Automatic Light Control of Vehicle-A Review

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Abstract: In the present era, road accidents have become an everyday problem even though there have been several advancements for increasing the safety of the passengers inside a vehicle. This paper has emphasized on the review of works done for headlight needs of the driver while taking into account the research gap they present when inclusion in newly designed automobiles. It focuses on the works based on using of switching mechanism between high and low beams of headlight during night-hours for avoiding accidents with some other factors that could enhance the working of a vehicle light control.

Index Terms **- Arduino Uno, LDR, Accelerometer, Radiofrequency, Headlight.**

I. INTRODUCTION

The world has seen various advancements in different technologies through the years. These developments came by as their necessity became evident with time. As for the population, it is growing at a rapid rate and so is the demand of vehicles.

Looking back to when the first patent of a 3-wheel drive gasoline-powered Benz's 'Motorwagen' was accepted as the first car in history, it can be said with zero doubt that our generation have come a long way in the development of the technology we call as 'automobile'. With changing decades, world has seen the shift from gasoline to petrol/diesel to electrically-powered vehicle technology [1]. So with ever increasing population, automobile-manufacturer have to keep in mind their safety while designing the new-age wheels.

Air bags were one such idea for providing safety but importance of light when we talk about vehicles, be it the front-facing or rear lights of the car, cannot be ignored. This paper emphasizes on the difficulty faced by a typical driver when he drives an automobile on road, irrespective of the automobile being a 2-wheel, 3-wheel or 4-wheel drive [2]. Also, it takes into account the new regulations that are promising for the safety as well as try to improvise for the purpose of economical use of power.

Road accidents have become fairly common in our day-to-day life and one of the reasons behind it is when drivers tend to not turn on the headlights when evening approaches. This results to partial vision for the driver and the approaching vehicle also faces difficulty in recognizing the vehicle on time. This may and sometimes does lead to accidents. To overcome this problematic situation, steps were taken, such as spreading awareness among drivers for the proper use of headlight at evening but results were unsatisfactory. So, some of the governments across world took the measure of implementing Automatic Headlight On (AHO) feature in automobiles [3]. This means the headlight of the vehicle will start automatically when the vehicle is started. Thus, for switching on headlight, driver does not need to judge if the time is morning, evening or night. The headlight will stay on 24x7. But, after the inclusion of AHO safety regulation in vehicles, drainage of battery has increased due to use of headlights in daytime.

Another drastic reason for increasing number of road accidents, is the improper use of headlights during night. People need to understand the difficulty of an approaching driver when the former has high-beam light turned on during night-time. When the former, does not switch their high-beam light to dimmer (or low-beam light), as is generally instructed for road safety, it becomes a huge difficulty for the latter to judge as to what steps to take for safely passing by of the two. Poor judging at such times leads to collision of the two vehicles. For tackling this situation, several works have been done earlier and hence this paper becomes a platform where many such systems, based on an automatic switching between high beam to low beam and vice versa as per light intensity falling from approaching vehicle, have been keenly studied for getting insights for better understanding of the safety mechanism it offers.

The paper methodically takes review of the previous works done in this regard and tries to acknowledge the research gap in the respective areas. As per the research gap, it discusses about the research findings of some of the below mentioned reviews and tries presents a solution to some extent. In the end, it tries to sum up the findings done in this field to gain proper understanding of the systems studied.

II. LITERATURE REVIEW

Rath proposed an advanced and smart light controlling system for various applications which used the same light intensity sensor as the prototype used for this paper i.e. Light Dependent Resistor (LDR) sensor for evaluation of outside condition of lighting. The sensed data is then sent to Arduino which then commands for adjustment of light intensity of LEDs used [4].

Muhammad et al. designed a system that can be utilized in vehicles to change the mode of lighting of headlamps and reflectors on the basis of two factors, i.e. road contour and light beam falling on the vehicle from approaching vehicle. They used MPU6050 accelerometer for sensing road contour, movement in downhill or uphill direction. Also, for light intensity sensing, they used Luxmeter BH1750 module combined with Arduino [5].

Poornima et al. proposed a design of street light management system combined with PIR sensor for detecting a passing vehicle in the range of that specific street light. They combined this system with the headlight automation using LDR for saving loss of energy in the form of light [6].

ThetKoKo et al. described a design using fuzzy logic control for changing of headlight modes by detection using LDR sensor and wiper speed control by detection using piezoelectric and impedance sensor. The sensor provided information of intensities of light and rain respectively and using the fuzzy logic algorithm they were further controlled to a certain intensity and speed respectively [7].

Abhishek et al. showed the usage of a dash-board camera for sensing the light from the approaching vehicle by capturing the video sequence. Then the information was sent to Arduino for processing which intelligently shifts light beam from high to low or vice versa as and when required [8].

Al-Subhi et al. made a system which utilized two sensors, i.e. ultrasonic and LDR. The LDR module detects light intensity of surroundings and the ultrasonic sensor module detected objects present in its range. The data processed in Arduino, gave an idea of headlight intensity control [9].

Arpita et al. proposed a design where LDR sensing of light intensity is done and combined with potential divider circuit. Also, an obstacle alerting system was presented with the help of Zigbee communication. Combining all these with the headlight of a vehicle, it proposed an automatic light control system with alerting feature certain cases when required [10].

Connell et al. designed a system of headlight controller in different weather conditions. They presented an IHC system design that evaluated the surrounding environment and functions the working of headlight beam accordingly [11].

Roy et al. described a design that lets the two approaching vehicle communicate their need for switching from high-beam to low-beam according to the light intensity measured. The system used RF transmitter and receiver, meant to be installed in every vehicle with a buzzer which would alert the drivers in case light intensity increases to a certain range [12].

Shreyas et al. highlighted on functioning of a headlight system that could adapt at times while driving so as to eradicate blind spots of visibility that might lead to road accidents. They used Atmel AT89S52 microcontroller unit for driving the stepper motor further connected to the headlamp and reflectors to steer them in the blind spots encountered while driving such as turning or bends in roads [13].

Prabhakaran et al. proposed a design of an Electronic Control Unit (ECU) for combined with RF transmitter and receiver module. The receiver would be installed in a car and when this vehicle will enter a city, it would automatically switch the headlight beam from high to low and when the vehicle exited the city border it would switch it back to high-beam thus making driving in city safer [14].

Manjula et al. showed a design using Zigbee communication between drivers of approaching vehicles. Combining with phototransistor input processed by Arduino, commands were given to the respective driver to lower their beam for easy and safe passage of the two vehicles [15].

Pallavi et al. presented a system with Arduino Nano combined with BH1750 and IRF520 MOSFET module. Its working changed high beam to low beam when two vehicles passed each other and changed it back to high beam when they have passed using the sensed data [16].

Gayatri et al. described an experimentation design model using the LDR for light sensing and an electric circuit that uses IC555 timer integrated together. When combined in the way depicted by them, the timer acts like a trigger, when surplus light falls on the LDR sensor, to switch from high -beam to low-beam and when in proximity of insufficient light, the high-beam would again turn on [17].

Jadhav et al. proposed a design that not only combined the headlamp but also took into account the dipper and fog lamps. The LDR sensed light intensity and further improvised on the use of respective light based on the command provided by Arduino [18].

Akinsanmi et al. showed a prototype that used LDR as sensor and potential divider network as a simple comparator which further is connecter to a NPN transistor. An SPDT relay is used with the transistor for switching to different modes of light beam in the vehicle when another vehicle approaches according to light intensity [19].

Vaghela et al. studied light energy wastage during times of full brightness and full darkness for the street lights and proposed a design with LDR sensor to measure intensity of light in their environment and work accordingly using MOSFET switching so to save energy wastage [20].

Balaji described a system with the use of LDR, ultrasonic and various other sensors for proper evaluation of the environment around a vehicle. The Arduino Uno then processed the data received through these sensors to switch headlight intensity automatically. Also, the use of Zigbee communication is suggested for accident avoidance [21].

Kilari et al. presented a design of a room with 4 LDRs in the four corners. Combined with IRF520 driver module, the illumination inside a room is controlled by switching on or off of LEDs inside that room [22].

Pal and Bhaskaran proposed a multi-trait affordable headlight design which was capable of moving in different directions viz. left/right and up/down that consequently led to creating more visibility in night condition and curved roads [23].

Alcantarilla et al. presented a system with the use of computer vision and driver-assistance for detecting oncoming vehicles from the opposite direction. At night-time and according to the conditions, the headlight automatically changed intensity from high beam to low beam and vice versa [24].

Wu and He designed an intelligent LED headlamp system with the use of different sensors to detect the road condition and driving status. According to output received from the sensors, the system performed different functions like low beam and high beam switching, band and ramp adaptive lighting [25].

Gupta et al. described a user friendly design which could control the headlight intensity to prevent accident in blind spot area. It was based on fuzzy interface system. Human visual comfort zone was the only parameter bounded for the fuzzy interface system [26].

Aramice and Miry proposed a design which could switch the vehicle headlight high beam to low and vice versa depending on the parameters of vehicle speed and intensity level of the surrounding light. The system worked on fuzzy logic control with the help of embedded system [27].

Narkar showed an automatic dipper light control prototype with the help of different components like IC555, LDR, RELAY and switches. The system had two modes i.e. automatic and manual modes. The manual mode was functional for working in cities and automatic mode for working in highways [28].

Li et al. designed a learning based headlight control design with the help of machine learning approaches such as SVM and AdaBoost. The system automatically controlled the light beam to enhance driver's performance in blind spot areas [29].

Chopade and Dhole presented a design of an adaptive headlight system. The system added extra LED which could turn on automatically when sensing the blind spot areas to improve visibility and prevent accidents [30].

Jaint et al. showed an automatic dipper system prototype with the help of Raspberry Pi and Open CV. The dipper automatically worked when an oncoming vehicle was detected [31].

III. Result and Discussion

From the above literature reviewed, it was observed that effective night headlight switching system was practically possible to build. Some of the researches were more promising than the other and should be acknowledged for their work by proper designing and implementation of such systems for real-time driving. Some other researches were directed towards a different goal than that mentioned in the paper but paves way for a promising system that can be applied to increase safety in night-time driving.

One of such systems was proposed by Khilari et al. in which lighting of a room was done according to two factors, i.e. average of 4 LDRs placed in 4 corners of the room or according to the necessity of the user. They developed a very easy-to-use and implement system which worked on the principle of LDR combined with Arduino and MOSFET for proper usability. They developed their design keeping in mind the wastage that occurs during daytime when surplus amount of sunlight is present and there is no need for lights in the household. Also, they have taken into account the necessity of different light intensity for different rooms. The following figures gives an idea about their design [22].

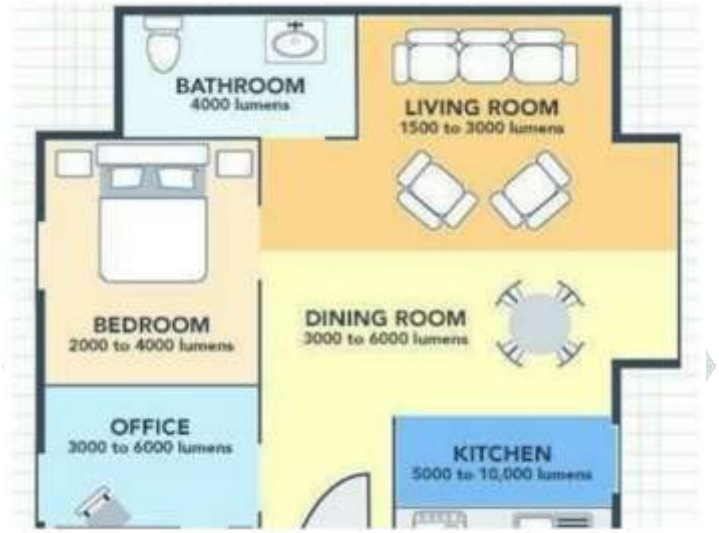

Fig. 1. – Lumens needed in different rooms of a typical house [22].

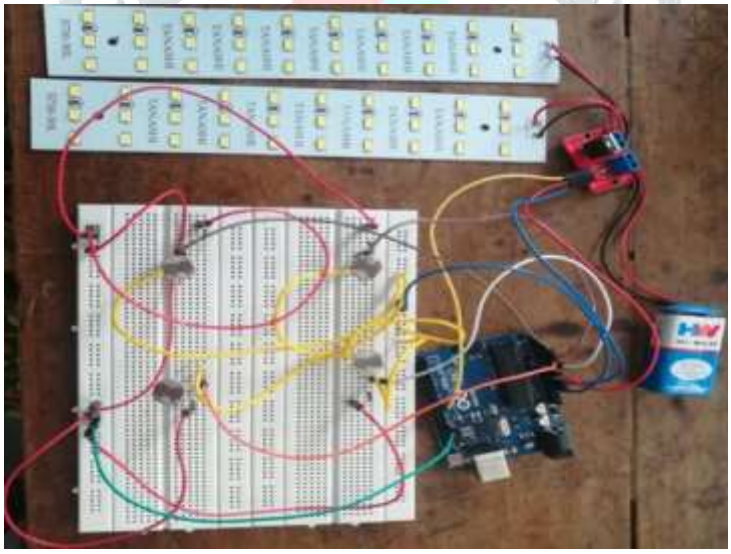

Fig. 2. – Circuit showing connections of different components for working [22].

Although it was thought of for a lighting inside a room but it gives suitable picture of the need to save energy wastage by people. Further, it provides a simple alternative to such wastage which could be implemented in vehicles by proper placing of LDRs which could measure light intensity of the surroundings, e.g. sunlight conditions, going through a well-lit road during night or glare by an approaching vehicle, and accordingly differ the luminescence of the headlight.

Another promising design was proposed by Roy et al. in which they had implemented a vehicle alerting system for driver of an approaching vehicle to switch mode of light from high to low beam, in case the former driver faced difficulty in driving due to the glare. It basically presented a system integrated with Arduino, photo-sensitive sensor module and Radiofrequency (RF) transmitter-receiver pair with a buzzer attached to the oncoming vehicle. The working could be summarized using the following flowchart [12].

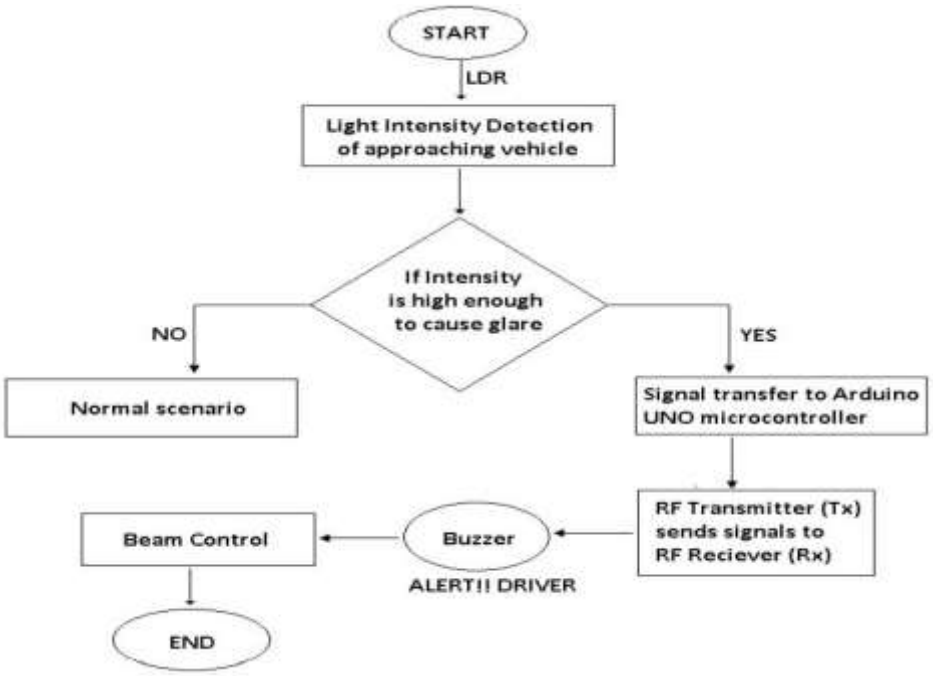

Fig. 3. – Flowchart of working of Driver Alerting System [12].

The system could act as a good solution for avoiding road accidents at night but it needs to be understood that even after the buzzer has alerted the driver of the oncoming vehicle, there is a high chance of him not working according to the rule stated in the flowchart because it is already evident that the manual control has its own limitations in a way. It is generally seen that even after the glare is affecting a driver and this driver has alerted the oncoming vehicle to switch light beam by using its own changing of light modes, the driver of approaching vehicle does not switches high beam to low beam in most cases. This leads to the need for automatic control.

Another similar model that used RF transmitter-receiver pair was proposed by Prabhakaran et al. in which an ECU was designed and RF pair was installed at a city's entrance and exit borders. These pairs alerted the driver when entering a city and when leaving a city in a similar manner as the previous mentioned model worked and consequently would switch headlight high beam to low beam when inside the city [14].

Fig. 4. – Automatic high to low beam switching and vice versa when crossing city limits [14].

Still, it needs to be taken into account that installation of such RF pair in every city of a country is a tiresome task and in cases where the driver needs high beam light even inside a city should be considered. It would be a tough task to implement such a model in rural areas and it does not provides a safety feature that could work outside city limits like in case of passing through forest areas and suddenly another approaching vehicle, with its high beam on, poses a situation of glare for the former driver, as discussed earlier.

In their paper by Muhammad et al., beam from another oncoming vehicle and road contour are taken into account to make a design that could switch headlights automatically is presented. They have used Lux-meter BH1750 sensor module which could sense light from approaching vehicle and accordingly switch lights. It also used MPU6050 accelerometer sensor module which could sense road contour while going uphill or downhill. Then it used servomotors fixed to the reflectors of headlight that could change direction of light beam given by the headlight according to the sensed contour by accelerometer module. All of them are connected and worked according to the following block diagram [5].

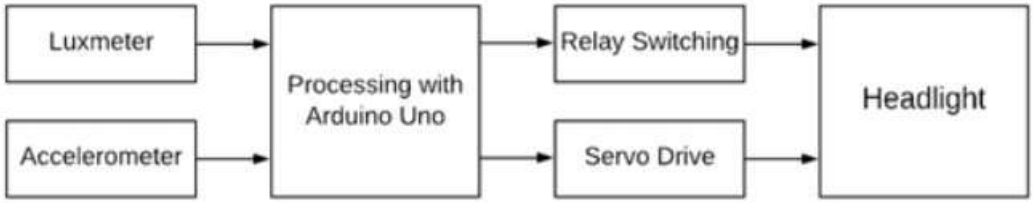

Fig. 5. – Block diagram for Lux-meter and Accelerometer based module [5].

This design has taken into account the need for the automatic switching of headlight into account which was previously mentioned. These works, and several others that are mentioned in the previous sections, show that advancements are being made in the fields of safety for driver and passengers inside a vehicle but development of such system and implementation in real-time driving has not been evident yet in our daily life. Also, more scenarios should be considered and further solutions needs to be developed accordingly. One such scenario is when the driver of the vehicle passes street lights arranged consequently. The sensor might get confused by the light falling on it with that of an approaching vehicle and switch the light mode of the vehicle in study. This could be seen as an option for energy saving as well but issues of the driver by continuous switching must be taken into account.

IV. Conclusion

The paper has presented a review of the previous works done in the development of safety features for driving in different conditions. It has tried to discuss how one solution arose another necessity which needed to be addressed and the subsequent solution led to another problem statements and so on. Overall, it provides a brief picture of the safety mechanism in terms of light beam control in any kind of automobile, that seem promising and implementable in the future. With the consideration of numerous scenarios in real-time driving, the system for automatic headlight control could be perfected in near future.

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