Adaptive Head Light System With Vehicle Detection, Distance And Speed Measurement System Using Lidar Sensor, Along With Automatic Horn System

Pranav Bairagi[1], Soniya Vaidya[2], Mangesh Mhetre[3]
[1]Dept. Of Mechanical Engineering, DR. D. Y .Patil College, Akurdi, Pune,
[2] Dept. Of Electronics and Telecommunication Engineering, Bramha Valley College of Engineering and Research Institute Nashik, Maharashtra, India.
[3] Dept. Of Mechanical Engineering, KJ's Trinity College of Engineering and Research, Yewalevadi, Pune.

Abstract- *In this invention we are going to make an automated vehicle which can act according to the external environment. There the combination of matrix beam led and the adaptive head lamps turning is used and implemented with help of servo motor and the rotary encoders. In advancement to this the vehicle is equipped with the advanced vehicle detection using the Camera. Distance and speed measurement of the front and rear vehicle using the lidar sensor for accident prevention. The measured distance and the vehicle pre detection is been transferred to the Vehicle driver using the speaker. A specialized GPS used to determine the curves and turns of the roads, whereas the camera is used to identify the vehicles position. The combination of all three devices are used to in order to improve the road safety. Also while taking the turns need not to press the horn repetitively it will automatically press the horn as soon as we activate the indicator and turn the steering with the help of rotary encoder. Rotary encoder, Relay drivers, indicator button, LIDAR sensor, Camera and Arduino controller brings out the Automation. The distance measurement system also guides us during the traffics as well as during overtaking of vehicle.*

Keywords- Adaptive head light system, LIDAR sensor, Rotary encoder, Vehicle guiding system, Automation, Servo motor, Etc.

I. INTRODUCTION

Whenever the person is travelling via four wheeler during the day time as well as in the night time, it become very difficult for the rookie driver to understand the distance between the front vehicle and also the vehicle present in the opposite lane, i.e. the vehicle coming in the opposite direction of that of the driver and the vehicle present behind his vehicle. As well as the speed of the opposite vehicle. Because of this improper understanding this result into Accident, traffic jam, etc. because whenever the operator tries to change the lane or to overtake the preceding vehicle Accident occur. In order to prevent this adaptive head lamps as well as the vehicle position and speed detection and road detection system is been implemented.

When we say travelling via four wheelers during night time first important thing came into our minds are head lights. There are various types of headlights.

The project work aimed to build a combination project that have adaptive head lamps that means the head lamps in the direction of the turn of vehicle turns the same direction and as well as an array of Matrix of led. This project basically was developed and implemented by BMW Germany and Audi which is being considered to be lifesaving thus the project can be used vast scale. The dark ages of vehicle lighting are coming to an end, with state-of-the-art lighting technologies offering bright ideas to automobile engineers and owners.

We have made such an arrangement that when we turn the steering as well as activate the indicator there is automatic horning of vehicle so that we need not to push the horn button repetitively during driving i.e. while taking a turn. Such a system is helpful to prevent accident such that the people who may not be aware about coming of vehicle will get aware by listening and observing light of headlamps previously as we have used adaptive headlight system

1.1. NECESSITY OF ADAPTIVE HEAD LAMPS:

To increase the safety of four wheeler by preventing accidents during taking sharp turn as well as during curve roads.

To rule out the conventional headlamps which are not helpful in risky turning.

As well as to indicate the corner object

1.2. NECESSITY OF VEHICLE DETECTION, SPEED MEASUREMENT, CURVE IDENTIFICATION AND AUTOMATIC HORN SYSTEM:

Prevent accident during overtaking or during change of lanes.
Avoid repetitively pressing of the horn during curves.
Also to determine the road curves

II. LITERATURE REVIEW

2.1 BACKGROUND [2]

Turning headlamps: These recent advances in front lighting technology have revived and improved on an old idea that had all but disappeared. In 1948, the tucker corporation produced 51 vehicles that, among other innovative ideas, had a center headlamp that swiveled with the turning of the steering wheel to light a curve before the vehicle entered it. Then in the early 1970s, Citroen had headlamps that turned in sync with the steering wheel on its short-lived sm model. Now vehicle makers have revived the idea of headlamps that shine around corners, and through the use of electronics and computer controls, are working to perfect its operation.

Different versions of active front lighting systems are currently available from three European vehicle makers: Audi, BMW and Mercedes-Benzes. Lexus is also offering a turning headlamp system as an option on the 2004 rx 330. The Audi system is only available in Europe so far, on the 2004 a8. BMW and Mercedes-Benzes are offering the systems on North American vehicles. The BMW system is available as an option on the 3-series coupe and convertible. The Mercedes-Benzes system is being offered on the e-class sedan.

2.2. AUDI ADAPTIVE LIGHT [4] [3] [2]

Audi and Hella Corporation developed "adaptive light" cornering headlamps for use on the new a8. This system has an additional static non-movable lamp located between the low and high beam headlamps in the hid xenon headlamp assembly (see figure 2). The additional lamp uses a free-form reflector and halogen bulb positioned at about a 15° angle to the side relative to the other headlamps. This lights the area directly adjacent to the low beam lamps at 90° in relation to the centerline of the vehicle. The system control module uses inputs from vehicle speed, steering angle, and turn-signal operation to determine whether or not to activate the cornering lamp. The cornering lamp will only function at speeds of 70 km/h (43 mph) or less with the headlamps on low beam. When the vehicle is shifted in reverse, both front cornering lamps are illuminated to increase the peripheral vision around the front end of the vehicle.

2.3. MERCEDES-BENZ ACTIVE SYSTEM [4] [3] [2]

Mercedes-Benzes uses a different approach, a totally active system, called "active cornering headlamp system." with this system, the headlamps swivel in the direction of the curve or corner.

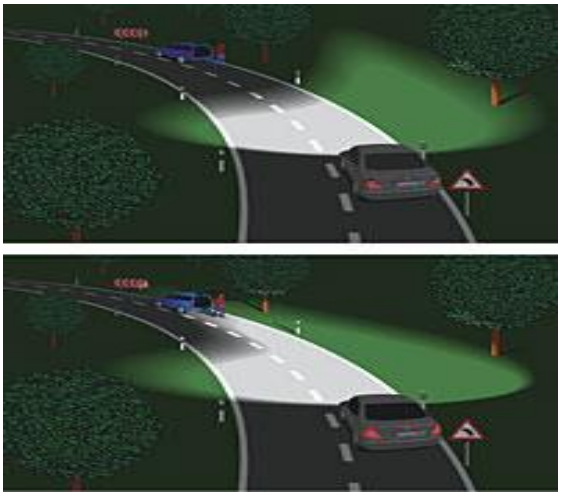

Figure 01

-this illustration shows the difference in light distribution between conventional headlamps (top) and the Mercedes-Benzes active cornering headlamp system (bottom).

The system uses bi-xenon projector headlamps that have an electronics unit and electric motor to swivel the projector unit inside the assembly. The bi-xenon headlamps produce both the low and high beams from a single xenon lamp. The headlamps are controlled by a control module that receives inputs on vehicle speed and steering angle to determine how fast and how far to swivel the lamps. This system works at all speeds, and with the headlamps in both low and high beam. The system matches the speed of the vehicle, the swiveling mechanism reacting almost instantly at high speeds and progressively slower as vehicle speed decreases.

2.4. BMW ADAPTIVE LIGHT CONTROL [4] [3] [2]

BMW uses a system called "adaptive light control" that also has swiveling bi-xenon projector headlamps. The projector swivels in a range from 15° outward to 8° inward. This system takes the approach one step further; the control module receives input on vehicle speed, steering angle and lateral acceleration, as well as using data from the BMW navigation system. By using data.
From the global positioning satellite (GPS) navigation and electronic road map features in the navigation system, the system can adjust the headlamps for optimal lighting of the road ahead.

BMW shines a bright light on road

SAFETY:

- Computer controlled swiveling headlamps a first for Australia
- 90 percent improved visibility
- Option available beginning with world release of the new 5 series
- Available locally from July 2003 production on e46 3 series coupe and convertible

The new BMW adaptive headlights system will be available as an option on the soon to be released new BMW 5 series and from july 2003 production on the recently face-lifted 3 series coupe and convertible. The option price for the 3 series coupe and convertible, already specified with bi-xenon headlights and headlamp power wash, has been confirmed at a premium of $860. Option pricing for the new 5 series will be released closer to the launch date.

The active adaptive headlights system is the first of its type to be offered in Australia by any carmaker, confirming BMW's leadership in the implementation of advanced technology for safety-conscious drivers. The adaptive headlights system employs intelligent technology to allow a pair of bi-xenon headlights to follow the shape of the road to provide drivers with up to 90 percent more visibility.

This major advance in night-time safety gives drivers more time to act or react if approaching road hazards. The system works by allowing the headlamps to swivel through an arc of 15 degrees right and left, controlled by data provided by steering angle and yaw rate input sensors as well as vehicle speed and GPS-fed road data. The active has is thus able to 'predict' the arrival of the vehicle at a corner or bend and can adjust the pattern of illumination via the bi-xenon lamps, shining into the corner along the driver's intended path, rather than continuing to shine straight ahead. Bi-xenon headlamps themselves extend the pool of illumination a further 200 meters in front of the vehicle compared with conventional high-beam globes. The active element of the ah system means that the lamps move to illuminate the bends only when certain parameters are met which means they do not, as fixed systems may, needlessly illuminate the side of the road, which could be distracting for the driver. Adaptive headlights also incorporate a host of other safety features such as dynamic headlight range control that automatically adjusts the light spread to avoid dazzling oncoming traffic. On wet roads, the angle of incidence is controlled so that on-coming drivers are not blinded by light reflecting off the surface.

The system is also smart enough to be able to differentiate between travelling through built-up areas - during which period the light spread is wider to help the driver identify pedestrians, merging traffic, etc. - and inter-urban areas where road illumination typically is limited. When out of town the has provides a more focused, narrower yet longer throw of light to give the driver as much up-front illumination as possible.
Combine all this advanced functionality with the ability to swivel the headlamp beams to follow the shape of the road and it is clear to see BMW has developed the safest and most advanced headlamp system thus far available. It also helps to make night-time driving less tiring, further contributing to road safety.

III. COMPONENTS USED AND SPECIFICATION [7]

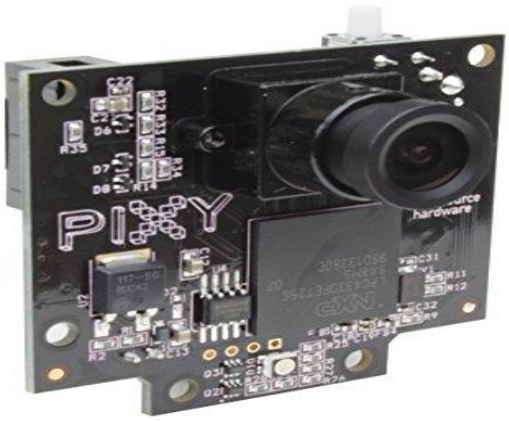

Figure 02

3.1. HIGH DEFINITION SMART CAMERA

PIXY 1.0 SMART VISION SENSOR-OBJECT TRACKING CAMERA

1. Small, fast, easy-to-use, low-cost, readily-available vision system
2. Learns to detect objects that you teach it
3. Outputs what it detects 50 times per second
4. Connects to Arduino with an included cable. Also works with Raspberry Pi, Beagle Bone, and similar controllers
5. All libraries for Arduino, Raspberry Pi, etc. are provided
6. C/C++ and Python are supported
7. Communicates via one of several interfaces: SPI, I2C, UART, USB or analog/digital output
8. Configuration utility runs on Windows, MacOS, and Linux
9. All software/firmware is open-source GNU-licensed

3.2. ARDUINO MEGA 2560 MICROCONTROLLER [7]

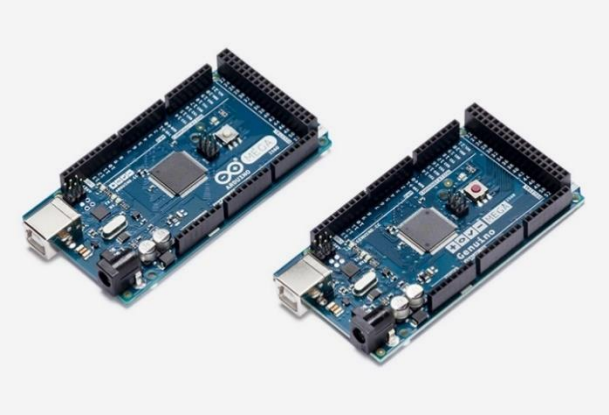

Figure 03

The Arduino MEGA 2560 is designed for projects that require more I/O lines, more sketch memory and more RAM. With 54 digital I/O pins, 16 analog inputs and a larger space for your sketch it is the recommended board for 3D printers and robotics projects. This gives your projects plenty of room and opportunities maintaining the simplicity and effectiveness of the Arduino platform. This document explains how to connect your Mega2560 board to the computer and upload your first sketch.

The Arduino Mega 2560 is programmed using the Arduino Software (IDE), our Integrated Development Environment common to all our boards and running both online and offline. Rotary Encoder

3.3. DC DIGITAL SERVO MOTOR [7]

Figure 04

TowerPro MG995 Metal Gear Servo Motor (180 degree Rotation)

1. Model: MG995
2. Weight: 55 gm
3. Operating voltage: 4.8V~ 7.2V
4. Servo Plug: JR
5. Stall torque @4.8V : 10 kg/cm
6. Stall torque @6.6V : 12 kg/cm

3.4. MATRIX BEAM LED LAMPS [6]

Matrix Beam LED headlights boast a fascinating design for day and night time driving, plus, they offer new functions not available elsewhere.

With high-precision illumination and individually controllable LEDs, these innovative Matrix LED headlights provide a special driving experience.

Matrix LED High Beam Mode ensures bright homogenous road illumination. Split into numerous individual light emitting diodes, the system dims light shining directly on oncoming and preceding vehicles, whilst casting full light on zones between and beside them.

With added functions to provide even greater safety, the Matrix LED headlights double up as a cornering light. Using predictive route data supplied by the MMI Navigation Plus the beams shift towards the bend before the driver turns the steering wheel.

3.5. GPS MODULE [7]

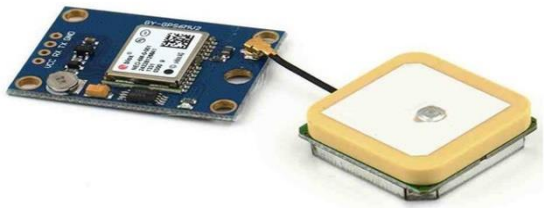

Figure 05

U-blox NEO-6M GPS Module with EPROM

This is a complete GPS module that is based on the Ublox NEO-6M. This unit uses the latest technology from Ublox to give the best possible positioning information and includes a larger built-in 25 x 25mm active GPS antenna with a UART TTL socket. A battery is also included so that you can obtain a GPS lock faster. This is an updated GPS module that can be used with ardupilot mega v2. This GPS module gives the best possible position information, allowing for better performance with your Ardupilot or other Multirotor control platform.

Features:

1. 5Hz position update rate
2. Operating temperature range: -40 TO 85°CUART TTL socket
3. EEPROM to save configuration settings
4. Rechargeable battery for Backup
5. The cold start time of 38 s and Hot start time of 1 s
6. Supply voltage: 3.3 V
7. Configurable from 4800 Baud to 115200 Baud rates. (default 9600)
8. Super Sense ® Indoor GPS: -162 dBm tracking sensitivity
9. Support SBAS (WAAS, EGNOS, MSAS, GAGAN)
10. Separated 18X18mm GPS antenna
11.

3.6. LIDAR SENSOR [7]

Figure 06

High sensitivity, measuring distance up to 22 meters, accuracy in cm level. Scan frequency up to 100Hz, real-time detection of distance with a 500 times/second refresh rate for more accurate data. TF02 has a complete system, containing a protective shell made of materials with a high transmittance of infrared, which doesn't affect the optical performance.

1. Detection Range: 0.3-22m.
2. Accuracy: Centimeter-level (1% Relative error).
3. Detection Frequency: 100Hz.
4. FOV: 3° (3 degrees).
5. Protection level: IP65.
6. Anti-ambient light: Function under 100k Lux ambient light.
7. Power: 5VDC, <200ma.
8. Interface: UART/CAN.
9. High sensitivity, and able to measure as far as 22 meters.
10. High-speed measurement with a maximum sampling frequency of 100Hz.
11. Anti-corrosive against pesticide.
12. Small in size and light.

3.7. SERVO MOTOR DRIVER [7]

16-Channel 12-bit PWM/Servo Driver I2C interface PCA9685 for Arduino

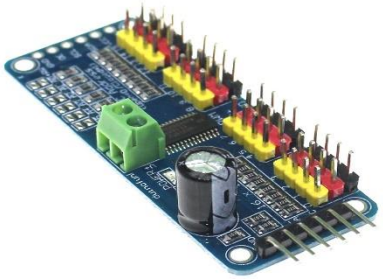

Figure 07

Specifications and Features:

1. Dimensions: 62.5 x 25.4 x 3 mm.
2. Weight: 9 gm.
3. This board/chip uses I2C 7-bit address between 0x60-0x80, selectable with jumpers
4. Terminal block for power input (or you can use the 0.1″ breakouts on the side)
5. Reverse polarity protection on the terminal block input
6. Green power-good LED
7. 3 pin connectors in groups of 4 so you can plug in 16 servos at once (Servo plugs are slightly wider than 0.1″ so you can only stack 4 next to each other on 0.1″ header
8. "Chain-able" design
9. A spot to place a big capacitor on the V+ line (in case you need it)
10. 220 ohm series resistors on all the output lines to protect them, and to make driving LEDs trivial
11. Solder jumpers for the 6 address select pins
12. I2c-controlled PWM driver with a built in clock. Unlike the TLC5940 family, you do not need to continuously send it signal tying up your microcontroller, it's completely free running!
13. It is 5V compliant, which means you can control it from a 3.3V microcontroller and still safely drive up to 6V outputs (this is good for when you want to control white or blue LEDs with 3.4+ forward voltages)
14. 6 address select pins so you can wire up to 62 of these on a single i2c bus, a total of 992 outputs – that's a lot of servos or LEDs
15. Adjustable frequency PWM up to about 1.6 KHz
16. 12-bit resolution for each output – for servos, that means about 4us resolution at 60Hz update rate

17. Configurable push-pull or open-drain output
18. Output enable pin to quickly disable all the outputs

3.8. ROTARY ENCODER [7]

Figure 08

Orange 1000 PPR AB 2-Phase Incremental Optical Rotary Encoder

A rotary encoder is a type of position sensor which is used for determining the angular position of a rotating shaft. It generates an electrical signal, either analog or digital, according to the rotational movement. Orange 1000 PPR Incremental Optical Rotary Encoder is hi-resolution optical encoder with quadrature outputs for increment counting. It will give 4000 transitions per rotation between outputs A and B. A quadrature decoder is required to convert the pulses to an up count. The Encoder is built to Industrial grade
Speakers
Horn

IV. WORKING PRINCIPAL [7]

Lidar Sensor Optical Principle

TOF is short for Time of Flight. It refers that a sensor emits modulated near infrared light, which reflects when objects are in the way. TOF then convert the distance away from the filmed scenery by calculating the time difference or phase difference between emission and reflection, thereby generating in-depth information.

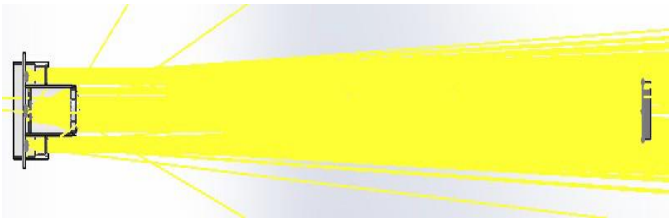

Figure 09

V. FLOW CHART

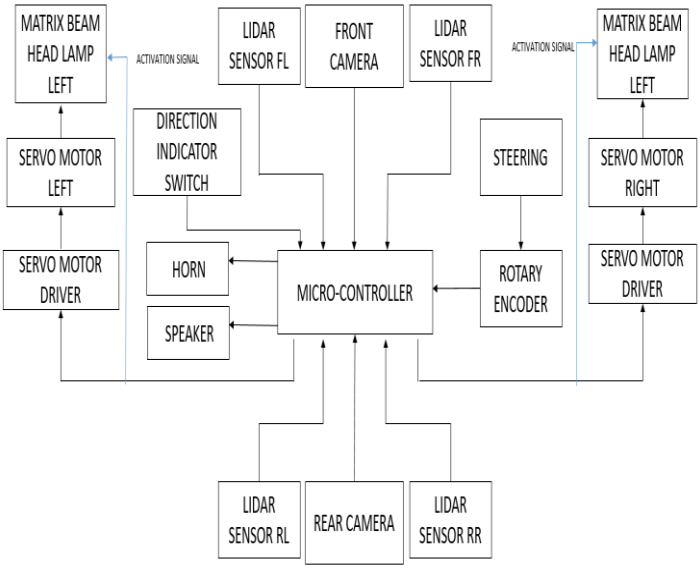

Figure 10

FL - FRONT LEFT
FR - FRONT RIGHT
RR - REAR RIGHT
RL - REAR LEFT

The micro controller receives the signals from the LIDAR sensors and Camera from front as well as rear side. Thus in addition to this the rotary encoder also sends the signals to microcontroller. The controller is then analyzes the signals and sends the output PWM signals to the servomotor driver, horn and speaker. This servo motor driver then operate the servo motor based on that signals. When servo motor rotates then the matrix lamp also rotates. The matrix lamp is been controlled by the control signals from the microcontroller.

VI. MOUNTINGS

LIDAR FL is mounted on front left side of the vehicle. Whenever the vehicle is coming from the left side (from front) the sensors measure it and respond accordingly.

LIDAR FR is mounted on front Right side of the vehicle. Whenever the vehicle is coming from the right side (from front) the sensors measure it and respond accordingly.

LIDAR RL is mounted on Rear left side of the vehicle. Whenever the vehicle is coming from the left side (from Rear) the sensors measure it and respond accordingly. I.e. during overtaking we need to see the rear vehicle at that time this sensor came into existence.

LIDAR RR is mounted on Rear Right side of the vehicle. Whenever the vehicle is coming from the Right side the sensors measure it and respond accordingly i.e. during overtaking we need to see the rear vehicle at that time this sensor came into existence.

Front Camera as the name only suggest that camera is placed at the front side of the vehicle.

Rear Camera this camera is placed at the rear side of the vehicle. Rotary Encoder This encoder is placed near the steering rod, with a gear mechanism with a 1:2 ratio. In order to get the larger resolution.

Speaker the cars speaker is used to get the distance output and the speed output.

Horn the horn is in its original position.

Matrix beam head lamp Left this lamps are placed at the front left side of the vehicle. This head lamp is mounted on to the servo motor with hinged point mounted inside the walls of the Lamps Cabinet

Servo motor left this motor is used to fix the left side matrix head lamp.

Matrix beam head lamp Right this lamps are placed at the front Right side of the vehicle. This head lamp is mounted on to the servo motor with hinged point mounted inside the walls of the Lamps Cabinet

Servo motor Right this motor is used to fix the Right side matrix head lamp.

VII. METHODOLOGY

SYSTEM 1 AUTOMATIC HORN CONTROLL

During driving of the vehicle the whenever we need to turn our vehicle we uses the direction indicator switch. As we turn on the toggle switch where ever we want to take turn, the indicator light of that side gets operated and the front or rear persons came to know that the vehicle needs to turn at that direction of which the indicator is on. But when we have to take sudden turn we operate the indicator, but the persons who is standing 90 degree turn or more will receive the light indication which result into the accident or miscommunication. In order to avoid this the automatic Horn system is been implemented.

In the automatic horn system the components used are rotary encoder, indicator switch. Whenever the driver needs to turn he operate the indicator switch in order to give visual indication. And then he turns steering. So the steering comprises of the rotary encoder which generates the pluses as soon as the shaft of the encoder rotates. This both signals received by the microcontroller which analyzes the signals and gives the output signals to the relays driver which operates the horn. Thus in this way the automatic horn system works. Note: in order to operate this condition the driver needs to rotate the steering more than 30 degree. Then only the above system works.

If there any one of the signals is missing i.e. the steering is rotated but the indicator is not operated then this system would not operate. And the horn will not blow. Whereas if the indicator is operated but the steering in not turned more than 30 degree then also this horn will not blow.

The horn is operated on timer so that it only operated for specified time such as 1000 milliseconds, etc. also the intensity of the horn is depended on the how fast the driver turns the steering.

SYSTEM 2 DISTANCE AND SPEED MEASUREMENT OF THE FRONT AND REAR VEHICLE

Lidar sensor is used for the measurement of the distance between two bodies. This lidar sensor measure the distance in terms of meters. Thus let us consider the vehicle needs to overtake the preceding vehicle from right side he turns his vehicle little bit outside of his lane to overtake. At that time the front right lidar sensor and rear right lidar sensor identifies the driver needs to overtake the preceding vehicle by right side. Since the user first operate the indicator switch to move outward at that time the right side front and rear lidar sensor get activated. The front sensor then measures the distance from the front cars and the rear sensor measure the distance from the rear cars. By pointing the sensors towards the car. Thus the microcontroller sends the signals speaker this speakers then tell the noted value to the driver that distance of the front right side car is XX m and that of rear right side car is YY m. This system only operates when the driver follows the traffic rules. That is to turn left he should operate the right side indicator and to left he should operate the left one. The controller is installed with the certain set of codes which determines or compares the normal overtaking limits with the measured limits and then if the values are more than or equal to the stated limits then it is good to overtake if the values are not matching the stated limits then it is not good to overtake. In this way the distance measurement and guidance system works.

In order to measure the speed the controller uses the general mathematics. As we know that speed is equal to the distance upon time. When the sensors measures the distance the controller automatically starts the timer by which the controller measures the distance for certain interval of stated time. Thus by dividing this distance by the stated time we gets the speed of the respective vehicle. This speed value is been then given to the speaker and then this speaker tells us the speed of the respective vehicle as "the speed of the front right vehicle is XX m/s and that of rear vehicle is YY m/s. thus in this way the speed measurement system works

The LIDAR sensor is capable enough to determine the profile of the object whichever is coming in front of it by using the certain sort of coding by which in advancement we can get the image processing without using the camera. Thus this system is used in future scope.

SYSTEM 3 FRONT REAR CAR DETECTION AND OPERATION OF THE MATRIX BEAM LEDS

The matrix beam works on the basis of the image processing. The camera is situated on the front and rare side helps the car to detect the vehicle in front and rare side respectively. The camera captures the image from the front and rear side this image is then processed further. Thus after processing this image the vehicle is detected and then we get the car in front and rare side. Whenever the car is in front of us then that certain patch in which the car is been shut down and thus the front driver does not get blinded from our lights. This same principal is been followed whenever we are overtaking a vehicle. During the rainy season there the water is spread on to the roads this water produces glare which when reflect to our eyes does not allows us to look forward in order to overcome this the matrix beam led reduces the glare of the road. In this way the matrix beam led works.

SYSTEM 4 GPS BASED ROAD AND CURVE DETECTION

The car is been connected to the GPS module this GPS this module is measure the angle of curve, profile of road, type of road and also the speed limit of the road. This signals is been sends to the main controller which process this signals and tells the driver accordingly that the speed should be XX values and the respective curve of the road is YY degree. This value is stored in the controller for further process.

SYSTEM 5 MATRIX BEAM LAMP ROTATION

The value of the steering rotation is been measured with the help of the rotary encoder. This values is in the range of 0 to 5 v. this values when read by the arduino this values get converted into 8 bit values as the arduino is 8 bit controller with maximum input voltage measurement in the range of 0 to 5 volts. This value arduino consider 0 volt as 0 and 5 volt as 1023 value. Thus as we know that the values coming out from the encoder is in terms of pulses thus when we read this value we need to record this values in to a certain variable. When the steering is in the center position the encoder gives the 0 value. Whereas when steering rotates in clock wise direction encoder gives positive values and when it rotates in anticlockwise direction it gives negative values. The encoder values is been mapped in to the 0 to 180 degree with the initial position of the servo is in 90 degree and the leftmost value as 0 and right most value as 180 degree. Thus we can say that we the value from the encoder is 0 the servo angle is 90 degree, when the values of the encoder is negative then the servo angle is between 0 to 90 degree and when the values from the encoder is positive then the angle of the servo is in between 90 to 180 degree.

For the calibration of the value of steering which is to be mapped at first the maximum and the minimum limit of the steering is find out. Thus for example if the steering moves 300 pulses in clockwise direction and -300 pulses in anticlockwise direction then value is mapped according to the syntax given below for arduino.

A = map (Sensor value, b, c, B, C);
Where,
Sensor value is value read from encoder
b is lower limit of value read from encoder
c is higher limit of value read from encoder
B is the mapped value to which we want lower limit value b to be get converted.
C is the mapped value to which we want higher limit value c to be get converted.
A = map (encoder value, -300, 300, 0, 180);
Thus from the syntax above our value -300 to 300 get converted into 0 to 180 degree.

Thus because of this we get the precise value of the matrix rotation according to the steering angle. With this we can locate the corner object whenever we are taking turns.

Thus by combination of all the above systems we get the required safety system for cars while driving.

VIII. CONCLUSION

Thus from this we have developed the safety system for the four wheeler vehicle.

Thus by using the above system the overtaking problem is been solved by using the LIDAR sensors.

The speed limit on to the road and road angle detection is been carry out.
The independent distance and speed measurement is been carry out.
The matrix beam lamp rotation using encoder is been carry out with precise degree of rotation.
Combination of matrix beam led system with beam bending system using servo motor is carry out.
The system with vehicle detection and matrix beam operation is carry out
GPS based system for curve angle detection is carried out.
Combination of all this system into one for safety system is been carry out.

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