Advancements in Vehicle Lighting System for Road Safety

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Abstract – According to information on accidents, the maximum of road accidents occurs during night time and many of them occur at the curved roads. Though only 25 percent of the driving is done at night but 55 percent of the total driving accidents happen during this period. Moreover, the data clearly shows that the most of the accidents occur at night or in unsuitable weather because of very difficult visual conditions. Under such bad conditions, or in extreme weather, it is difficult for drivers to be able to see traffic signs, streets, lanes, other vehicles, pedestrians, animals, and any other potential hazards. Therefore it is of a very great importance to use available technology or to build a system to contribute to road safety by increasing the visual conditions provided by vehicle headlights. When an oncoming vehicle's headlights fall on our eyesight, the driver may face temporary blindness due to it, which will result into a state called Dazzling of headlights, which causes a major threat and results in loss of many lives including the driver and the fellow passengers. So, it is very important that the driver is can see the road and the vehicle properly with correct lighting. Therefore headlights play an important role in preventing many accidents. Good visibility of the road and the vehicles contributes a lot to the driver's confidence and enables a more relaxed and safer driving.

Index Terms – Road Safety, Visual Conditions, Temporary blindness, Dazzling of Headlights.

1. INTRODUCTION

Night time driving with conventional head lights is extremely unsafe because they give glare which makes it extremely difficult to see the approaching vehicles or pedestrians for the driver. This improves visibility for driver and so achieve a significant increase in safety and driving comfort. The major problem hindering safe and more comfortable driving is the driver and his/her limited reaction time in the presence of changing road conditions during the night time. Drivers rely on headlights in the dark and in bad weather for a clear view of the road and to illuminate possible hazards ahead. It is, therefore, of great importance to use available technology to contribute to road safety by improving the visual conditions provided by vehicle headlights. So to enable that, this model creates an Adaptive headlight system which will decrease the glare and thereby enable easy driving. This done with help of a sensor which will detect the information and send it to motor to adjust head lights of the vehicle to get the lighting beam which is suitable. In order to provide improved night time safety measures, this work aims to design and build a prototype of an Adaptive and Smart Headlight system. This models key focus is on making an adaptive system for the headlights to increase road safety especially at night time by giving flexibility in driving. That enables the driver to react more quickly because he/she will see the road ahead more clearly. This is a step taken in aim of development in active safety is to reduce the reaction time of the driver by improving visibility and thus achieve a significant increase in road safety and driving comfort. Adaptive Front-lighting system (AFS) swivel the head light beams in advance of the vehicles turning. This places light into the turning radius, with the result that the drivers cornering visibility being dramatically improved. The vehicles data network also contains real-time sensor data on steering angle and wheel speed. Based on this information, AFS equipped head lights can match the light distribution with the vehicles turning angle so that approaching curves and intersections receive maximum illumination, especially at the driver's gaze point.

2. RELATED WORK

The related works that have been done by other researchers that are related to the current research problem are summarized here.

2.1.

The paper [1] focuses on building a prototype of adaptive front lighting system that improves the night time illumination of the curved roads to the driver. In this proposed system, unlike the traditional AFS which uses steering wheel for the headlamp's horizontal adjustment, we are using a camera and ultrasonic as sensors to adjust the headlamps horizontally and vertically. This AFS uses camera as image sensor to detect and capture the details of the curved road ahead of the vehicle. Ultrasonic sensor to detect any oncoming vehicle.

2.2.

Steering angle-based adaptive headlight controller for safe operation in emergency situations is proposed by adopting the compensation method of the symmetric two angle sensor data.

Adding the intelligence in automotive applications results in increased chance of unsafe operations, requiring the integration of additional safety functions. Integrate the safety observer with the adaptive headlight controller, still providing safe angle control in an abnormal situations by the steering angle. If the symmetric behavior of two angles is broken in the unknown interruption, the backup angles are restored into the active angle control value [2].

2.3.

Analyzing photometric characteristics of vehicle headlamps when turning the corner, and developed a new kind of AFS (adaptive front-lighting system) based on CCD (charge-coupled device) which was better than traditional AFS. This new AFS used CCD image sensor to detect information about the corner and then sent curvature radius to electronic control units in advance. Meanwhile, electronic control units would calculate accurate rotation angle of headlamps through velocity and curvature radius, and send it to motor to adjust headlamps to get the lighting beam which was suitable for the corner. Through this way, it could avoid "blind spot" caused by the fixed lighting area when coming into the corner, and improve driving safety. This paper gave a modeling for horizontal rotation angle of vehicle headlamps, and simulated it with MATLAB [5].

2.4.

In order to enhance safety driving at night, an adaptive front-lighting system (AFS) of automobile controlled by STC12C5A60AD which is the core of electric control unit is designed in this paper. The AFS is based on the steering wheel angle and speed changes to adjust light axis angle to light up the road in the front, so the drivers' security vision are improved. The work principles of the AFS and control model and hardware circuits are particularly described. Application and design of sensors circuit, signal conditioning circuit, stepper motor circuit and power supply and power protection circuit, and then a software method was brought up [7].

3. PROPOSED MODELLING

By this project, a little contribution is made to the engineering society and save the lives of many. In this project there will be three features they are:

- To reduce the headlight glare
- Adaptive headlight during curved road
- Remote control of head lights.

3.1. Raspberry Pi Board

The allure of the Raspberry Pi comes from a combination of the computers small size and affordable price. Enthusiasts envision using the small form-factor PC as a cheap home theatre PC (HTPC), or secondary low-power desktop. Institutions, like schools and businesses, could benefit from deploying a fleet of computers for a fraction of the cost of traditional desktop towers. The small size makes for an easy to-hide computer that sips power and can be mounted behind the display with an appropriate case. It could also be used in niche applications, like digital signage. While it will not blow away any recent hardware in performance, it does make for a cheap secondary computer which could be useful for troubleshooting and researching solutions if your man rig fails to boot as well.

3.2. Camera

Camera used here for take analyze the intensity and It is connected to the raspberry pi USB port with 6 bright lights, which is used to monitor the road and captures the headlights of an oncoming vehicle.

3.3. Ultrasonic Sensor

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

3.4. Motor

Basically Servomotor works on the Pulse Width Modulation (PWM) signal, its angle of rotation is controlled by duration of applied pulse to its signal output pin through a variable resistor. A servo motor is a rotary actuator or motor that allows for a precise control in terms of angular position, acceleration and velocity, capabilities that a regular motor does not have. It makes use of a regular motor and pairs it with a sensor for position feedback. The controller is the most sophisticated part of the servo motor, as it is specifically designed for the purpose.

3.5. Raspbian Wheezy(Linux)

Raspbian Jessie is a free open source operating system based on Debian distribution. It is booted in the raspberry pi to make interaction between the user and the whole system.

3.6. Python

Python is a flexible, high-level, interactive, interpreted, highly readable, object-oriented scripting language and also runs on different standards editors like leaf pad, nano or vim. Programming of Raspberry pi is done using python programming language in order to control the brightness of headlights.

3.7. Control Algorithm

This project promoted the control algorithm the Bending lighting algorithm research of Adaptive Front-lighting System which simulates driver behavior. By using the eye tracking

system, the test of the driver's preview distance changing which under different speed and road curvature is taken. It further completed the existing dynamic prediction algorithm of the car's motion trajectory in the future based on the drivers' optimal acceleration model. Based on these theories, we had built an algorithm about corner lighting of adaptive front-lighting which regards to imitating driver's behavior. Finally, we prove the control effect of the algorithm by the simulation analysis and the change process of the front lighting illuminating area under the algorithm's controlling when it was turning.

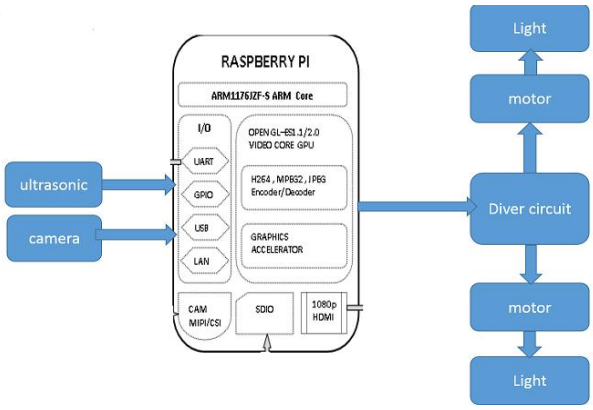

Figure 1 Block Diagram

4. RESULTS AND DISCUSSIONS

The headlights are placed at either ends of the vehicle and camera is placed at the center that is between the headlights. The two headlights and camera are individually placed on three varied Servomotors and they are controlled by the Raspberry pi. Here the steering wheel of the vehicle will be attached to the steering wheel sensor at the center which is a 10 thousand rotational potentiometer and sends a pulse width modulation signal which will be generated by the Raspberry pi board, to the servomotors for controlling the movements of the headlights to avoid glare and also the purpose of the camera at the center is to capture the headlights of the approaching vehicle and also the image which is captured is given as an control input to the Raspberry pi board through SPI communication where processor of the Raspberry Pi processes the captured image using open CV and also the ADC converter converts the intensity of the light of captured image into a digital value and sends that data to the Raspberry pi board which then controls the brightness of headlights of our vehicle in a way to reduce the glare from the oncoming vehicles and illuminate the path properly. The potentiometer is used as the input. There will be a difference in the voltage which is from 0V to 5V. The potentiometer gives an analog input, which need to be converted into digital input by PIC via ADC. The digital number thus obtained by the ADC gives the proportion related to the fact that the input voltage is of the complete voltage range of the converter. For instance, by applying 2V to the input of an ADC with a full-scale range of 5V will give the result in a digital output which is 40 percent of the full range of the digital output (2V / 5V = 0.4). The digital output ranges are usually expressed in the terms of bits. The number of bits at the output determines the range of numbers that may be read from the output of the converter. An 8-bit converter will provide outputs from 0 to 28 -1 or 255. Hence, when 2V is applied to a converter with a full scale range of 5V, an 8-bit converter would read 40 percent of 255 or 102.

Figure 2 Sensor and Head lights

Coming to the software part, firstly we need to boot Raspbian Jessie with pixel with a Linux operating system based also open CV is installed for the purpose of image processing where various conversions likes RGB to Gray conversion, Gaussian blur algorithm are performed for obtaining the maximum amount and the position of intensity of light value from the image captured by the camera and python language is used for programming. In RGB to Gray conversion, a colored image will be converted into an image in gray scale and in Gaussian blur algorithm lighter areas intensity values of an image are connected to binary (1's) and darker areas intensity values of an image are connected to binary (0's). This is done for obtaining the maximum position of intensity value of light and a blue circle in the image is made at maximum location with radius 41 and thickness 2. Based on this intensity of light value the headlights are adjusted accordingly to control the brightness of headlights of the approaching vehicles. When going around curves, they illuminate the side of the road more than the road itself. Adaptive headlights react to the steering, speed and elevation of the car and automatically adjust to illuminate the road ahead. When the car turns right, the headlights angle to the right. Turn the car left, the headlights angle to the left. This is important not only for the driver of the car with adaptive headlights, but for other drivers on the road as well. The glare of oncoming headlights can cause serious visibility problems. Since adaptive headlights are directed at the road, the incidence of glare is reduced. A car with adaptive headlights uses electronic sensors to detect the speed of the car, how far the driver has turned the steering wheel, and the yaw

of the car. Yaw is the rotation of the car around the vertical axis - when a car is spinning, for example, its yaw is changing.

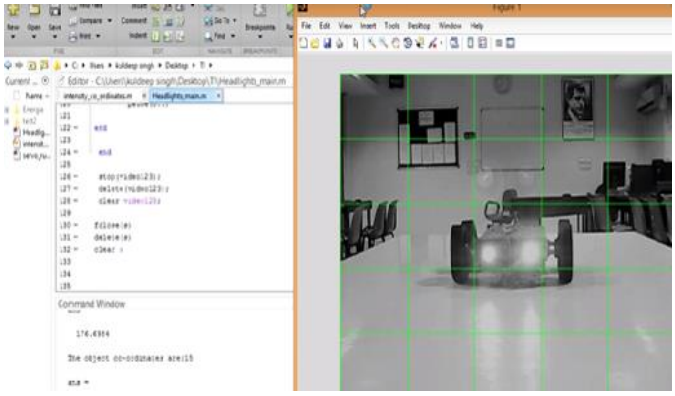

Figure 2 Sensor Capture

The sensors direct small electric motors built into the headlight casing to turn the headlights. The sensor is present in between the two head lights as shown above. This captures the image of the approaching vehicle.

Figure 3 Headlights dimness and rotation to decrease the glare

5. CONCLUSION

The existing conventional light systems do not provide illumination in the right direction on curve roads. Due to this constrain, a need to understand an alternative technology solution. This paper propose the new system which is based on camera as input sensor to adjust the horizontal rotation of headlamp and this newly proposed Adaptive front lighting system (AFS) helps to improve drivers visibility at night time hence achieving enhance safety. The headlight design developed provides unprecedented light beam control over angle and time. Essentially, the full headlight beam can be split into hundreds of thousands of tiny little beams that can be turned on or off for very short durations (milliseconds). The flexibility and control of the headlight will allow us to perform numerous tasks for the first time: Allowing drivers to use high beams without glaring any other driver on the road, allowing oncoming drivers to see the vehicle and road clearly despite the high beams, allowing drivers to see better in rain, snow and fog, and allowing better illumination so lanes, sidewalks and dividers can be visible clearly. The sensitivity of LDR sensor can be further enhanced to reduce the deferment of switching between high beam and low beam. Real time analysis on number of accidents and mode of accidents taking place in a high ways can be noted down to construct statistical model. It should be capable of adapting to the environment to improve the safety in poor visibility.

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