AUTOMATIC HEADLIGHT BEAM CONTROL SYSTEM

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Abstract - An Automatic Headlight Beam Control System (AHBCS) for a motor vehicle includes two phototransistors as a normal light sensors, one has a field of view forward of the vehicle, while other has a field of view normal to the road surface and it facilitates not only auto-switching of the headlight but also, beam modulation. This article aims at describing the work accomplished for the development of AHBCS.

Index Terms - AHBCS, Arduino UNO R3 Microcontroller, Beam, CMVR 1989, MVA 1988.

I. INTRODUCTION

The Central Motor Vehicle Rules **(**CMVR-1989) 105 (2) (ii) and DMVR (Delhi Motor Vehicles Rules, 1993) 112 (G) and 177 of MVA (Motor Vehicle Act, 1988) penalizes for improper use of headlight/taillight and lighting of high beam on vehicle where not required. In Chennai, inside the city, use of high beam is not allowed. When you are speeding up your vehicle, it is good practice to use high beam to illuminate road ahead of vehicle as far as possible, because increasing speed increases stopping distance. But it is expected that driver should dip to low beam while driving on narrow roads or when vehicle is oncoming. High beam and low beam are integrated part of sealed beam headlight unit of a vehicle as a norm expected to be followed by drivers. The 1955 General Motors adventure car CADILLAC ELDORADO BROUGHAM concept had quad headlight units with an “Autronic Eye”; having twin headlight at the front end of each fender. Outer lamps are flat-beam city lights; inner lamps are for free highway use.

Though a system similar to AHBCS already exists, it is present on luxury vehicles only. However, low cost vehicles like delivery vans and pickup vans are mostly equipped with 60Ah battery which may get drained in 10 - 12 starts. Ape (3W) and Porter (4W) are high end cargo transporters for Indian road conditions. If headlight remains on during daytime it put extra load on battery and accounts for **frequent battery drainage** due to overload. Also, vehicles are more prone to accidents due to **ineffective beam control**. The objective is to provide reliable solution to these problems at low cost. This system is synthesized using **Arduino Uno R3** microcontroller whereas the system costs only 2000 INR.

As per [1], the glare during night causes temporary blindness which causes accidents. Systems like AHBCS can avoid this by automatic beam modulation.

Reference no. [2], [5] shows that the Concept of image processing can be adopted for beam modulation using camera sensor, which captures the light footage in darkness and records the instantaneous spectra captured from oncoming, traffic leading and overtaking vehicle, then processes it.

As per reference [4] relays are used as meant for switching. When the intensity of daylight falls below the luminance suitable for driving, this system automatically put the headlight to ON state and vice versa. Such systems are also useful in reducing the energy consumption. Now a day, smart cities are adopting these systems for street lighting.

As per reference [6] high beam provides better visual acuity, it inversely affects oncoming traffic. This problem is compounded when both drivers uses upper beam, causes blindness.

It is also possible to operate the headlight as per the working conditions of engine as shown in [7], whereas [3] has shown that the cornering models are also possible to be synthesized to avoid the accidents on turns.

The proposed system focuses on automatic beam modulation and also, switching off the headlamps during daylight. To sense the illumination (normal light), two phototransistors are used. One of the sensors is located on the roof and second on the front fascia.

II. ARCHITECTURE OF PROPOSED SYSTEM

As shown in the fig. 1, the system comprises of power source, sensors, microcontroller, interrupts and actuators (here, sealed beam headlight unit).

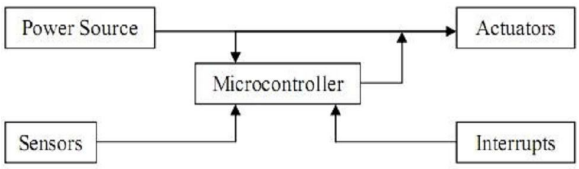


Fig. 1 - Basic Concept of Intelligent Electronic Control System

As and when the intensity falls below preset limit, headlight are switched on. This intensity is sensed by phototransistor mounted on the roof. When the headlight is in operation, beam modulation plays its role. The mounting of sensor comply with FMVSS section 571 standard 108 clause - f. All the time when intensity is above preset limit, headlights are in OFF state until the system receives interrupts for overtaking. At the time of overtaking, driver is expected to modulate the beam so that the driver in lead will get the intentions of lagging vehicle to overtake.

III. PRIMARY ELEMENTS OF AHBCS

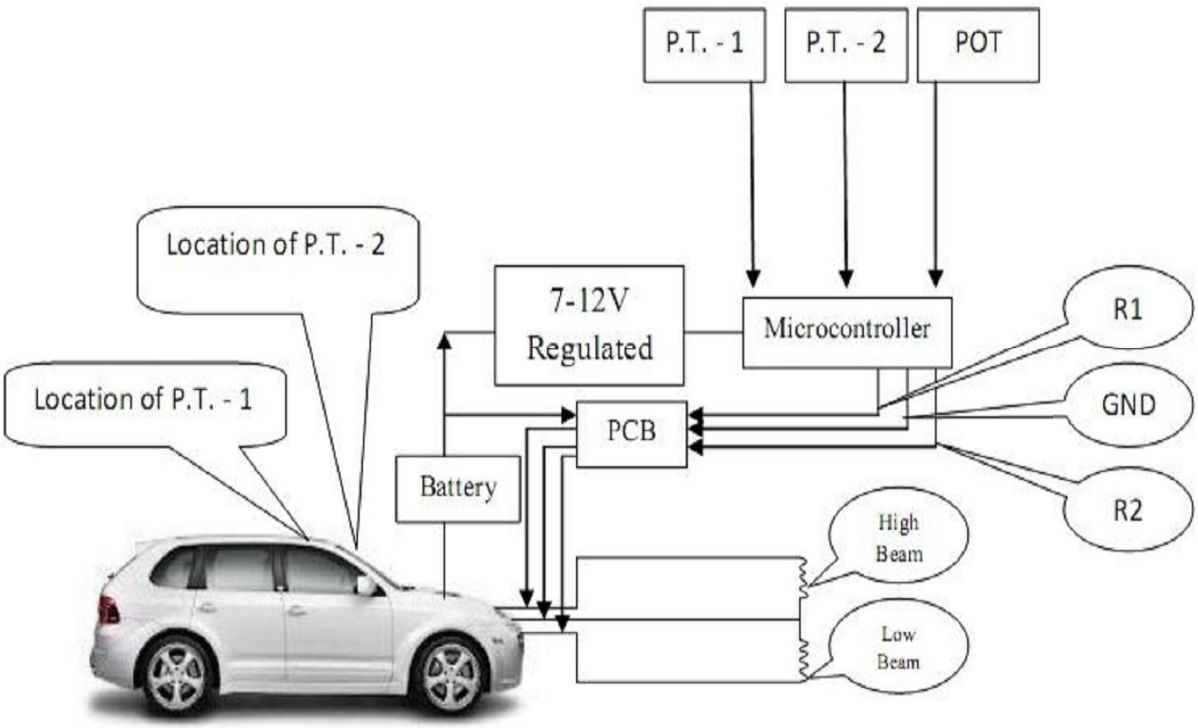
Table - 1: Components of AHBCS

Sr. No.	Component	Make & Specification
1	Silicon Phototransistor	L14G1
2	NPN Transistor	BC547
3	Diode	1N4001
4	Relay (SPDT)	JQC-3FC
5	Resistor	1 kΩ, 5% accuracy
6	Microcontroller	Arduino UNO R3

IV. FUNCTIONING OF AHBCS

If the operating environment has low light intensity (light intensity not suitable for driving condition) as read by the phototransistor-1, as shown in fig. - 2, the microcontroller switches ON the headlight to high beam. As high beam illuminates the road ahead at a distant equivalent to stopping distance, the vehicle can be brought to stop safely. When the phototransistor-2, as shown in fig. - 2 which is mounted at the level of drivers' eye on windshield, detects normal light producing glare, the AHBCS switches from high beam to low beam. This distance, at which the beam modulation takes place, is approximated to 100 m. When the oncoming vehicle passes off the field of vision of phototransistor-2, the headlight are again switched back to its high beam state. When the headlights are OFF, beam modulation is non-functional. The presence of calibrated potentiometer is a provision for selection of level of luminance suitable for driving, which provides integrity with driver's visual requirement. When driver modulates the beam, seeking permission for overtake, headlight switches between its high and low beam and restores to its original state at the end. This is how the AHBCS works.

The table-1 gives the details of components used for the synthesis of AHBCS.



Nomenclature: P.T. - 1: 1st Phototransistor, P.T. - 2: 2nd Phototransistor, PCB - Printed Circuit Board, POT - Potentiometer, R1 - Digital input to 1st relay, R2 - Digital input to 2nd relay, GND – Common grounding to emmiter side of transistor

Fig. 2 – Overall Layout of the Automatic Headlight Beam Control System

CONCLUSION

Arduino Uno R3 microcontroller has clock speed of 16 MHz, which means it can execute one instruction set (considered equivalent to one cycle) within 62.5 nanoseconds. Whereas the operation cycle of relay is of 18 ms. Thus, the response of AHBCS is instantaneous to interrupts and sensor inputs. Hence, the system is advantageous over conventional front lighting system as it saves battery drainage and also automatically controls the beam switching, reducing the drivers' efforts.

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