper viewing at night. Major difficulties of visibility while driving at night will be either due to bad weather conditions or due to approaching vehicles high beam striking on the driver. High beams create a problem called glare which makes the driver have partial blindness for a small-time period. The solution for this glaring effect is to either deviate the incident high beam light of the vehicles or to reduce the brightness of the light so that the glare caused can be reduced. This work is an experiment to show how the glare can be reduced by reducing the brightness of the high beam light, by taking inputs of the vehicle speed and proportionally altering the voltage supplied to the head-lamps. With embedded C program language, an experimental setup was made where the voltage supply to the bulb is controlled according to the program. This results in reducing the luminous of the light source. This methodology can be adapted to the existing vehicles

Keywords: Glare, High beam, PIC, Voltage variation, etc…

I. INTRODUCTION

It is very important for people driving at night to have a proper vision of the roads, so headlights are the must for visibility. There are two modes of beam i.e. low beam which provides light distribution in order to have an adequate forward as well as lateral illumination without causing excessive glare and high beam provides an intense and center-weighted distribution of light without any control on glare. Low beams are used where the visibility needed is for a shorter length and wider range whereas; high beams are used for visibility of the farther area. This beam of light strikes directly on the oncoming vehicle's driver results in Troxler effect which is partial blindness or temporary blindness. It is dangerous as it mainly leads to losing the concentration needed while driving. Many types of research have been carried out to reduce glare but the processes are not cost-effective to include in all vehicles. A study on the impact of adaptive frontal lighting system considering the road safety to analyze some unseen values like potential impact in safety and accident prevention that arises along with the Economic Commission for Europe (ECE) regulatory framework[1]. The development in making a headlight glare simulator used for driving simulations by using LED splitters in headlights made to superimpose on a driving simulator to get two approaching vehicles as in real-time. The simulation mainly depends on the glare simulator as it synchronizes in spatial movements of headlight positions which are coming in the opposite direction with LED illumination sequence. It also indicates that glare simulator takes the real-world headlight brightness perceived like a driver. This varies according to the spatial positioning of a driver's car and the opposite traffic [2]. An evaluation on the approaching speeds for motorcycles across dissimilar lighting levels and the effect of an improved tri-headlight configuration was considered. Results used three vehicles that are a car, a motorcycle and a tri headlight motorcycle in five levels of lighting to reduce the accidents occurring due to lack of light in motorcycle's judgment by oncoming traffics [3]. There are reports to show the drivers being affected by glare due to opposite approaching vehicles. When a large survey was conducted, around 30% of drivers reported glare causing a problem while driving at night [4]. Automatic dipping of headlights from high beam to low beam was used in some cars. The work was to sense the oncoming traffic and to dip automatically to low beam condition [5]. Brightness can be controlled by varying the power supply to the headlights so that the intensity will be varied from 2000 lumens to maximum 12000 lumens [6]. An experiment was conducted to show a drivers ability to see the presence of pedestrians at night is affected due to headlight glare [7]. A smart car was designed using radiofrequency identifying systems for also reducing the intensity of the headlights. It was to sense the approaching vehicles and reduce brightness [8].The effect of glare on the ability of the driver to detect any pedestrians and the subjective feel of discomforts of the pedestrians where examined.

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As the intensity of glare increased, the driver's visibility decreased and also their judgment in knowing the approaching vehicles speed [9]. At last a survey for National Highway Traffic Safety Administration (NHSTA), US Department of Transportation was considered for Assessing on Headlight Glare and Potential Countermeasures: Survey of Advanced Front Lighting System (AFS).

The survey concluded that how adaptive frontal lighting systems helped in changing the various headlight beams in different road geometry along with visibility conditions [10]. These studies made a conclusion on the effect of glare at night driving conditions are dangerous and the technology to reduce it is not so economical. This work is an attempt to solve the problem caused by glare by reducing the brightness automatically using a programmable PIC unit taking the inputs from vehicle speed. This method can be easily incorporated into existing vehicles as a retrofit.

II. EXPERIMENTAL SETUP

To effectively control the luminosity of high beam light the following experimental setup is utilized. This representation is like vehicles having two different beams of light that is bulbs being a single filament which will have one for high beam and other as low beam headlights.

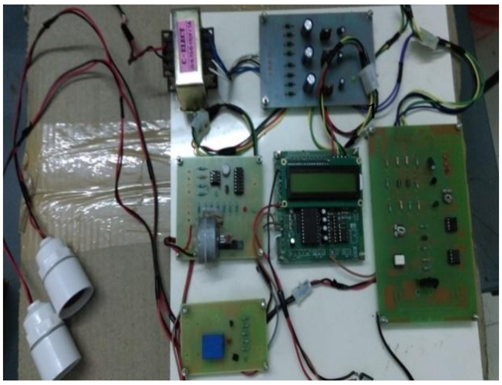

Fig 1. Picture of the experimental kit setup

III. MODELING SPECIFICATIONS

3.1Power supply

A step-down transformer is used to get a step down from 230V normal AC voltage to 0 – 9V and 15 – 0 - 15\ V level. A full-wave bridge rectifier which is a four diode circuit is used where the diodes are 1N4007 PN junction to get a cut off of 0.7V. Using this rectifier the direction of the current through the opposite diodes can be altered, so total drop in voltage will be 1.4V. Capacitors provide the filtration. A capacitor will be added in parallel with a load resistor of the rectifier in order to form a filter circuit. These regulators are to deliver current around 1A to 1.5A at a fix voltage levels. The capacitors across the input and output of the regulator IC are connected to improve the regulation.

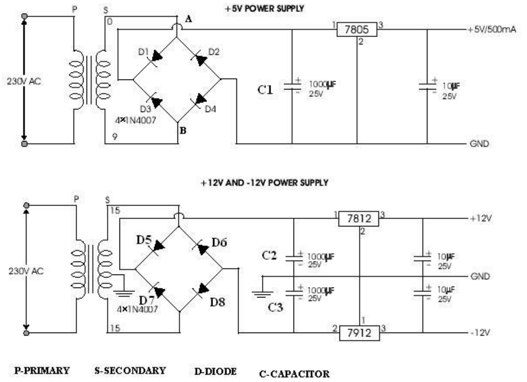

Fig 2. Electrical circuit diagram of the power supply unit.

With this power supply circuit 5, 12 and -12 Volt output is got. The electrical circuit is indicated in Figure 2. When implementing on vehicles, batteries which are available is enough to supply a constant 12V DC voltages and using ICs the circuit can be completed.

3.2 12 Volt motor with the control unit

The control unit is made in order to vary the speed of the motor. The voltage signals are varied using a variable resistor to the amplifier circuit. LM741op- amp is used. The amplified signal produced is being supplied to the SL100 power transistor and transistor side the motor is connected. The motor speed is controlled with a potentiometer .Using this circuit the motor speed can be monitored .The protruding shaft of the motor is being attached with a pulley .The pulley gets rotated across the U Slot sensor. An IR transmitter cum receiver is present in the U Slot sensor placed opposite in line to each other. When the supply is ON, the IR rays falls on the receiver, which is connected to the transistor, base BC547 through resistors to form a switch. At the time when the motor is in off condition, the rays will be received completely as produced. This creates a positive 5V to be given at input and 0V at the output. Only when the motor shaft rotates the pulley interprets the IR rays so 0.7V is transmitted to the transistor base. This voltage makes the transistor to conduct and shorts the terminal of collector and emitter. The zero voltage is given to inverter input and +5V is taken as output. Square pulse 0 – 5V is generated depending on the speed of the motor generating an output given to the micro controller to count the generated pulse. This pulse is used to convert speed with respect to time. The electrical circuit is indicated as in Figure 3. This speed can be either taken from vehicle wheel speed signals or can be tapped from speedometer connections.

3.3 LCD Display

Liquid crystal displays (LCD-016M002B) is used to display the speed and mode of light is controlled. A 16x2 character LCD of 5X8 dots and KS0066 as a controller. It uses a 5V power supply and has 16 pins with a duty cycle of 1/16. It uses a 5V power supply and has 16 pins with and it uses a 5V power supply and has 16 pins with a duty cycle of 1/16. In this LCD each character is displayed in a 5x7 pixel matrix.

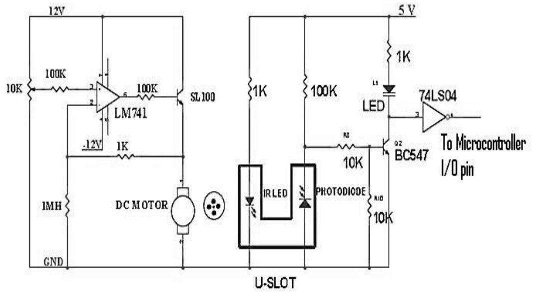

Fig 3. Electrical circuit diagram of 12V motor with the control unit.

3.4 PIC module

The micro controller used is PIC16F87X series and is made of CMOS(complementary metal-oxide-semiconductor) and RISC (Reduced Instruction Set Computer) that has a separate bus for instruction along with data allowing access of the program and data memory.

This together makes it consume less power with reduced size pins and has good resistance towards the noise. The series is of 16F877 pic which is a flash technology as it can be programmed as well as re-programmed without its properties being affected. It is having an operating clock speed of DC-20 MHz and an instruction cycle of 200 nanoseconds. It has an operating voltage range of 2.5V to 5.5V with high sink or source current of 25mA. It can be operated at both commercials as well as industrial temperatures.

3.5 Digital to analog converter

A digital-to-analog converter is a device needed in order to convert a digital code to an analog signal. DAC runs with encoded signals called pulse code modulation. The input compressed signals are converted to electrical voltages which will be a linear function of the input numbers.

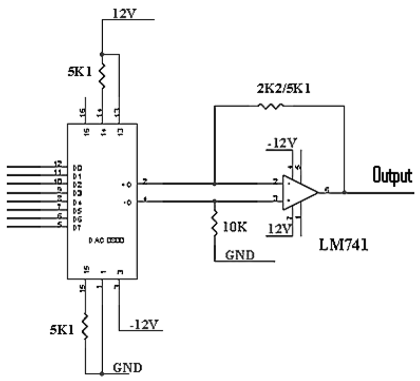

Fig 4. Electrical circuit diagram of Digital to analog convertor.

3.6 TRIAC control circuit

A TRIAC is basically a triode used for alternating currents where two silicon controlled rectifiers are connected with their polarity reversed and gates connected. This makes it a switch which allows current to flow in both the directions when activated. It can be triggered using its electrode at the gate by a positive or negative voltage. The LM1458 is used as it is a dual operational amplifier. It has a temperature range from 0-70^{0}C. It conducts current till a threshold valve is obtained and this makes the TRIAC to work as a switch for alternating current circuits. Isolation is constructed by using MOC3011 Opto-coupler. At the controlling point in an AC circuit, the trigger pulse will be applied to control the current flowing through it. The electrical circuit diagram as indicated in Figure 5.

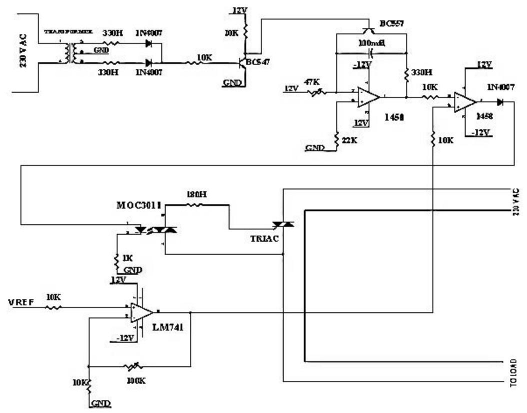

Fig 5. Electrical circuit diagram of TRIAC control circuit unit.

IV. PSEUDOCODE FOR THE PROGRAM WRITTEN ON PIC

```
Start
Configure DAC to port
Initialize the input and output variables
Declare ADC and get values from ADC
WHILE(1)
Lcd8_Display(0x80,"SPD:",4);
Lcd8_Decimal3(0x84,ext_val);
Lcd8_Decimal3(0xc0,sec);
IF(sw)
Lcd8_Display(0xCC,"HIGH",4);
 relay=0;

 IF(ext_val<10)
 Lcd8_Display (0x88,"STATUS 1",8);
dac=165;Delay(65000);Delay(65000);Delay(65000);ext_val
=0;
ENDIF
    IF((ext_val>11)&&(ext_val<20))
Lcd8_Display(0x88,"STATUS 2",8);
dac=180;Delay(65000);Delay(65000);Delay(65000);ext_val
=0;
   ENDIF
IF((ext_val>21)&&(ext_val<35))
    Lcd8_Display(0x88,"STATUS 3",8);
   dac=208;Delay(65000);Delay(65000);Delay(65000);ext_
val=0;
   ENDIF
 IF(ext_val>36)
   Lcd8_Display(0x88,"STATUS 4",8);
   dac=240;Delay(65000);Delay(65000);Delay(65000);ext_
val=0;
   ENDIF
IF(!sw)
relay=1;
Lcd8_Display(0xCC," LOW",4);
dac=240;
ENDIF
ENDIF
ENDWHILE
Get values from timer
```

IF(TMR0IF==1)
Increment counter
IF(count>1000)
Increment sec and set counter to 0
IF(sec>10)
sec=0;
Set timer interrupt flag to 0
ENDIF
IF(CCP1IF)
Increment external value and set CCP1IF to 0
IF(ext_val>80)
Set external value to 0
ENDIF
ENDIF
ENDIF
Stop

The program is coded in a way as it takes inputs from motor speed and then it alters the voltage accordingly.

V. DISCUSSION

The block diagram of the circuit board is as indicated in Figure 6. The potentiometer is used to control the speed of the motor. The speed is tapped with the help of U-slot sensor and conditioned.

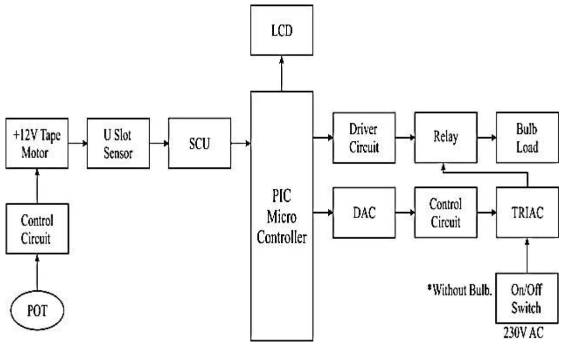

Fig 6. Block diagram of experimental kit.

The PIC microcontroller is programmed in a way as it gets the input signals from the speed sensor to proportionally control the voltage to be sent to the bulbs. Two conditions are given with the help of a switch as to select between high beam and low beam. Selecting the low beam the PIC doesn't control the voltage but with high beam mode on it outputs the voltages sent to bulbs in according to input speed signals. Change in voltages given to the bulb varies its brightness. As a result of this, the luminosity of the bulbs is varied. Speeds taken as inputs range are set in the form of 0-10kmph, 11-20kmph, 21-35kmph, and 36kmph and above. So, the programmed PIC voltages are 165V, 180V, 208V, and 240V. The bulbs use dare 11WCFL bulb for low beam and 200W filament bulb for high beam.

VI. RESULTS AND CONCLUSIONS

The toggle switch is selected too high beam mode. When small increments are given to the potentiometer, I increase the speed of the motor used .The speed sensor sends signals to the PIC programmed controller to alter the voltages which have to be sent to the bulbs. While conducting the trial, four brightness is seen for speeds of 1kmph, 14kmph, 27kmph and 51kmph as indicated in Figure 7. This not only helps in reducing the glare but also reduces the battery usage. As it is not sending a constant high power at low speeds where the necessity is NIL. This can be now adapted to the present vehicles as a best and economical add on solution for a reduction in glaring effect at night driving situations. Future vehicles can use this brightness reduction by taking inputs from GPS as for city road conditions or by long-range infrared sensors to know the density of vehicles ahead or oncoming.

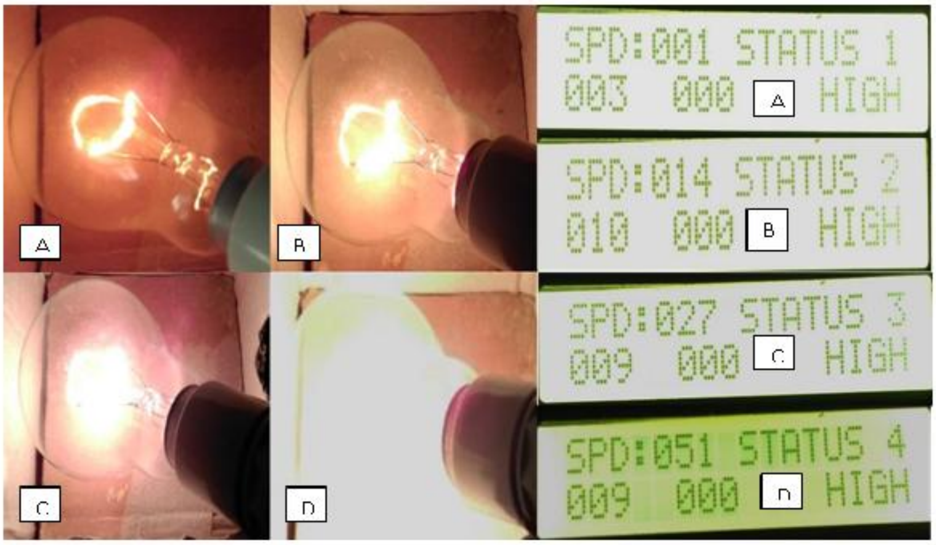

Fig 7. Different brightness along with speed on display.

VII. ACKNOWLEDGMENTS

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REFERENCES

1. A. Peña-García, P. Peña, A. Espín, F. Aznar, Impact of Adaptive Front-lighting Systems (AFS) on road safety: Evidences and open points, Safety Science 50 (2012) 945–949.
2. [2] Alex D. Hwang, Eli Peli, Development of a headlight glare simulator for a driving simulator, Transportation Research Part C 32 (2013) 129–143.
3. M. Gould, D.R. Poulter, S. Helman, J.P. Wann, Judgments of approach speed for motorcycles across different lighting levels and the effect of an improved tri-headlight configuration, Accident Analysis and Prevention 48 (2012) 341– 345.
4. Singh. S, & Perel. M, Drivers' perceptions of headlight glare from oncoming and following vehicles. NHSTA 2003 report no. DOT HS 809 669. Washington, D.C.: U.S. Department of Transportation.
5. Muralikrishnan.R, Automatic headlight dimmer a prototype for vehicles, IJRET 2014, eISSN:2319-1163 | pISSN: 2321-7308.
6. K. Ashiq Ahamed, A.S.Ranganathan, Automatic dimming of headlights using vehicle speed, EETA 2015, ISSN: 0974-2115.
7. Stephanie A. Whetsel Borzendowski, Ashley A. Stafford Sewall, Patrick J. Rosopa, Richard A. Tyrrell, Drivers' judgments of the effect of headlight glare on their ability to see pedestrians at night , Journal of Safety Research 53 (2015) 31–37.
8. B. Ramya Sundaram, Shriram K. Vasudevan, E. Aravind, G. Karthick and S. Harithaa, Smart Car Design using RFID, Indian Journal of Science and Technology, Vol 8(11), DOI: 10.17485/ijst/2015/v8i11/71767, June 2015.
9. Theeuwes, J., Alferdinck, J.W. A. M., & Perel. M, Relation between glare and driving performance. Human Factors 2002, 44, 95–107.
10. Yukio Akashi, John Van Derlofske, Jennifer Watkinson, Charles Fay, Assessment of Headlamp Glare and Potential Countermeasures: Survey of Advanced Front Lighting System (AFS), National Highway Traffic Safety Administration NHTSA 2005, NRD-13 400 7th St SW Washington, DC 20590 , DOT HS 809 973.

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