A Case Study: Headlights Tilting According To Steering

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Abstract - **The issue occuring driving home from a weekend vacation. It's late at night, and the winding two-lane road has no streetlights. You approach a curve at 60 kmph -- slow enough to make the turn, but too fast to stop suddenly if you need to. There is waiting an obstracle, just beyond the range of your headlights. Standard headlights shine straight ahead, no matter what direction the car is moving. When going around curves, they illuminate the side of the road more than the road itself. The lights will turn their beams around each bend in the road, giving you a better view of what's ahead. Improved night driving isn't a trivial matter -- over 46 percent of fatal accidents in 2006 occurred at night, a number much higher than the proportion of driving done at night . In this project, we'll develop how "Headlights Tilting According to Steering" differ from standard headlights and make it possible that they can make nighttime driving safer. We'll also try some headlight innovations in the works. "Headlights Tilting According to Steering" react to the steering, 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 "Headlights Tilting According to Steering" are directed at the road, the incidence of glare is reduced. A car with "Headlights Tilting According to Steering" will use electronic sensors to detect the position of the car wheels to give input to the controller to turn the headlight. The sensors will direct small electric motors built into the headlight casing to turn the headlights. A typical "Headlights Tilting According to Steering" would turn the lights up to 16 degrees from center giving them a 32-degree range of movement.**

***Keywords* — Potentiometer, Stepper Motor, Reflector, Digital Convertor, Microcontroller, Watchdog Timer.**

I. INTRODUCTION

A headlamp is a lamp, usually attached to the front of a vehicle such as a car or a motorcycle, with the purpose of illuminating the road ahead during periods of low visibility, such as darkness or precipitation. Headlamp performance has steadily improved throughout the automobile age, spurred by the great disparity between daytime and night time traffic fatalities: the U.S. National Highway Traffic Safety Administration states that nearly half of all traffic-related fatalities occur in the dark, despite only 25% of traffic travelling during darkness. While it is common for the term headlight to be used interchangeably in informal discussion, headlamp is the technically correct term for the device itself, while headlight properly refers to the beam of light produced and distributed by the device. A headlamp can also be mounted on a bicycle (with a battery or small electrical generator), and most other vehicles from airplanes to trains tend to have headlamps of their own. Additionally automotive night vision systems work to supplement headlights. The goal behind developing the project titled "Headlights Tilting According to Steering" is to illuminate the vision of driver at the time of turning and cornering in night time driving, and hence avoiding the night time accidents. In this project we have tried to develop a system combination of "Mechanical" and "Electronics" technology. In this system head beam of headlight will be so guided to swivel by the steering system, that it will illuminate the sideways during turning and cornering.

II. LITERATURE SURVEY

The earliest headlamps were fueled by acetylene or oil and were introduced in the late 1880s. Acetylene lamps were popular because the flame was resistant to wind and rain. The first electric headlamps were introduced in 1898 on the Columbia Electric Car from the Electric Vehicle Company of Hartford, Connecticut, and were optional. Two factors limited the widespread use of electric headlamps: the short life of filaments in the harsh automotive environment, and the difficulty of producing dynamos small enough, yet powerful enough to produce sufficient current. In 1912, Cadillac integrated their vehicle's Delco electrical ignition and lighting system, creating the modern vehicle electrical system.

Fig. 1

"Dipping" (low beam) headlamps were introduced in 1915 by the Guide Lamp Company, but the 1917 Cadillac system allowed the light to be dipped with a lever inside the car rather than requiring the driver to stop and get out. The 1924 Bilux bulb was the first modern unit, having the light for both low (dipped) and high (main) beams of a headlamp emitting from a single bulb. A similar design was introduced in 1925 by Guide Lamp called the "Duplo". In 1927, the foot-operated dimmer switch or dip switch was introduced and became standard for much of the century. The last vehicle with a foot-operated dimmer switch was the 1991 Ford F-Series. International headlamp styling, 1983–present. In 1983, granting a 1981 petition from Ford Motor Company, the 44-year-old U.S. headlamp regulations were amended to allow replaceable-bulb, nonstandard-shape, architectural headlamps with aerodynamic lenses that could for the first time be plastic. This allowed the first U.S.-market car since 1939 with replaceable bulb headlamps – the 1984 Lincoln Mark VII. These composite headlamps were sometimes referred to as "Euro" headlamps, since aerodynamic headlamps were common in Europe.

A. Recent developments

Complex-reflector technology in combination with new bulb designs such as H13 is enabling the creation of European-type low and high beam patterns without the use of a Graves Shield, while the 1992 US approval of the H4 bulb has made traditionally European 60□□□□40% optical area divisions for low and high beam common in the US. Therefore, the difference in active optical area and overall beam light content no longer necessarily exists between US and ECE beams. Dual-beam HID headlamps employing reflector technology have been made using adaptations of both techniques.

B. International headlamp styling, 1983–present

In 1983, granting a 1981 petition from Ford Motor Company, the 44-year-old U.S. headlamp regulations were amended to allow replaceable-bulb, nonstandard-shape, architectural headlamps with aerodynamic lenses that could for the first time be plastic. This allowed the first U.S.-market car since 1939 with replaceable bulb headlamps – the 1984 Lincoln Mark VII. These composite headlamps were sometimes referred to as "Euro" headlamps, since aerodynamic headlamps were common in Europe. Though conceptually similar to European headlamps with non standardised shape and replaceable-bulb construction, these headlamps conform to the SAE headlamp standards of US Federal Motor Vehicle Safety Standard 108, and not the internationalized European safety standards used outside North America. Nevertheless, this change to US regulations largely united headlamp styling within and outside the North American market.

In the late 1990s, round headlamps returned to popularity on new cars. These are generally not the discrete self-contained round lamps as found on older cars (certain Jaguars excepted), but rather involve circular or oval optical elements within an architecturally-shaped housing assembly.

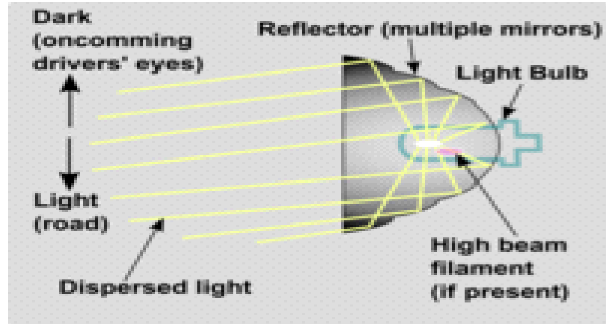


Fig. 2. Reflector Optics

Starting in the 1980s, headlamp reflectors began to evolve beyond the simple stamped steel parabola. The 1983 Austin Maestro was the first vehicle equipped with Lucas-Carello's homofocal reflectors, which comprised parabolic sections of different focal length to improve the efficiency of light collection and distribution. CAD technology allowed the development of reflector headlamps with nonparabolic, complex-shape reflectors. First commercialised by Valeo under their Cibié brand, these headlamps would revolutionise automobile design.

C. Recent developments in technology

Complex-reflector technology in combination with new bulb designs such as H13 is enabling the creation of European-type low and high beam patterns without the use of a Graves Shield, while the 1992 US approval of the H4 bulb has made traditionally European 60% / 40% optical area divisions for low and high beam common in the US. Therefore, the difference in active optical area and overall beam light content no longer necessarily exists between US and ECE beams. Dual-beam HID headlamps employing reflector technology have been made using adaptations of both techniques.

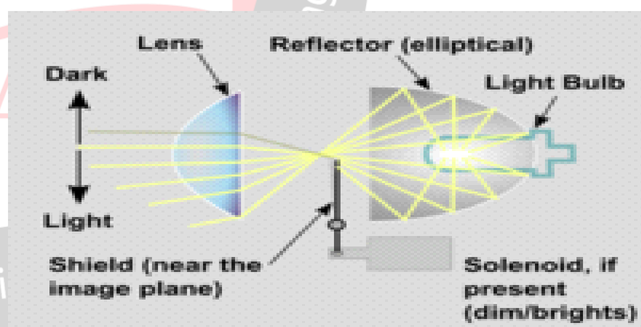


Fig. 3. Projector Lamps

In this system a filament is located at one focus of an ellipsoidal reflector and has a condenser lens at the front of the lamp. A shade is located at the image plane, between the reflector and lens, and the projection of the top edge of this shade provides the low-beam cutoff. The shape of the shade edge, and its exact position in the optical system, determines the shape and sharpness of the cutoff.[18] The shade may have a solenoid actuated pivot to provide both low and high beam – the shade is removed from the light path to create high beam, and placed in the light path to create low beam, and such optics are known as BiXenon or BiHalogen projectors, depending on the light source used. If there is no such arrangement, the cutoff shade is fixed in the light path, in which case separate high-beam lamps are required. The condenser lens may have slight fresnel rings or other surface treatments to reduce cutoff sharpness. Recent condenser lenses incorporate optical features specifically designed to direct some light upward towards the locations of retro reflective overhead road signs.

Projector main headlamps first appeared in 1981 on the Audi Quartz, the Quattro-based concept car designed by Pininfarina for Geneva Auto Salon. Developed more or less simultaneously in Germany by Hella and Bosch and in France by Cibié, the projector low beam permitted accurate beam focus and a much smaller-diameter optical package, though a much deeper one, for any given beam output. The version of the 1986 BMW 7 Series sold outside North America was the first volume-production auto to use polyellipsoidal low beam headlamps.

D. Adaptive High beams

Adaptive highbeam assist is Mercedes-Benz' marketing name for a headlight control strategy that continuously automatically tailors the headlamp range so the beam just reaches other vehicles ahead, thus always ensuring maximum possible seeing range without glaring other road users. to the distance of vehicles ahead. It was first launched in the Mercedes E-class in 2009. It provides a continuous range of beam reach from a low-aimed low beam to a high-aimed high beam, rather than the traditional binary choice between low and high beams. The range of the beam can vary between 65 and 300 meters, depending on traffic conditions. In traffic, the low beam cutoff position is adjusted vertically to maximise seeing range while keeping glare out of leading and oncoming drivers' eyes. When no traffic is close enough for glare to be a problem, the system provides full high beam. Headlamps are adjusted every 40 milliseconds by a camera on the inside of the front windscreen which can determine distance to other vehicles. The S-Class, CLS-Class and C-Class also is offering the technology. In the CLS, the adaptive high beam is realised with LED headlamps - the first vehicle producing all adaptive light functions with LEDs. Since 2010 some Audi models with Xenon headlamps are offering a similar system; with LED headlamps it is still not available.

E. Glare-Free High Beam & Pixel Light

Glare-free high beam is a camera-driven dynamic lighting control strategy that selectively shades spots and slices out of the high beam pattern to protect other road users from glare, while always providing the driver with maximum seeing range. The area surrounding other road users is constantly illuminated at high beam intensity, but without the glare that would result from using uncontrolled high beams in traffic. This constantly changing beam pattern requires complex sensors, microprocessors and actuators, because the vehicles which must be shadowed out of the beam are constantly moving. The dynamic shadowing can be achieved with movable shadow masks shifted within the light path inside the headlamp. Or, the effect can be achieved by selectively darkening addressable LED emitters or reflector elements, a technique known as Pixel light.

The first production vehicles with glare-free high beam are the 2011 Volkswagen Touareg the function is part of that vehicle's "Dynamic Light Assist" package the Phaeton and Passat.

III. METHODOLOGY

The methodology for the design of Headlights Tilting According to Steering is explained by following steps:
Determining the turning angle of the wheel and hence the angle through which the strut has been turned. Calculating the time range required to tilt the headlights while turning. Calculating the change in resistance of potentiometer per degree rotation of strut. Selecting stepper motor of required specification. Selecting appropriate rotational sensor. Establishing relation between potentiometer rotation & headlight rotation. i.e. stepper motor rotation.

IV. COMPONENTS OF MECHANICAL SYSTEM

A. Steering System:
- *a. Conventional Steering System.*
- *b. Power steering.*
- c. *Rack & Pinion.*

B. Rack & Pinion.
C. MacPherson Strut.
D. Advantages & Disadvantage:

Geometric analysis shows it cannot allow vertical movement of the wheel without some degree of either camber angle change, sideways movement, or both.

It is not generally considered to give as good handling as a double wishbone suspension, because it allows the engineers less freedom to choose camber change and roll center.

Another drawback is that it tends to transmit noise and vibration from the road directly into the body shell, giving higher noise levels and a "harsh" feeling to the ride compared with double wishbones, requiring manufacturers to add extra noise reduction or cancellation and isolation mechanisms.

Also, because of its greater size and robustness and greater degree of attachment to the vehicle structure, when the internal seals of the shock absorber portion wear out replacement is expensive compared to replacing a simple shock absorber.

Despite these drawbacks, the MacPherson strut setup is still used on high performance cars such as the Porsche 911, several Mercedes-Benz models and nearly all current BMWs (including the new Mini but excluding the 2007 X5, 2009 7-series, 2011 5-series and 5-series GT).

V. DESIGN OF ELECTRONIC COMPONENTS

The main component of the adaptive headlight system is the electronic circuit. It consist of the various electronic components such as Printed circuit board (PCB), Micro-controller, A/D convertor, ULN 2003A IC, the short description of these components are given below.

F. Printed circuit board

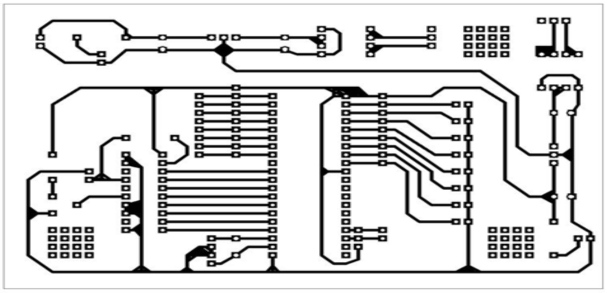


Fig. 4 PCB

It is a plane board consist of a copper sheet consist which is insulated on both side. The circuit is printed on the board by removing the insulation. The connections are made by soldering the component on the board.

G. Analog to Digital Convertor

The ADC0804 and 8-bit successive approximation A/Converters that use a differential potentiometric ladder—similar to the 256R products. These converters are designed to allow operation with the NSC800 and INS8080A derivative control bus with TRI-STATE® output latches directly driving the data bus. These A/Ds appear like memory locations or I/O ports to the microprocessor and no interfacing logic is needed. Differential analog voltage inputs allow increasing the common-mode rejection and offsetting the analog zero input voltage value. In addition, the voltage reference input can be adjusted to allow encoding any smaller analog voltage span to the full 8 bits of resolution.

Fig. 5

Features:

Compatible with 8080 uP derivatives—no interfacing logic needed - access time - 135 ns. Differential analog voltage inputs. Easy interface to all microprocessors, or operates "stand alone". Logic inputs and outputs meet both MOS and TTL voltage level specifications. Works with 2.5V (LM336) voltage reference. On-chip clock generator. 0V to 5V analog input voltage range with single 5V supply. No zero adjust required. 0.3" standard width 20-pin DIP package. 20-pin molded chip carrier or small outline package. Operates ratio metrically or with 5 VDC, 2.5 VDC, or analog span adjusted voltage reference.

Key Specifications:

Resolution 8 bits.

Total error ±1⁄4 LSB, ±1⁄2 LSB and ±1 LSB.

Conversion time.

A. Potentiometer

A potentiometer informally, a pot, in electronics technology is a component, a three-terminal resistor with a sliding contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. In circuit theory and measurement a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, whence its name.

Potentiometers are commonly used to control electrical devices such as volume controls on audio equipment. Potentiometers operated by a mechanism can be used as position transducers, for example, in a joystick. Potentiometers are rarely used to directly control significant power (more than a watt), since the power dissipated in the potentiometer would be comparable to the power Sin the controlled load (see infinite switch). Instead they are used to adjust the level of analog signals (e.g. volume controls on audio equipment), and as control inputs for electronic circuits. For example, a light dimmer uses a potentiometer to control the switching of a TRIAC and so indirectly to control the brightness of lamps.

B. Microcontroller

The P89V51RD2 is an 80C51 microcontroller with 64 kB Flash and 1024 bytes of data RAM. A key feature of the P89V51RD2 is its X2 mode option. The design engineer can choose to run the application with the conventional 80C51 clock rate (12 clocks per machine cycle) or select the X2 mode (6 clocks per machine cycle) to achieve twice the throughput at the same clock frequency.

Features:

80C51 Central Processing Unit. 5 V Operating voltage from 0 to 40 MHz. 64 kB of on-chip Flash program memory with ISP (In-System Programming) and IAP (In-Application Programming). Supports 12-clock (default) or 6-clock mode selection via software or ISP. SPI (Serial Peripheral Interface) and enhanced UART. PCA (Programmable Counter Array) with PWM and Capture/Compare functions. Four 8-bit I/O ports with three high-current Port 1 pins (16 mA each). Three 16-bit timers/counters. Programmable Watchdog timer (WDT). Eight interrupt sources with four priority levels. Second DPTR register. Low EMI mode (ALE inhibit).

TTL- and CMOS-compatible logic levels.

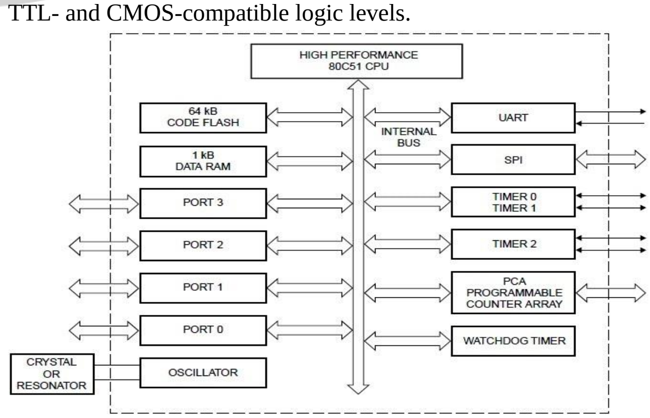


Fig. 6 Block Diagram

C. Functional description

a. Memory organization

The device has separate address spaces for program and data memory.

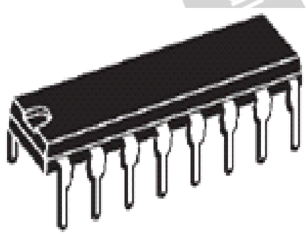
b. Flash program memory

There are two internal flash memory blocks in the device. Block 0 has 64 kbytes and contains the user's code. Block 1 contains the Philips-provided ISP/IAP routines and may be enabled such that it overlays the first 8 kbytes of the user code memory. The 64 kB Block 0 is organized as 512 sectors, each sector consists of 128 bytes. Access to the IAP routines may be enabled by clearing the BSEL bit in the FCF register. However, caution must be taken when dynamically changing the BSEL bit. Since this will cause different physical memory to be mapped to the logical program address space, the user must avoid clearing the BSEL bit when executing user code within the address range 0000H to 1FFFH.

c. Data RAM memory

The data RAM has 1024 bytes of internal memory. The device can also address up to 64 KB for external data memory.
The device has four sections of internal data memory:
1. The lower 128 bytes of RAM (00H to 7FH) are directly and indirectly addressable.
2. The higher 128 bytes of RAM (80H to FFH) are indirectly addressable.
3. The special function registers (80H to FFH) are directly addressable only.
4. The expanded RAM of 768 bytes (00H to 2FFH) is indirectly addressable by the move external instruction (MOVX) and clearing the EXTRAM bit.

D. ULN 2003A IC



DIP16

Fig. 7

The ULN2003 are high voltage, high current Darlington arrays each containing seven open collector Darlington pairs with common emitters. Each channel rated at 500Ma and can withstand peak currents of 600mA.Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout. The four versions interface to all common logic families. These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal print heads and high power buffers.

E. Stepper Motor

A stepper motor (or step motor) is a brushless DC electric motor that can divide a full rotation into a large number of steps. The motor's position can be controlled precisely without any feedback mechanism (an open-loop controller), as long as the motor is carefully sized to the application.

Working: Stepper motors consist of a permanent magnet rotating shaft, called the rotor, and electromagnets on the stationary portion that surrounds the motor, called the stator. illustrates one complete rotation of a stepper motor. At position 1, we can see that the rotor is beginning at the upper electromagnet, which is currently active (has voltage applied to it). To move the rotor clockwise (CW), the upper electromagnet is deactivated and the right electromagnet is activated, causing the rotor to move 90 degrees CW, aligning itself with the active magnet. This process is repeated in the same manner at the south and west electromagnets until we once again reach the starting position. In the above example, we used a motor with a resolution of 90 degrees or demonstration purposes. In reality, this would not be a very practical motor for most applications. The average stepper motor's resolution -- the amount of degrees rotated per pulse -- is much higher than this. For example, a motor with a resolution of 5 degrees would move its rotor 5 degrees per step, thereby requiring 72 pulses (steps) to complete a full 360 degree rotation.

You may double the resolution of some motors by a process known as "half-stepping". Instead of switching the next electromagnet in the rotation on one at a time, with half stepping you turn on both electromagnets, causing an equal attraction between, thereby doubling the resolution. As in the first position only the upper electromagnet is active, and the rotor is drawn completely to it. In position 2, both the top and right electromagnets are active, causing the rotor to position itself between the two active poles. Finally, in position 3, the top magnet is deactivated and the rotor is drawn all the way right. This process can then be repeated for the entire rotation. There are several types of stepper motors. 4-wire stepper motors contain only two electromagnets; however the operation is more complicated than those with three or four magnets, because the driving circuit must be able to reverse the current after each step. For our purposes, we will be using a 6-wire motor.

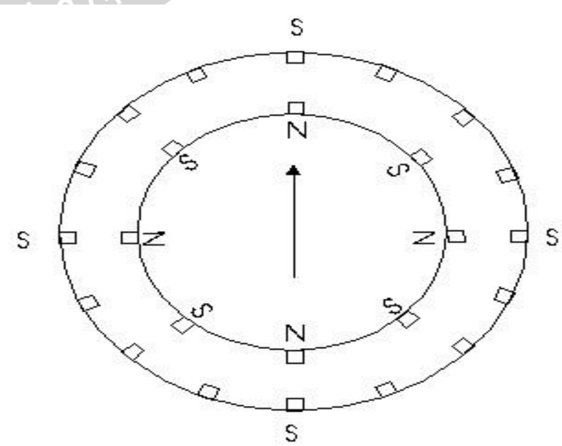


Fig. 8 rotor poles

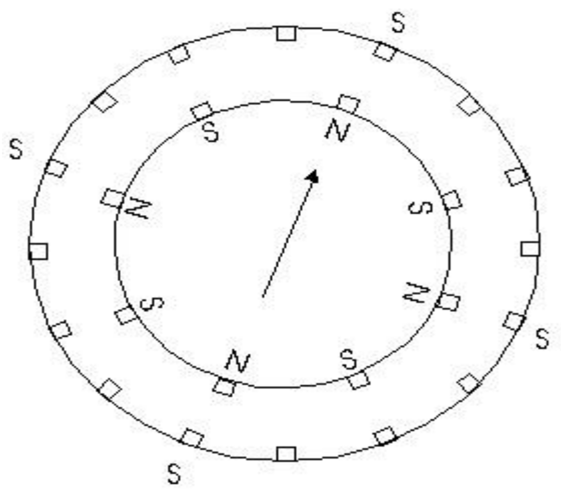


Fig. 9 rotor poles

Unlike our example motors which rotated 90 degrees per step, real-world motors employ a series of mini-poles on the stator and rotor to increase resolution. Although this may seem to add more complexity to the process of driving the motors, the operation is identical to the simple 90 degree motor we used in our example. An example of a multipole motor can be seen in fig 9. In position 1, the north pole of the rotor's permanent magnet is aligned with the south pole of the stator's electromagnet. Note that multiple positions are aligned at once. In position 2, the upper electromagnet is deactivated and the next one to its immediate left is activated, causing the rotor to rotate a precise amount of degrees. In this example, after eight steps the sequence repeats.

VI. CONCLUSION

The Headlight tilting according to steering is the concept necessary for the fast moving world. This concept prevents the accidents occurrence at the highway at night. This system is easily fitted in the small available space in car. It is less costly so a vehicle of low cost can also afford it. It is of less maintenance as mechanical linkages are not so much. The glare of oncoming headlights can cause serious visibility problems. Since "Headlights Tilting According to Steering" are directed at the road, the incidence of glare is reduced. Also in some critical cases the chances of getting accidents are minimized. And the electronics part is playing a great role in turning lights. This system is also much essential for road accident point of view in future purpose.

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