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On-road Night-time Smart Vehicle Light Detection

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***Abstract*— It is always infuriating while traveling in the nights due to the glare produced by the headlights. This is primarily due to high-intensity light rays from the car approaching towards us. At nights, due to presence of fog and street lights also contribute to the same.**

In the presence of fog at night, the driver gets dazzled by his own high beam as well and can lead to a disaster. If the vehicle can detect night fog, the high beam assist can be adapted accordingly.

Modern cars come with manual headlight control, but some cases may lead to accidents due to negligence or ignorance of the driver.

If two cars approach each other with a high beam of lighting, they produce a very high glare for both drivers. The solution is to either switch the headlights to a low beam or reduce the intensity of the LED headlight. We can have a system that is constantly monitoring every instance of intensity of light in the surroundings and upon which it takes the decision to switch to a high beam or low beam.

The light intensity which is approaching in reversed direction to us is detected using the photo detector and processed. The wavelength of visible light varies from 400 to 750 nm, so photo detectors of Si and Ge can be considered.

With the help of photo detector, the optical signal is converted to an electrical signal and this electrical signal is again converted into a digital signal. This digital signal is handled by the monitoring system for further decision making. A stepper motor is used to alter the reflector angle which is fixed to the LED headlight, based on the program implemented by the monitoring system.

***Index Terms*— LED headlight, stepper motor, fog detector, Photo-detector (Si-Gi)**

I. INTRODUCTION

One of the main issues during night-time driving is a good visibility of the road ahead. According to road accident surveys, majority of the accidents occur in dark. Although the traffic volume is much lower during night-time, the percentage of traffic accidents is much higher. The aim is to improve visibility for the driver, thereby achieving significant increase in road safety and driving comfort. High-beams are used in non-appropriate situation and it is annoying when there is an intense headlight glare, thus dazzling other drivers. The most common system in the market is based on the manual switching between low and high beams, the drivers prefer not to use them because of the labor involved in the work of driving. Hence, it can lead to poor visibility, discomforts for drivers, reduces efficiency of driver leading to insecurity of passengers. In this aspect, we have automated tilting of the reflector in the headlight to ease the driver off a possible high intensity glare.
To solve this problem, night-time vehicle detection has an appreciable significance. The possible solution to the problem is to automate the process of tilting of headlamp reflector based on the measured light intensity. Based on a survey conducted in USA, the intensity value is standardized. We have fixed an intensity limit for glare value. A light sensor is fixed on the front side of the vehicle. The measured light intensity at every point of time is compared with the intensity limit value and a decision is taken whether to tilt the reflector up or down. Thus, the glare is prevented and hence a possible catastrophe is avoided.

Light intensity value (in lux)	Visual Response
0 to 0.25	Unnoticeable
0.25 to 0.75	Satisfactory
0.75 to 2	Just admissible
2 to 4	Disturbance
Above 4	Unbearable

Table.1. Shows the Visual Response to Light Intensity

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Fig. 1: Two ways of headlight beam control, Low and high beam.

II. PHOTODETECTORS

Photo detectors are light sensors and are primarily used as an optical receiver to convert light energy into current. The principle is based on photoelectric effect, which is the effect on a circuit due to light.
A photo detector has a p–n junction that converts light photons into current. The junction is coated with an anti-reflective to absorb photons. The junction is covered by the illumination window. The absorbed photons make electron-hole pair in the depletion region. The external light intensity is measured by the photo detector.

The conductivity of photodiodes is as follows:

$$\sigma = \sigma_{th} + \sigma_{ph}$$

σ_{th} is thermal conductance
σ_{ph} is the photodiode conductivity

This can be represented by the electron hole charge carrier concentrations:

$$\sigma_{ph} = q(\mu_n n + \mu_p p)$$

μ_n is the mobility of electrons
μ_p is the mobility of holes
n is the charge concentration of electrons
p is the charge concentration of holes

III. IMAGE BASED FOG DETECTION

Fog can be detected by using Image sensing techniques. Modern vehicles are equipped with a lot of sensors, cameras and radars around the complete vehicle and their use in many practical applications is extensive. Fog can be detected by using the images captured by the camera mounted. We can analyse the images differentiating the traffic signs, lane markings, rear lights of the vehicle travelling in front and the headlights of the vehicles approaching, to detect presence of fog. But context to all these work, image descriptors can be used to classify images based on the presence of fog. Gabor filters at different frequencies, scales and orientations are globally used to describe the entire image using image descriptor. In the vision of a computer, image descriptors are descriptions of the visual features of the contents in images, algorithms, videos, or applications that produce such descriptions. Elementary characteristics such as shape, color, texture is among them which they describe.

The different fog categories:

Visibility Distance	Fog Feature
Above 1000 m	No Fog
Between 300 and 1000 m	Low Fog
Between 100 and 300 m	Fog
Below 100 m	Dense Fog

Table.2. Shows Visibility Distance to Fog Feature.

Fig.2. Examples images for labelling categories. From left to right: No Fog, Low Fog, Fog and Dense Fog

If fog is detected by vehicle, its front and rear fog lights could be turned on or off, as it is often done for low beam and high beam lights in today's vehicles.
Using the camera which is mounted inside a vehicle, a system was introduced to estimate the visibility range. It aims to cover all possible situations of low visibility caused by dazzling, rain, snow of fog. The visibility range is thereby estimated by the attenuation of the contrast along similar road features like lane markings, banquet or even oil stripes.

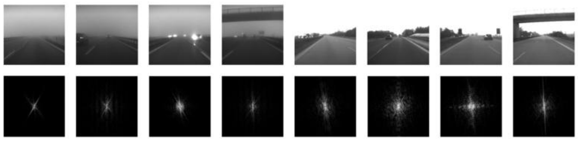

Fig.3. Images of Fog and Fog free scenes

IV. SYSTEM SETUP

The setup consists of the following components:
- An Image Descriptor for Fog Detection
- A photo detector
- NI MYDAQ Card
- Reflector beam operated on 12V battery
- A tilting mechanism
- UNI-STEP 1.8° step, AC stepper motor
- Program working on Lab VIEW 8.2 platform

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The steps involved:

• The headlight is positioned by the actuating mechanism.

• The external light Intensity is measured by using a Photo detector

• The measured value is fed as input to the LabVIEW Program through MYDAQ

• Based on measured value, LabVIEW executes the program

• Based on the output of the program, MYDAQ Actuates the stepper motor steps

• Now if there is any fog in the surrounding of the vehicle, its presence is detected by the Image Descriptors.

• Based on the presence of Fog, the vehicles Front and Rear Fog Lamps are automatically turned on or off without the driver's action.

There are several constraints in the actuating process. They are explained below.

• The maximum angle of tilt should not exceed 45°.
• The initial position of the headlight is to be specified by the user criteria.
• The assumed motor speed is 200rpm.
• It is assumed that 0° corresponds to high beam and 45° corresponds to low beam.

The flow diagram is as follows:

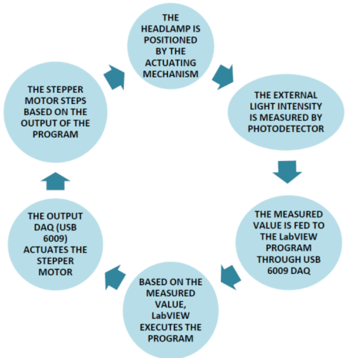

Fig.4. The Flow Diagram

V. CONCLUSION

In this paper, a method for smart headlight control is presented. It is evident that most of the drivers in the present world find it annoying to switch between high beam and low beam manually. Hence a system which does it automatically for the driver will be a immense help, thus saving a lot of time. It eases in maintaining the visibility and concentration of the driver thus helping in averting accidents. It is slightly costly compared to manual switches, but it is worth spending considering the advantages it offers. But the cost can be brought down by building a specific Monitoring System for both acquisition and actuation. The idea of detecting vehicles at night time is useful for various applications such as, traffic surveillance, smart headlight beam control, lane departure warning etc.

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