EMERGENCY STEERING SYSTEM TO AVOID COLLISION BY USING MICROPROCESSOR CONTROLLER

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ABSTRACT:

Present days, the automotive industry is mainly focusing on the road safety measures. The automobiles have been constantly updating with new sensing technologies to avoid vehicle crash due to physical damages and arrival of unexpected object in travelling path. This problem is one of the major cause for road accidents, almost 1.32 million people die in road accidents each year. For providing solution to the problems, in our paper emergency steering control system is introduced. This system activates the steering mechanism automatically to position the vehicle from the interrupted object, without causing maximum damage to the vehicle structure. Infrared sensor is used to detect the object which gets interfered in its path as well as it senses the safe position to stop the running vehicle. When the vehicle is moving out of control of driver at a certain speed, then if the vehicle faces the situation to collide with the resting object (say if the vehicles are waiting for signal and our vehicle is facing the above mentioned problem). The condition of the object gets interfered on the path of moving vehicle is sensed by the ultrasonic sensor and the sensed data is sent as the feedback signal to the ECU. The sensors placed at the lateral side of the vehicle senses the condition of free road and activates the dc motor to rotate towards the free road side direction up to certain time during this vehicle is turned to the free road side and the motor get rotated in the opposite direction to move the vehicle in the free road.

Keywords: I.R sensor, PIC microcontroller, ECU

1. INTRODUCTION

Recently, evolved the cars unmanned driving technology and battery technology, interest of developing manned and automatic vehicle is increasing. Apart from technological advances, being serious oil prices rising, energy depletion and air pollution, research and development for manned and automatic electric cars is rapidly progressing in related industries. Also, auto parts suppliers is developing parts used in automatic electric cars because manned and automatic electric cars use different parts and Mechanism that use existing engine. Manned and automatic electric vehicle need manual steering device when driving manned and
manned, automatic electric vehicle need automatic steering device when driving unattended. Mechanical steering device and hydraulic power steering device in an engine vehicle has been used a lot. Recently in case of car that is available for auto parking, electric power steering device EPS, MDPS using electric motors has applied on behalf of the hydraulic device. EPS is in charge of sponsored role when driving a manned. However, EPS has problems of handle locking caused by overheating to protect the system itself due to self-protection system. Handle locking while driving car causes very dangerous situation. Most of the vehicle uses engine power and hydraulic power to manipulate the handle. But manned and automatic vehicle needs change of the steering mechanism because it is using battery and motor to move or automatic gear. In this paper, we propose design of manual and automatic steering mechanism and controller that have solved problem when applied to electric vehicles automatic gear vehicles. Proposed steering mechanism is manual and automatic combined steering device of new structure applying servo motor and electronic clutch. Servo motor is connected to electric microcontroller (ECU) and operated by ultrasonic sensor and IR sensor. Wheels turn with help of rack and pinion, servo motor.

1.1 Introductions to steering system: 
The steering system converts the rotation of the steering wheel into a swivelling movement of the road wheels in such a way that the steering-wheel rim turns a long way to move the road wheels a short way. The system allows a driver to use only light forces to steer a heavy car. The rim of a 15 in. (380 mm) diameter steering wheel moving four turns from full left lock to full right lock travels nearly 16 ft (5 m), while the edge of a road wheel moves a distance of only slightly more than 12 in. (300 mm). If the driver swivelled the road wheel directly, he or she would have to push nearly 16 times as hard. The steering effort passes to the wheels through a system of pivoted joints. These are designed to allow the wheels to move up and down with the suspension without changing the steering angle. They also ensure that when cornering, the inner front wheel - which has to travel round a tighter curve than the outer one - becomes more sharply angled. The joints must be adjusted very precisely, and even a little looseness in them makes the steering dangerously sloppy and inaccurate. There are two steering systems in common use - the rack and pinion and the steering box. On large cars, either system may be power assisted to reduce further the effort needed to move it, especially when the car is moving slowly. At the base of the steering column there is a small pinion (gear wheel) inside a housing. Its teeth mesh with a straight row of teeth on a rack - a long transverse bar. Turning the pinion makes the rack move from side to side. The ends of the rack are coupled to the road wheels by track rods. This system is simple, with few moving parts to become worn or displaced, so its action is precise. A universal joint in the steering column allows it to connect with the rack without angling the steering wheel awkwardly sideways. At the base of the steering column there is a worm gear inside a box. A worm is a threaded cylinder like a short bolt. Imagine turning a bolt which holding a nut on it; the nut would move along the bolt. In the same way, turning the worm moves anything fitted into its thread. Depending on the design, the moving part may be a sector (like a slice of a gear wheel), a peg or a roller connected to a fork, or a large nut. The nut system has hardened balls running inside the thread between the worm and the nut. As the nut moves, the balls roll out into a tube that takes them back to the start; it is called a recirculating-ball system. The worm moves a drop arm linked by a track rod to a steering arm that moves the nearest front wheel. A central track rod reaches to the other
side of the car, where it is linked to the other front wheel by another track rod and steering arm. A pivoted idler arm holds the far end of the central track rod level. Arm layouts vary. The steering-box system has many moving parts, so is less precise than the rack system, there being more room for wear and displacement.

1.2 ULTRASONIC SENSOR:
An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back.

By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

1.3. IR SENSOR
A sensor is a transducer used to make a measurement of a physical variable.

Types of sensor: Passive sensors detect the reflected or emitted electro-magnetic radiation from natural sources, while active sensors detect reflected responses from objects which are irradiated from artificially generated energy sources, such as radar.

Fig 2. Sensor

The most popular sensors used in remote sensing are the camera, solid state scanner, such as the CCD (charge coupled
displacement.

Fig 3. Sensor components

<table>
<thead>
<tr>
<th>Electrical Parameters</th>
<th>HC-SR04 Ultrasonic Module</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>DC-5V</td>
</tr>
<tr>
<td>Operating Current</td>
<td>15mA</td>
</tr>
<tr>
<td>Operating Frequency</td>
<td>40KHZ</td>
</tr>
<tr>
<td>Farthest Range</td>
<td>4m</td>
</tr>
<tr>
<td>Nearest Range</td>
<td>2cm</td>
</tr>
<tr>
<td>Measuring Angle</td>
<td>15 Degree</td>
</tr>
<tr>
<td>Input Trigger Signal</td>
<td>10us TTL Pulse</td>
</tr>
<tr>
<td>Output Echo Signal</td>
<td>Output TTL level signal, proportional with range</td>
</tr>
<tr>
<td>Dimensions</td>
<td>45<em>20</em>15mm</td>
</tr>
</tbody>
</table>
device) images, the multi-spectral scanner and in the future the passive synthetic aperture radar. Laser sensors have recently begun to be used more frequently for monitoring air pollution by laser spectrometers and for measurement of distance by laser altimeters. Laser sensors have recently begun to be used more frequently for monitoring air pollution by laser spectrometers and for measurement of distance by laser altimeters.

1.4. PIC MICROCONTROLLER:
PIC is a family of microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to Peripheral Interface Controller, then it was corrected as Programmable Intelligent Computer. The first parts of the family were available in 1976; by 2013 the company had shipped more than twelve billion individual parts, used in a wide variety of embedded systems.

Early models of PIC had read-only memory (ROM) or field-programmable EPROM for program storage, some with provision for erasing memory. All current models use flash memory for program storage, and newer models allow the PIC to reprogram itself. Program memory and data memory are separated. Data memory is 8-bit, 16-bit, and, in latest models, 32-bit wide. Program instructions vary in bit-count by family of PIC, and may be 12, 14, 16, or 24 bits long. The instruction set also varies by model, with more powerful chips adding instructions for digital signal processing functions.

1.5 ELECTRONIC CONTROL UNIT

In automotive electronics, Electronic Control Unit (ECU) is any embedded system that controls one or more of the electrical system or subsystems in a transport vehicle. The development of an ECU involves both hardware and software required to perform the functions expected from that particular module. Automotive ECU’s are being developed following the V-model.

In this Electronic Control Unit, sensor will transmit data to ADC controller, ADC will transmit signal to PIC Micro controller and the microcontroller starts to trip the relay to start the stepper motor.

2. COMPONENTS AND DESCRIPTION

i) RACK AND PINION: A rack and pinion is a type of linear actuator that comprises a pair of gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the
rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.

![Image of rack and pinion](image1.jpg)

**ii) DC MOTOR:** A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

![Image of DC motor](image2.jpg)

**iii) WHEEL AND ARRANGEMENTS:** Wheel is made up of stainless steel and rubber. The rim size is 2.5*6 inches.

**iv) SHAFT:** A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The various members such as pulleys and gears are mounted on it.

![Image of shaft](image3.jpg)

**V) FRAME:** Frame is made up of Mild steel with the size of 1.5mm as per the length required.

**Vi) BEARING:** The ball bearing is made up of stainless with inner diameter 12mm and outer diameter 40mm.

![Image of bearing](image4.jpg)

2. **WORKING PRINCIPLE:**
When the vehicle is moving out of control of driver at a certain speed, then if the vehicle faces the
situation to collide with the resting object (say if the vehicles are waiting for signal and our vehicle is facing the above mentioned problem). The condition of the object get interfered on the path of moving vehicle is sensed by the ultrasonic sensor and the sensed data is sent as the feedback signal to the ECU. The sensors placed at the lateral side of the vehicle senses the condition of free road and activates the dc motor to rotate towards the free road side direction up to certain time during this vehicle is turned to the free road side and the motor get rotated in the opposite direction to move the vehicle in the free road.

**DEGREE OF FREEDOM OF THE VEHICLE**

In physics, the degree of freedom (DOF) of a mechanical system is the number of independent parameters that define its configuration. It is the number of parameters that determine the state of a physical system and is important to the analysis of systems of bodies in mechanical engineering, aeronautical engineering, robotics, and structural engineering. The position of a single railcar (engine) moving along a track has one degree of freedom because the position of the car is defined by the distance along the track. A train of rigid cars connected by hinges to an engine still has only one degree of freedom because the positions of the cars behind the engine are constrained by the shape of the track. An automobile with highly stiff suspension can be considered to be a rigid body traveling on a plane (a flat, two-dimensional space). This body has three independent degrees of freedom consisting of two components of translation and one angle of rotation. Skidding or drifting is a good example of an automobile's three independent degrees of freedom. The position and orientation of a rigid body in space is defined by three components of translation and three components of rotation, which means that it has six degrees of freedom.

4) **DESIGN ANALYSIS:**

1. To estimate rack and pinion gear tooth strength

   i. Production gears must be designed using Lewis Form Factor or FEA
   ii. By Alex Slocum 1/18/01, last modified 9/28/2007 by Alex Slocum
   iii. Pinion tooth geometry is assumed the same as for the rack!

3. **Inputs**
4. Pitch, P-24
   Pressure angle, alpha (degrees, ad)-14.5
   Safety factor, sf -2
   Number of teeth on pinion, N -24
   Tooth Material = Nylon
   Allowable bending stress, sb (psi) -6000
   Tooth width, wr (in) – 0.250

3. Tooth geometry

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>PARTS</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Wheel</td>
<td>4</td>
</tr>
<tr>
<td>II.</td>
<td>Ball bearing</td>
<td>5</td>
</tr>
<tr>
<td>III.</td>
<td>Steering plate</td>
<td>1</td>
</tr>
<tr>
<td>IV.</td>
<td>shaft</td>
<td>1</td>
</tr>
<tr>
<td>V.</td>
<td>IR sensor</td>
<td>2</td>
</tr>
<tr>
<td>VI.</td>
<td>ECU</td>
<td>1</td>
</tr>
<tr>
<td>VII.</td>
<td>Ultrasonic sensor</td>
<td>1</td>
</tr>
<tr>
<td>VIII.</td>
<td>frame</td>
<td>1</td>
</tr>
<tr>
<td>IX.</td>
<td>Dc motor</td>
<td>2</td>
</tr>
<tr>
<td>X.</td>
<td>Chain drive</td>
<td>1</td>
</tr>
<tr>
<td>XI.</td>
<td>Rack and pinion</td>
<td>1</td>
</tr>
</tbody>
</table>

Circular pitch (in) -0.1309
Tooth height (root to tip), hr (in) -0.104
Addendum, ar (in) -0.042
Duodenum, br (in) -0.052
Clearance, cr (in) -0.010
Tooth thickness, tr (in) -0.065
Tooth thickness at root, trr (in) -0.097
Shear area, Arear (in^2) -0.016
I/C at root, locr (in^3) -3.9E-04
Distance pitch line to root, hl (in) -0.062

4. Rack

Maximum tangential force to shear failure, Fsr (lbs) -49.1
Maximum tangential force to bending failure, Fb (lbs) -37.5
Maximum allowable tangential (rack)force, Fmax (lbs) -18.7

Resulting force along line-of-action, FLA (lbs) -19.4
Resulting separation force, Fspread (lbs) -5.0

5. Pinion

Pitch diameter, PD (inches) - 1.000
Torque to create axial force, Tmin (in-lbs, N-mm) - 9.7

5) LIST OF MATERIALS:
The list of materials or components used in emergency steering system to avoid collision by using microprocessor controller.

6) ADVANTAGES

1. It able to increase the sureness in steering system.
2. System able to increase the pre-cash safety.
3. System able to provide more safety to the passengers.
4. System plays an important role to save human life in road accidents.

6.1) LIMITATIONS

1. System has few limitations in densely traffic road.
2. System has no provision to prevent and cure the accidents from rear side of vehicle.
3. Hard and thick materials cannot be riveted.
4. Due to the linkages there will be frictional losses.
5. Maintenance will be more due to the number of moving

6.3) APPLICATIONS

1. This system may be applicable in all types of light vehicles like cars, Rickshaws, Tempos.
2. This system also successfully installed in the
heavy vehicles like buses, trucks, trailers, etc.

7) CONCLUSION

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We are feeling that we have completed the work within time successfully. The EMERGENCY STEERING SYSTEM FOR FOUR WHEELERS is working with satisfactory conditions. Thus we have prepared an “EMERGENCY STEERING SYSTEM TO AVOID COLLISION BY USING MICROPROCESSOR CONTROLLER” which helps to know how to achieve low cost product.