

LIMITATIONS OF PROBABLE VEHICLE HEADLIGHT TECHNOLOGIES – A CRITICAL REVIEW

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ABSTRACT. Day in and out there is an increase in the number of vehicles on the road. People are starting to prefer travelling at night times in order to avoid the heavy traffic. But while driving at night, a clear perception of the road and upcoming obstacles is not possible. Drivers generally switch on to high-intensity headlights while driving at night times which result in discomfort for the drivers driving from the opposite direction. People experience temporary blindness due to sudden glare of the high beam lights of the upcoming vehicle which in medical terms is referred as Troxler effect. In this paper, we have studied the possible methods which have been released by some developers but are limited to academic models. We have basically summarized all those methods and determined the reasons behind their failure to come into practical use. These technologies have certain loopholes which limit these to academic prototypes only. In addition to this, we have presented a new direction to work on this issue through the implementation of Internet of Things (IoT). This technology paves new roadways to share large information using cloud databases.

KEYWORDS

Photopic, Scotopic, Troxler Effect, LDR, Fuzzy logic, Pulse Width Modulation, Wireless Modulation Sensor.

1.INTRODUCTION

Light is an electromagnetic radiation. The word usually refers to visible light which is detected by naked human eyes. Light indeed is responsible for the sense of vision. 401-701nm(nanometer) holds the range of visible wavelengths surrounded by infrared (the longer wavelength) and ultrasonic (the shorter wavelength). The word usually refers to visible light which is noticeable to the human eye and it is responsible for what we see. Visible light is generally characterized as having the



wavelength in the range of 401-701 nm(nanometer). Between the infrared (Longer wavelength) and the ultraviolet (Shorter wavelength). Light can be produced by nature or by people. 'Artificial' light is normally created by lighting frameworks that change electrical energy into light. The human eyes are versatile to a specific range of vision. There are two visions to be specific Photopic and Scotopic vision [3]. Human eyes vary with various conditions of light surrounding it. In a bright environment, human eye opposes up to 3cd/m², called photopic view. During dull and dim surroundings our eye changes to Scotopic vision, ranging from 31-45 μ cd/m². It takes generally about 4 secs for human eyes to change from photopic to scotopic and vice-versa. This is also an additional case of TROXLER effect. With the brightness increase the strain, that expands the reaction time delaying the reaction. The need of headlights is inevitable for the night journey. The same headlight which helps the driver for better vision during night travel is also responsible for numerous accidents. Usually, the control is under the driver to switch in between high beam to low beam as per requirement. In Dark conditions, in absence of any other alternate source of light, high beam is preferred, to track the road or any obstacle ahead. Whereas in busy roads or heavy traffic low beam is preferred. In case of two-way traffic, the vehicles ply on both lanes. As the bright light from the vehicles of the opposite side falls on to the eyes of the driver of another side, results in glaring effect for sufficient amount of time. Even fraction of diversion might be the main cause of a fatal accident. Here, in the paper, we have discussed some most common concepts for changing the intensity of vehicle headlight which includes the use of LDR, Fuzzy logic sensor, Wireless Sensor Network, IR transmitter-receiver, Camera-based and PWM. But as of today these technologies have not been used in the practical scenario and are restricted within academic prototype. So this paper reflects the loopholes in these above-mentioned concepts and finally, we provide a different idea of these concepts.

2. LITERATURE REVIEW

Several authors and developers have researched and worked on different vehicle headlight technologies. These technologies or methods have certain limitations due to which they have been restricted to the theoretical domain. We studied these methods and segregated them and analyzed their drawbacks. Our critical review has been briefed on the following points:

2.1. LDR BASED INTENSITY CONTROL

In the LDR (Light Dependent Resistor) based headlight technology, LDR is implemented to change the intensity of light of the vehicle headlight. The resistance value of LDR varies according to the intensity of the incident light upon it. BJT and MOSFET are triggered by the gate current and are controlled by the implementation of the potential divider which consists of resistors. The switching device used in this method is Relay which has two contacts. Among the two contacts, high intensity LED is closed contact, whereas open contact is used to connect to low intensity LED [1] [2] [8].

LDR resistance varies over a wide range. They have a wide tolerance and their value changes with temperature change and with age. Sunlight and humidity destroy an LDR in a couple of years. Photo-diodes and photo-transistors are much better. Moreover, in this case, the light coming from the upcoming vehicle must fall on the LDR such that the LDR can work. This implies the LDR must be placed in the front. As a result, the LDR might experience Environmental effects and reduce its life [22]. In addition to this, the distance factor of the upcoming vehicle is not considered, which will also have its effect on the intensity of light. It hence is clear that use of LDR is not possible with this presented approach and has practical limits for use.

2.2 FUZZY LOGIC BASED INTENSITY CONTROL

PIC controller along with the implementation of fuzzy logic is used to control the intensity. The distance between the two vehicles, the Light intensity from the coming vehicle is received as inputs

by the fuzzy sensor. That checks whether it is confined within the tolerable limit. The information is conveyed to the micro-controller which converts it to the ambient light intensity. This software could be easily developed through MATLAB fuzzy logic toolbar, comprising fuzzy rules and values and act as the interference platform for the sensor and controller. The controller completes the process of fuzzification and defuzzification, the sensor output passed the information whether it is within or beyond the limit of tolerance [1] [24].

But the use of this concept is being limited as there are thousands of different fuzzy system configuration may arise conjunction disjunction, implication and diffusion choices, certain stem from the root interference means of fuzziness. The problem of dimension makes it an impossible practical implementation to set up rule base with more than three variables (if not only the light and distance but also considering the environmental aspect and other obstacles are detected, which is common the practical scenario). Application of learning controller from the input is still restricted to an academic prototype. Moreover, the recognition of gradual colour change is quite difficult and the technology used to acquire upcoming vehicle distance and light intensity is not clearly stated.

2.3 WIRELESS SENSOR NETWORK

A network that consists spatial distribution of autonomous devices comprising a collection of sensor nodes, that communicates and records surrounding conditions. Environmental monitoring, robotic control, smart grid, industrial automation and energy control systems etc are the fields of wireless sensors application [25]. The following system has an autonomous gateway which provides wireless connectivity to the wired databases and sensor nodes. Some of the distinguished parameters that can be monitored through WSN are humidity, temperature, pressure and sound intensity. With the help of this particular technology, a system can be established to control the headlight intensity. The process includes the sensing of the intensity of headlight by the sensor node which is then passed digitally to the wired or wireless media, to control the light strength [1]. But obviously, this technology and system working in the entire process have some flaws as it is still not in practical use. With intensity variable changing in different areas the sensor would find it difficult to capture the particular intensity of light. Fog, mist, humidity and rain decreases the intensity strength which almost makes the system absurd to sense the light. Alongside, with wireless media interference is always possible with other frequencies which will make it difficult to transfer the data efficiently and within a stipulated amount of time.

2.4 IR TRANSMITTER-RECEIVER

In this method, Infrared radiation is transmitted, which is being emitted by the LED, connected to the IR transmitter. The photodiode which is attached to the IR system receives the signal at receiving end. IR radiation which is not detected by human eye hence it is the preferable electro spectrum radiation used in wireless communication. The power supply is provided to this transmitting-receiving circuit. The IR rays which were emitted are reflected the receiver. Then the receiver receives and the device is turned on. The comparator gets the input voltage from the receiver, comparator thereby quickly compares the predefined threshold value with the received voltage. Comparator thereafter triggers the device to either switch on or off. Transmitter or MOSFET can act as a triggering device and Relay plays the switching device. Triggering device turns on followed by the switching device, then the LED shifted to low intensity. Again as the transistor is switched the high intensity LED too gets switched. Henceforth, the controller is developed through IR [1] [6].

But the uses of Infrared rays are being not practical in case of vehicles. The infrared signal sometimes faces an obstacle and gets blocked. Being a form of light, infrared only moves in straight lines. Therefore, the transmitters receivers have to be closely aligned to communicate directly inside of each other. The weather can also cause an effect, interference from sunlight, hail, storm, rain, dust

particles and pollution. The transmission range is quite short (within 10 meters). As a result, the performance also drops if the distance between the transmitter and the receiver is away from the range of IR device. Moreover, the speed at which transmission takes is quite slow [23].

2.5 CAMERA BASED INTENSITY CONTROL

A monochromatic or polychromatic optical device such as a still camera that captures still frames and easily transmits it or sends and record it via an electronic sensor. Generally, 4.3mm focal length is used due to its compatibility due to its human vision. Through various image processing techniques, the information of any vehicle approaching as well as vehicle coming from opposite direction as obtained. Hence the extraction is featured. After that, the analysis of the level of intensity is detected and henceforth the intensity of the vehicle headlights switches from high to low beam when required. High beams are preferred during the night only in absence of vehicles surrounding it and further switching it into low intensity with the increasing number of vehicles [1] [11]. As high-intensity headlights cause difficulties in the vision of the drivers and in certain cases it might be the cause of fatal accidents.

This method may not be reliable as the weather is prone to change and the diversity of reasons that come in handy place to place as the vehicle travels and climatic conditions that would affect the frames captured by the optical sensors. Fog mist dust particles etc. contribute to it. Rain, snow may ruin the frames and might not match causing the deviation. Resulting error in the detection of sensing and prediction of the light coming from ahead. Besides frames are varied with every light conditions from dawn to dusk. As it is a camera-based image processing unit it might mismatch with the database. The database which is predefined. Failure of matching of data in real-time environment conducts unwanted intensity of light. This might again arise a fatal effect while driving on highways.

2.6 PULSE WIDTH MODULATION

Pulse Width Modulation is the methods that deal with controlling simple circuits in the association of the microcontroller. The signal is digital in between processor to the controller. Noise is not an influential factor except when it can be strong enough to manipulate the binary logic. It has noise immunity over analogue controlling systems. By taking the output from the controller the intensity of the emitting headlight can be controlled. The duty cycles of PWM develops the power and glows the headlight, for instance, the duty cycle of the PWM considered 75% then the brightness would appear $3/4^{\text{th}}$. Another important factor is Pulse Width [1]. There will be a gradient of ON and OFF of the flashing of the headlights to change its brightness, then to have a constant focus light beam. The main setback lies on the microcontroller and its action to control and execute faster calculations to perform this operation [26].

PWM signals work in the 2kHz to 16 kHz, but sometimes it causes damage in DC and AC motors due to pulsating current (PWM). Among several effects, ball bearings are sensitive, and sometimes can be damaged due to the balls themselves being charged and discharged inside the rings (mainly due to EMF). Also, due to rise and fall of the current in PWM dimming Electromagnetic Interference (EMI) happens. This system also requires semiconductor device with low turn on and high turn off times but are very expensive.

3. CONCLUSION

In this paper, we emphasized on all the possible technology and methods that have been introduced to control the intensity of vehicle headlight for the purpose of reducing the discomfort of sudden glare at night time. We have studied and presented all the limitations of these methods and the reasons why these have not been implemented in the real scenario and are limited to academic prototype only. Our motivation was to direct the enthusiastic developer towards better methods, leaving the presented methods. Use of Internet of Things(IoT) can be a different direction for solving this issue. IOT can be implemented to distribute the information of headlight beam intensity of a car to other cars within a limited range. This information will be notified to both the drivers when both are within a particular range, to change their beam intensity as per the situation. If the driver does not change the intensity, after a minimum distance between the two cars, the low beam will be triggered automatically. Although this is a rough idea, a certain direction is being provided to work on this issue through the implementation of IoT.

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