Control Model of Adaptive Headlight System

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***Abstract*- For many of the drivers, the keys to a car is the keys to independence, but some of them are also the "Key" to serious injuries. Road accidents are considered to be one of the major causes of death of people fewer than 45 years of age. From the survey, it has been observed that every year over 40,000 deaths are taking place and the main reason behind that are the night accidents. More than 23% of these traffic fatalities occurred due to bad visual acuity at night. Dangerous traffic accident is when vehicles move on curve roads at night. The main reason is conventional head light does not provide sufficient and reasonable illumination for night time visibility to be adapted to curves. This paper discusses on control model for adaptive headlight system (AHS) of vehicles on curve roads.**

***Keywords*- AHS, Curve drive, Control Model, Bit-Xenon headlight, CAN, LIN**

I. INTRODUCTION

The research of driving safety of vehicle is one of the most important topics in the world. Driving at night is the main cause of high rate of traffic accident. Not only does it help you to reach your destination safer, the AHS system also makes it easier to see pedestrians, animals and other objects whenever you enter a bend, while reducing glare for oncoming drivers. From the institute for traffic accident research and data analysis, it has been found that approximately 70% of vehicle to pedestrian accident occurred in night time as depicted in Figure 1[1]. The adaptive headlight (AHL) is available as standard equipment. This system is installed only in connection with bi-Xenon headlight which contains Swivel module for bi-xenon headlight, stepper motor controller, stepper motor for headlight vertical aim control, side light corona or day time driving light corona, direction indicator and bi- xenon control unit. The adaptive headlight performs the exterior lighting functions.

It also enables the bi-xenon low beam and high beam headlight to move with the driving range while cornering. The AHL feature requires the rain/driving light/solar sensor as well as bi-xenon headlight. While cornering, the swivel range of the bi-xenon low beam and high beam headlight is continuously adapted [2]. The illuminated area while cornering therefore improves the field of view for the driver. The adaptive illumination while cornering results in safer cornering with faster recognition of obstacles, improved perception of surroundings and accident avoidance will also be there.

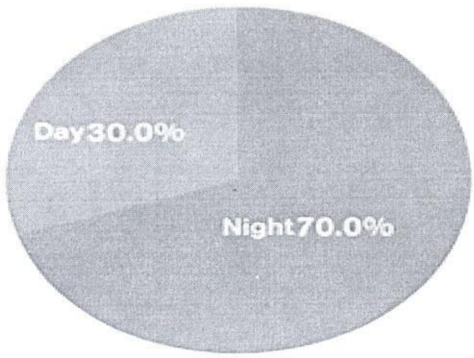

Fig. 1 Daytime Night time Ratio in Vehicle to Pedestrian Vehicle

The electronic module of the adaptive headlight facilitates faster response to the current road situation. The system is controlled by the electronic module and hence less susceptible than pure mechanical systems.

II. CONTROL MODEL FOR AHS

For adaptive headlight functioning, control model should be installed with following system components -

1) Foot well module
2) Car Access System 3
3) Dynamic stability control
4) Rain/driving lights/solar sensor
5) Roof functions center
6) Vertical dynamics management

For the entire exterior lighting system, the foot well module acts as the central control unit therefore also for the adaptive headlight [3]. The remaining control units such as the dynamic stability control, Rain or Driving light or Solar Sensor, Roof Functions, Centre & Vertical dynamics management provide specific type of input signals. The control unit with their generated type of input signal is shown in Table 1.

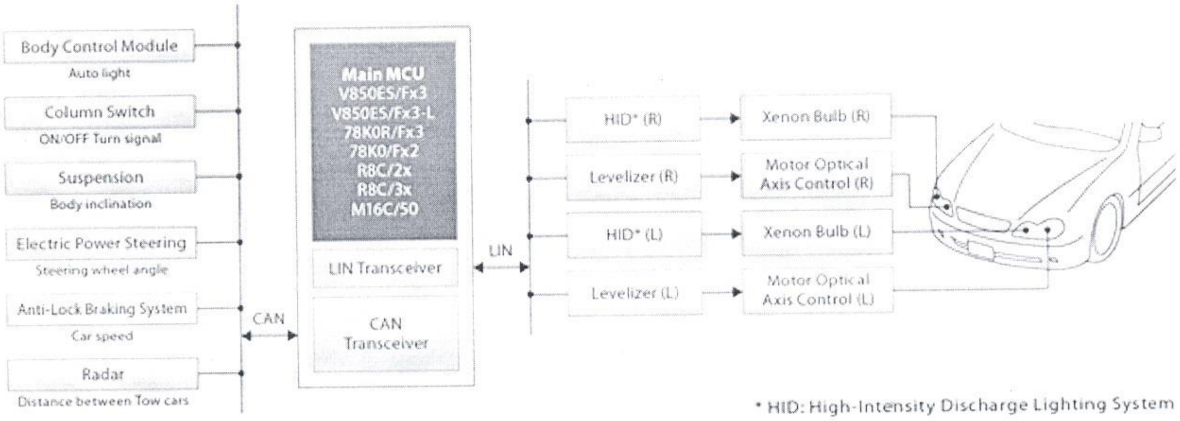

Fig. 2 System Block Diagram for AHS

Table I
RECOMMENDED PRODUCTS OF MCU WITH FEATURES

Semiconductor device	Recommended products	Features
MCU	V850/F Series	Memory and package lineups addressing a wide range of needs, 1 to 6 channels of CAN, enhanced peripheral functions, general automotive microcontroller.
	78K0R/F Series	Memory and package lineups addressing a wide range of needs, CAN, LIN, general automotive microcontroller.
	R8C/3x Series	Built-in data flash with background operation (BGO) function, CAN, LIN.
	R32C/100 Series	16-bit multifunction timer, enhanced communication function, CAN gateway, LIN.
	M16C/50 Series	16-bit multifunction timer, 10-bit ADC, CAN

TABLE 2

A.

Control Unit	Signal
Car Access System 3	Wake-up
Dynamic stability control	Vehicle speed and yaw rate
Rain/driving lights/solar sensor	Switch on lights when dark
Roof functions center	Transfer of RLSS signal to K-CAN
Vertical dynamics Management	Vehicle level

The control for the adaptive headlight is located in the foot well module. The foot well module is connected to three bus systems K-CAN, F-CAN and LIN-bus. Data from the vertical dynamics management system are received via the F-CAN [4]. The foot well module receives and sends data via the K-CAN and LIN-bus. The foot well module has no gateway for the F-CAN, however, it does have the gateway between K-CAN and LIN-bus. The Car Access System 3 sends the input signal as a wake-up signal to the control unit in the vehicle. The steering column switch cluster is connected directly to the wake-up line. The dynamic stability control sends signals relating to the yaw rate and vehicle speed to the adaptive headlight. From the signal send by dynamic stability control one can easily decide the speed of vehicle and in turn yaw rate. Due to presence of Rain or driving light or Solar, the light will get switched on when darkness is there. The light switch must be set to automatic high beam control for this purpose. The roof functions center receives the signals from the rain/driving light/solar sensor .The roof functions center makes the signals available on the K-CAN. Vertical dynamics management makes available the values for the dynamic headlight vertical aim control to the foot well module [5]. The foot well module receives these values via the F-CAN. In this way the headlight range can be adapted to the different driving situations, e.g. laden or unladed.

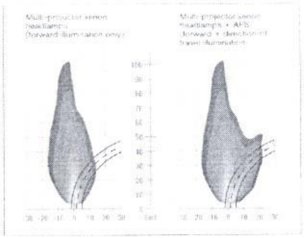

Fig. 3 Comparison of Headlamp Illumination Patterns

III. WORKING OF AHS

To ensure the operability of AHS, the adaptive headlight must be adapted to the vehicle specific data. The vehicle-specific data are located in the foot well module and in the stepper motor controllers [6]. The foot well module contains the data of Vehicle identification number and type of vehicle. The stepper motor controller contains the data for Headlight and headlight swivel range, Permitted acceleration and deceleration ramps, Characteristic speed maps, Encoding, Vehicle identification number and Vehicle type. The adaptive headlight can be activated as from terminal status "terminal 15 ON". Initially, the foot well module switches on the stepper motor controllers. The adaptive headlight is ready for operation following a reference run of the bi-xenon head lights [7]. A reference run is performed during every new start.

The conditions for switching on the adaptive headlight are:

- "Terminal 15 ON"
- Light switch in automatic driving light control position
- Rain/driving lights/solar sensor detects darkness
- Both bi-xenon headlights are intact

A. *CONTROL UNIT AND THEIR SIGNAL*

The AHS lamps illuminate the direction of travel when turning right or left at intersections, enabling the driver to better detect pedestrians or other objects in the crosswalk. It is shown in Fig.4.

IV. PERFORMANCE RESULTS

When cornering the AHS lamps are illuminated in the direction of travel to match the road curvature thereby improving the driver's forward visibility as shown in Fig.3. The foot well module detects a defective bi-xenon headlight by measuring the intake current of the respective bi-xenon headlight [8]. The adaptive headlight is switched on as soon as the rain/driving lights/solar sensor sends the switch-on signal for the low beam headlight [9]. The AHS lights shine in various ways in various conditions such as in the intercity, for cornering, for turning, as well as for rain function, it can be shown in Fig. 5.

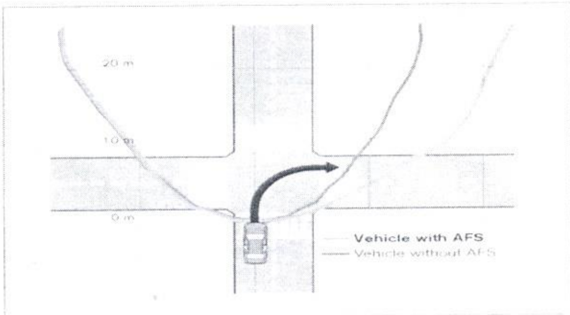

Figure 4: Concept of AHS Illumination (When turning right at an intersection)

V. CONCLUSION

The principle of the AFS system consists of the horizontal and vertical turning of both main headlamp modules depending on the car's speed. At slower speeds, the main headlamps are supplemented by turning lights in the form of fog lamps with corner functionality. This regime is activated by a car's speed and a time delay, so if the activation conditions are met, this regime can be activated outside a city too. It is active at speeds between 15 and 50 km/h [10]. The Intercity regime moves gradually into the Motorway regime, so that the change to the lighting is smooth and natural. It is active at speeds from 90 km/h, but has its maximum effect over 120 km/h [11]. This paper mainly studies the control model of vehicles' adaptive headlight system. We have also explained the control model with its system components required for the proper adaptive headlight system. From this paper we can conclude that using AHS system, the light of vehicle shines as per the situation such as intercity, rain function etc. This system is most beneficial to avoid the accidents at night. Not only does it help you to reach your destination safer, the AHS system also makes it easier to see pedestrians, animals and other objects whenever you enter a bend, while reducing glare for oncoming drivers.

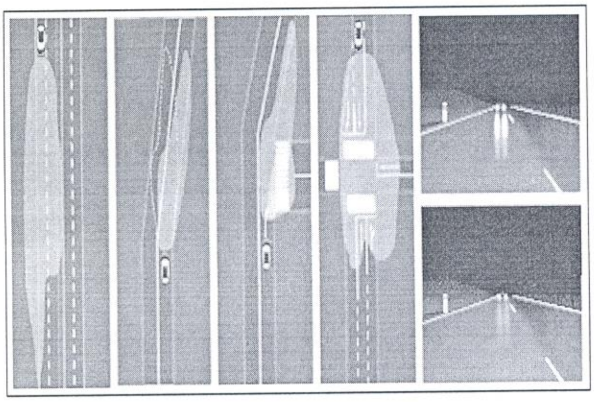

Figure 5: Lights that adapt to the situation
(From the left: in the Intercity, Cornering, Turning and City regimes, as well as the Rain function).

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