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Adaptive Headlamp and Side Mirror using Linear Regression based on Raspberry Pi3

Rahul Ekatpure[1]
D. Y. Patil College of Engineering, Akurdi
Pune, India
rahulekatpure2@gmail.com

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ABSTRACT

The greatest number of fatal traffic accidents occurs on curved roads at nighttime. In most cases, the late recognition of objects in the traffic zone plays an important role. This highlights to the importance of the role of automobile forward lighting systems. This paper developed a proto-type auto adjustable headlamp and mirror tilt to improve cost and reliability. Also, an adaptive mirror is implemented to remove the blind spots while taking turns. The methodology used here adaptive headlamps and mirrors are developed using Raspberry Pi3 as hardware and Python is used as programming language. Machine learning algorithm "Linear regression" is used for computing the output. Machine Learning Linear regression is considered here as it simple and efficient algorithm in terms of implementation and memory usage. Easily available components like Raspberry Pi3, LDR Sensor, ADXL Gyroscope are used and the design is developed to provide the steering mechanism for the headlamps and mirror which are actuated along with the steering of the front wheels. Around 15% increase in the illuminated area on road and 20% increase in the side mirror view is achieved.

Introduction:

As the automobile industry developed over the years, there was a great increase in the number of vehicles resulting in the increase in the number of road accidents. Road accidents at nighttime are more serious and result in more fatalities. In the research, we found that approximately 60% - 70% fatal vehicle - pedestrian accidents take place at nighttime. Poor visibility or improper illumination of the roads at road corners, curves and of surrounding area results in accidents. The main cause of most of the accidents occurring at nighttime is generally the driver fails to see the obstacle or the pedestrian and react in time or apply brakes in time. With the increase in human age the light requirement to the eyes also increases. A youngsters' or an adults' eye requires more light compared to a child to do a same task. Therefore, proper illumination is a very important task. The headlamps play a very crucial and major role in the driver's visibility and safe driving. Headlamps with AFS illuminate the curve of the road when the vehicle is turning at the curved road. The headlamp with AFS can illuminate the curved road fully which as a result does not block the driver from detecting the pedestrian in the way of the vehicle. Therefore, timely detection of the pedestrian leads to timely avoid any accidents or collision at the curved road. For this purpose, the traditional front lights are modified and controlled so that they provide additional illuminated road to the driver while taking turns.

On the similar front the side mirror view for the driver plays a very crucial role in the way the driver approaches the left or right turn or switches the lanes wherever required. Major challenges arise when the driver needs to switch from Highway to service lane or vice versa. In these cases, with traditional mirrors the driver has a view of only the barricade or the separator between highway and service lane. Providing the driver with an additional view of the highway or service lane will make it easier for the driver to make a better decision while making these turns. For this purpose, the traditional side view mirrors are modified and controlled so that they can provide this additional view to the driver.Linear Regression is a type of machine learning algorithm supported supervised learning. It performs a regression task. Regression models a target prediction value supported independent variables. It is mostly used for locating out the connection between variables and forecasting. Different regression models differ supported – the type of relationship between dependent and independent variables.

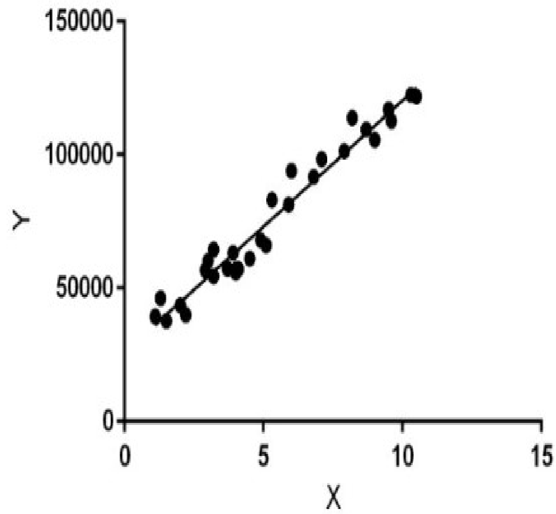

Fig. 1Grap of Linear Regression technique

Figure 1 shows graph of Linear regression technique.

The working principle of linear regression is that it predicts a variable (y) based on a given independent variable (x). Linear regression finds out a relationship between input (x) and output(y)Therefore it is names as Linear Regression.
The regression line is the best fit line for our model.

Hypothesis function for Linear Regression:

$$y = \theta 1 + \theta 2.x \qquad (1)$$

Equation 1 shows the hypothesis function for Linear Regression.

While training the model we must give following inputs:

x: Input training data

y: labels to data (supervised learning)

When training the model – it fits the best line to predict the value of y for a given value of x. The model gets the best regression fit line by finding the best θ1 and θ2 values.

θ1: intercept

θ2: coefficient of x

Methodology

A. Block Diagram

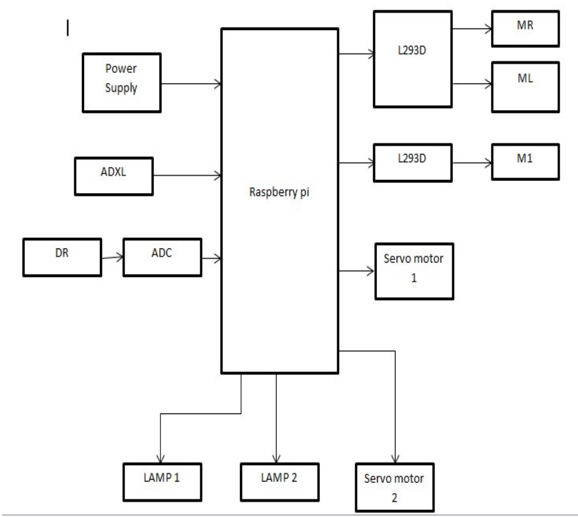

Fig. 2 Block Diagram of Adaptive Headlamp and Mirror using Raspberry Pi 3

Figure 2shows the block diagram of Adaptive headlamp and Mirror using Raspberry Pi3.

LDR sensor detects the ambient light and provides the input to the ADC which in turns converts the analog output of LDR sensor into digital format and this is further passed on as input to the Raspberry Pi. The Raspberry Pi processes the ambient light and then calculates the output to be sent to the headlamps to adjust the intensity of the headlamps as per the ambient light conditions.

Gyroscopic sensor ADXL provides continuous position of the vehicle as input to the Raspberry Pi and the controller further processes the data. When vehicle movement is detected in right direction, the headlamps are rotated slightly to the right direction and vice versa. Similarly, the side mirrors are adjusted so that additional view is available to the driver for turning in the either direction. When the vehicle is climbing or moving down a steep slope, the headlamps are adjusted accordingly.

The methodology of this paper is to disassemble the conventional headlight and modify the projector light for rotation of the beam. To manage system costs and complexity, a simple framework was laid out for the developed Automatic Headlamp and mirror Steering System. The latter consists of three important components: input sensors, a raspberry pi as the brain of the system, and a motor for positioning the headlights and mirror. The developed flow task diagram of Fig. 2 shows that the system first collects inputs, processes them, and then moves the actuator as output. In this design, there is no requirement for a feedback loop between the headlight and mirror positioning and the raspberry pi.

B. *Motor Initialization*

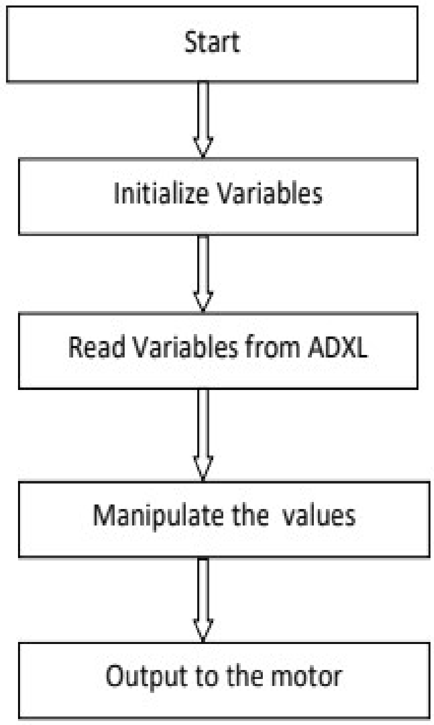

Fig. 3Servo Motor Initialization

Figure 3shows the algorithm for servo motor Initialization.

The servo motor that we have selected needs to be calibrated to provide the necessary torque for to control the swiveling of the headlamp. The microcontroller provides the control in digital format and it is received and required amplifications areto be performed to provide the necessary sweeping or swiveling of the headlamp.

A. *Linear Regression*

The prototype is trained considering various ambient conditions if light in daytime, evening, nighttime. This rigorous training ensures that the algorithm achieves maximum efficiency and accuracy.

LDR	State	LDR	State
1	0	19	2
2	0	20	2
3	0	21	2
4	0	22	2
5	0	23	2
6	0	24	2
7	0	25	2
8	0	26	2
9	0	27	2
10	1	28	2
11	1	29	2
12	1	30	2
13	1	31	2
14	1	32	2
15	1	33	2
16	2	34	2
17	2	35	2
18	2	36	2

Table No. 1shows the training matrix achieved while training the LDR for linear regression.

State 0: Headlamp Off

State 1: Headlamp Low Intensity

State 2: Headlamp High Intensity

Results

The prototype is tested and below are the results obtained.

The gyroscopic sensor is used to get the data related to actual position of the vehicle in terms of inclination of the vehicle and the sensor continuously monitors these values and provides the data as input to the Raspberry pi for further processing.

Below are the results achieved through reading the sensor data.

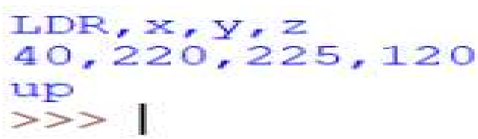

Fig. 4Simulation Results from Python

Figure 4 shows the simulation results from python. As we see the first reading 40 comes through the LDR to detect the ambient light so the headlamp can adjust its light accordingly.The next three readings are from the Gyroscopic sensor in x, y, and z (220, 225, 120) plane and same data is further processed.

Figure 5 shows the comparison between Minimum requirements and actual results achieved

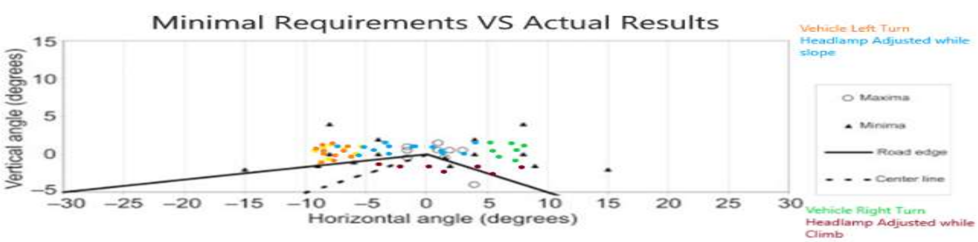

Fig. 5Minimum requirements Vs Actual Results for Road Illuminatio

Table No.2Comparison of Minimum Requirement Vs Actual Results

Sr No.	Minimum Requirements	Achieved Results	Comments
	Measurement in Degrees		
1	Horizontal Angle	Horizontal Angle	
2	(-5 to 5)	(5 to 10)	Vehicle Turn Right
3	(-5 to 5)	(-5 to -10)	Vehicle Turn Left
	Verticle Angle	Verticle Angle	
4	(-1 to 1)	(-2 to 1)	Vehicle Climbing
5	(-1 to 1)	(-1 to 2)	Vehicle on Slope

Table No. 2shows the comparison between Minimum requirements and actual results achieved.As we can see we have achieved increased area in terms of degrees of the illuminated road.

Conclusion

This paper introduces a simple, dependable, and inexpensive solution for Automatic steerable headlamps and automatic tilt mirrors.The headlamps can be moved left, right, up, down, and even upper and dipper adjustment is achieved in accordance with the steering wheel movement and the ambient light conditions. The advantage of this developed headlamp and mirror adjustment system is highly adaptable and can be easily configured with variety of vehicles. Along with the adaptive headlamps, the system also provides adaptive mirrors to eliminate the blind spot.

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