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ARDUINO OPERATED STEERING SYSTEM

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ABSTRACT

Steering system, in automobiles, steering wheel, gears, linkages, and other components used to control the direction of a vehicle's motion. Because of friction between the front tires and the road, especially in parking, effort is required to turn the steering wheel. To lessen the effort required, the wheel is connected through a system of gears to components that position the front tires. The gears give the driver a mechanical advantage, many of the cars use a power-steering system, Rack and pinion steering system, Ackermann steering system and adaptive steering system. If it turns at a slower rate it is said to under steer; if it turns faster it is said to overseer... As a safety feature in many modern cars the column on which the steering wheel is mounted will collapse if the driver is thrown against the wheel in a collision.

The automotive industry has already implemented many advanced computer systems in an attempt to increase safety and comfort of drivers. In parallel with these advancements we see a big shift from mechanical systems to electrical systems and steer-by-wire is another implementation that is very promising in terms of safety and functionality. Already, there are some commercial prototypes of such by-wire system and there is a lot of research, it describe a method for controlling a vehicle steer-by-wire system. It gives a novel control structure for the steer-by-wire system using arduino Uno to implement steering functions and to improve the vehicle handling performance. The focuses on the implementation of various steering functions by applying control design methods. A steer-by-wire system aims to eliminate the physical connection between the steering wheel and the wheels of a car by using electrically controlled motors to change the direction of the wheels and to provide feedback to the driver and provide easy and safe control with weight reduction. Stir by Wire system can be used to reduce space required for steering column and linkages

Keywords: Steering System, Arduino, Mechanical Engineering, Automatic.

I. INTRODUCTION

Steer by wire systems are a relatively new development compared to the traditional mechanical, hydraulic, or electric steering systems that are currently used for motor vehicles. It provides the potential benefits of enhanced vehicle performance, improved handling behavior, and fully integrated vehicle dynamic control. In a steer-by-wire system, there is no mechanical coupling between the steering wheel and the steering mechanism, i.e., the vehicles steering wheel is disengaged from the steering mechanism during normal operation. Even though the mechanical linkage between the steering wheel and the road wheels has been eliminated, a steer-by-wire steering system is expected not only to implement the same functions as a conventional mechanically linked steering system, but it is also expected to provide the advanced steering Functions. Wire technology, which used the motor system instead of a purely mechanical, hydraulic or pneumatic components. It is a symbol of the current development in automotive industry application. Steering-By-Wire system (SBW) has canceled mechanical linkage between the steering wheel and front wheel, and gotten out of restricting of traditional steering system, so we can design the steering characteristic freely. It is a leap for the design of steering system, as most car makers and research institutions paid high attention to it. However, there is no rigidity linkage between the steering wheel and front wheel, the SBW system has faced many challenges in Mechanical Engineering the aspect of safety and reliability.

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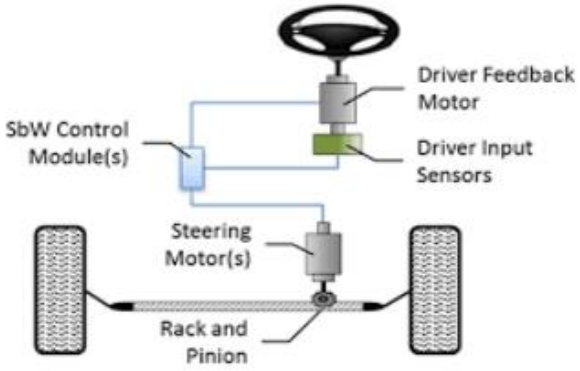

Figure 1.1: Steer by Wire Steering using rack and pinion system

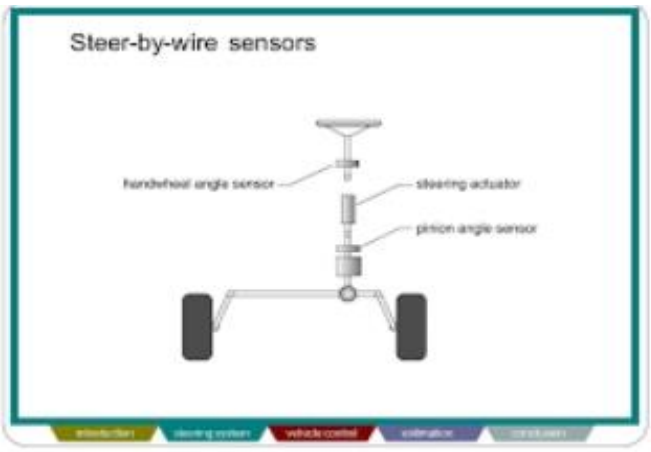

Figure 1.2: Steer by Wire Steering using Ackermann system

The elimination of the mechanical link between the subsystems can result in abnormal steering system performance. In this paper, the authors have defined steering system performance by two important attributes, steering feel and steering response. An additional performance quality of a steering system that will be discussed is termed free control. Free control describes the steering system behavior for the case of the driver's hands removed from the steering wheel.

II. LITERATURE SURVEY

Vixen Yao [1], carried out research on stir by wire. He deals with system according to the requirements of the vehicle steering functions and the control system. The different steering function requirements are converted into control design problems, and are solved by using a control system with novel control structures. An electronic control module (steer-by-wire controller) controls the steering wheel mechanism and the road wheel mechanism in coordinated fashion. The steer-by wire controller effectively links the steering wheel and road wheel mechanisms by wire through control signals.

Duane Jianmin, Wang Ran, Yu Yongchuan [2], Steer-By-Wire system, in which the conventional mechanical linkages between the steering wheel and the front wheel are removed, is suited to active steering control. Wire technology which used the motor system instead of a purely mechanical, hydraulic or pneumatic components. It is a symbol of the current development in automotive industry application.

Yang Liu [3], the steering of front wheels in steer-by-wire (SBW) system is controlled by electrical signals; it has the function that the traditional steering system doesn't have. A large number of papers and experimental studies show that the main characteristics of SBW system are improving the steering characteristics, improving the security and stability, improving the road sense and conducive to the integration control of forklift.

Yousef Yamaguchi et. al [4], Adaptive Control for Virtual Steering Characteristics on Electric Vehicle Using Steer-by-Wire System the experimental results of impedance control for the Steer-by-Wire system, the estimation method of the Vehicle parameters, and adaptive control for virtual steering, in this paper, an

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application to design steering wheel characteristics via a Steer-by-Wire system and a control method which helps the driver recognition of the road condition have been proposed.

Adam Kader [5], advanced computer systems in an attempt to increase safety and comfort of drivers. In parallel with these advancements we see a big shift from mechanical systems to electrical systems and steer-by-wire is another implementation. Author deal with two method of the steer-by-wire system. The steering section consists of the steering wheel, the feedback actuator and the feedback actuator angle sensor.

Sankey Amberkar, Farhad Bolourchi, Jon Demerly et.al [6], Steer by Wire systems provide many benefits in terms of functionality, and at the same time present significant challenges too. Chief among them is to make sure that an acceptable steering feel is achieved, the elimination of the mechanical link between the subsystems can result in abnormal steering system performance. In this project different steering function requirements are converted into control design problems, and are solved by using a control system with novel control structures using by servo motor and potentiometer operated on ardiuno. Computer systems in an attempt to increase safety and comfort of drivers. In parallel with these advancements we see a big shift from mechanical systems to electrical systems and steer-by-wire is another implementation. Steer by wire technology which used the motor system instead of a purely mechanical, hydraulic or pneumatic components.

III. CONVENTIONAL STEERING SYSTEM

The function of a steering system is to convert the rotary movement of the steering wheel in driver's hand into the angular turn of the front wheels on road. Additionally, the steering system should provide mechanical advantage over front wheel steering knuckles, offering driver an easy turning of front wheels with minimum effort in any desired direction. The steering system is designed to enable the driver to control and continuously adjust the steered path of the vehicle. Also it provides a positive response to whatever direction the driver Relationship of steer angle speed and vehicle speed for various steering conditions. Mostly used steering system are as follows. Rack And Pinion Steering System Rack and pinion steering system converts rotational motion of the pinion into linear motion of rack. Rotational motion applied to the pinion causes the rack to move pinion. The pinion gear is attached to the steering shaft. When you turn the steering wheel the gear spin, moving the rack. The tied rod at each end of the rack connects to the steering arm on the spindle.

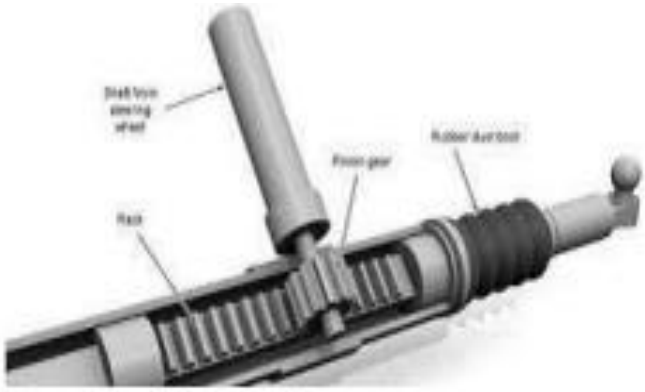

Figure 3.1: Rack And Pinion Steering System

Ackermann Steering System

Arrangement of linkages in the steering of a car or other vehicle designed to solve the problem of wheels on the inside and outside of a turn needing to trace out circles of different radii. The intention of Ackermann geometry is to avoid the need for tyres to slip sideways when following the path around a curve. Steering Wheel The steering wheel is the part of the steering system which is controlled by the driver. The rest of the steering system works with respect to the steering input.

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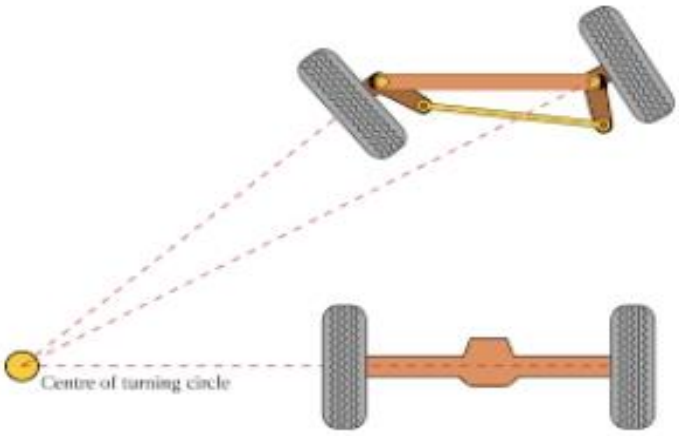

Figure 3.2: Ackermann Steering System

Steering column

The steering column is a device used for connecting the steering wheel to the steering mechanism. It transfers the driver's input from the steering wheel to steering mechanism.

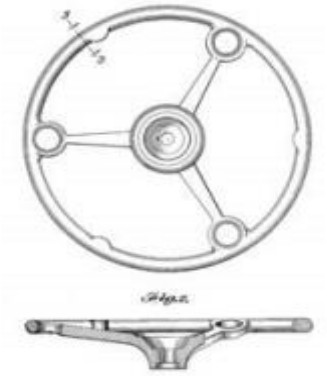

Figure 3.3: Steering Wheel

Figure 3.4: Steering Columnn

IV. DESIGN METHODOLOGY, ANALYSIS AND IMPLEMENTATION

The Design Methodology /Analysis.

Arduino UNO R3:

The Arduino Uno is a micro-controller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the micro-controller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The aim of arduino Uno system is to provide low cost to create devices that interact with their environment using sensors and actuators. It sends the output signal to battery for actuating the motor with respect to movement of sensing pinion. Revision 3 of the board has the following new features: 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes. Stronger RESET circuit at mega 16U2 replace the 8U2."Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform.

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Digital Pins:

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the pin Mode (), digital Read (), and digital Write () commands. Each pin has an internal pull-up resistor which can be turned on and off using digital Write () (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is 40 mA. Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. On the Arduino Decimal, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip. On the Arduino BT, they are connected to the corresponding pins of the WT11Bluetooth module. On the Arduino Mini and Lily Pad Arduino, they are intended for use with an external TTL serial module (e.g. the Mini-USB Adapter). External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attach Interrupt () function for details. PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analog Write () function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11. BT Reset: 7. (Arduino BT-only) Connected to the reset line of the Bluetooth module. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. LED: 13. On the Decimal and Lily Pad, there is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

Analog Pins:

In addition to the specific functions listed below, the analog input pins support 10- bit analog-to-digital conversion (ADC) using the analog Read () function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins. I2C: 4 (SDA) and 5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

Power Pins:

VIN (sometimes labelled"9V"). The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Note that different boards accept different input voltages ranges, please see the documentation for your board. Also note that the Lily Pad has no VIN pin and accepts only a regulated input. 5V. the regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.3V3. (Decimal-only) A 3.3 volt supply generated by the on-board FTDI chip. GND, Ground pins.

Other Pins:

AREF. Reference voltage for the analog inputs. Reset. (Decimal-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

V. PROGRAMMING

1. Servo Motor Control with Potentiometer

```
#include Servo.h
Servo servo;
int pot = 0;
int val;
void setup()
{
servo. attach(3);
}
void loop()
{
val = analogRead(pot);
val = map(val, 0, 1023, 0, 180);
```

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```
servo. write(val);
}
```

2. Servo Motor with LED Display

```
#include Servo.h
#include LiquidCrystal.h
Servo servo;
int pot = 0;
int val;
LiquidCrystal lcd(7, 9, 10, 11, 12, 13 );
byte v1
8] = { B11111, B11111, B11111, B11111, B11111, B11111, B11111, B11111 };
void setup() {
lcd.createChar(0, v1)
lcd.begin(16, 2);
servo. attach(3);
}
void loop()
val = analogRead(pot);
val = map(val, 0, 1023, 0, 180);
servo. write(val);
lcd.setCursor(0 ,0);
lcd.write(bit(0));
lcd.setCursor(7, 1);
lcd.print(val);
}
```

3. Servo Motor Control by Arduino

```
#include Servo.h
Servo myservo; // create servo object to control the servo
int potpin = 0; // analog pin used to connect the potentiometer
int val; // variable to read the value from analog pin
void setup()
{
myservo.attach(9); // Attaching the servo on pin 9 to the servo object
}
void loop()
val = analogRead(potpin); // read the value of the potentiometer ( value between
0 and
1023) val = map(val, 0, 1023, 0, 180); // scale it to use it with the servo (value
Between 0 and 180)
myservo.write(val); // sets the servo position according to the scale value
delay/(15)/; // waits for the servo to get there
```

VI. COMPONENTS

Servomotor:

The Servo Motor basically consists of a DC Motor, a Gear system, a position sensor and a control circuit. The DC motors get powered from a battery and run at high speed and low torque. The Gear and shaft assembly

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connected to the DC motors lower this speed into sufficient speed and higher torque. The position sensor senses the position of the shaft from its definite position and feeds the information to the control circuit. The Servo Motor generally requires DC supply of 4.8V to 6 V. A servo motor is controlled by controlling resistance provide due to potentiometer, rotation of potentiometer shaft can change the resistance and varied the servo meter speed. If a heavy load is placed on the motor, the driver will increase the current to the motor coil as it attempts to rotate the motor. Servomotors are used in applications requiring rapid variations in speed without the motor getting overheated. They are used in machine tools, packaging, factory automation, robotics etc.

Fig 6.1: Servomotor

Potentiometer:

Potentiometer is a small sized electronic component whose resistance can be adjusted manually. Increasing or decreasing the value of resistance controls the amount of current flowing in a circuit. The potentiometer is used in various electronics, for example: is used as volume knob in music systems, as fan regulators etc. Potentiometer has two strips made on it resistive and conductive. Resistive strip is made of carbon and is responsible for potentiometers resistance variance feature. Conductive strip helps the potentiometer to carry the current into the circuit in accordance with the resistance. To understand the theory of our humble potentiometers (or pots), let us know the parts of the potentiometer:

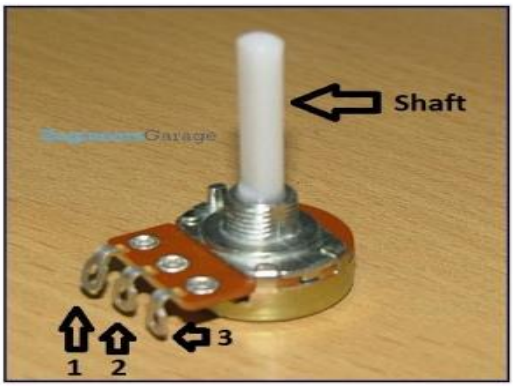

Fig 6.2: Potentiometer

Lugs: Potentiometers by convention have three lugs. They are numbered 1, and 3 as shown in the figure. Shaft: This is a plastic/metallic stick which is used to turn the potentiometer. Resistive Strip: This is the heart of the potentiometer. It is a carbon strip that is printed on a phenolic strip. There are metal contacts in the end to connect it to the lugs.

Metal Wiper: When we rotate the shaft, it in turn rotates a metallic wiper which connects the lug 1 and lug2.

VII. DISCUSSION AND RESULTS

Discussion:

Although there were many problems We encountered with each part of the project, in the end, I was able to show that a steer-by-wire system could work. However, given the slow responses of the system, my setup is far

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from ideal and needs many improvements. The feedback motor worked very well and to a certain extent it simulated the real driving experience. The steering motor did not work very well at all, and this can be attributed to the characteristics of the motor and the motor controller. The motor controller had a very slow switching time. It would take time seconds to switch from one direction to the other and this really delay the operation. Also, the steering motor was quite powerful so even though the motor controller were able to switch very fast, the motor would still be slow to react. In a real implementation, it might be a good idea to use two dedicated motors, one for each direction. The steering wheel can also be improved by adding dampers and springs. We believe that with various improvements, steer-by-wire can achieve some success. Sometimes even very small delays in reaction can be fatal so the delay between steering wheel rotation and actual steering might pose a great threat in the development of SBW systems. However, given other advancements in automotive technology, we see that more and more AI systems are being integrated into cars and combining SBW systems with these can be very promising. By Doing this project has improved our understanding of control systems greatly and I have gained significant experience in combining electronic and mechanical systems. Although I have not accomplished my initial goals of the project 100%, I believe that there was a lot of progress made and I think that this system can be improved upon.

Advantages:

It also increases the handling of car and gives more comfort to driver as the turning effort is very less. It provides the potential benefits of enhanced vehicle performance [1], improved handling behavior, and fully integrated vehicle dynamic control. In a steer-by-wire system, there is no mechanical coupling between the steering wheel and the steering mechanism, the steering wheel and the steering mechanism, i.e., the vehicles steering wheel is disengaged from the steering mechanism during normal operation. Even The advantage of the system brigs an important feature to control the steering wheel and the front-wheel steering independently. Absent of steering column, steering shaft, gear reduction mechanism allows much better space utilization.

Disadvantages:

As the motor is used to turn the wheels it increases the battery consumption. Electric equipment such as motor, sensors, potentiometer etc., are costly. Failure or cut of Wire cause failure of the steering system.

VIII. CONCLUSION

- Steer-by-wire system is an application in the field of vehicle power steering system it is the hotspot and advanced technology in the field of steering technology.
- Its main feature is removing mechanical linkage between the steering wheel and front-wheels; it can realize the desired steering target by electronic controlling system. SBW can get rid of the limitation of conventional steering system.
- The advantage of the system is the independence of steering wheel and front-wheels, so it is possible to design the angular transmission and force transmission characteristic, the more design flexible, the more perfect steering characteristic. SBW is significant reformation in development of steering system.
- By using Potentiometer shaft as a steering column and servomotor to control wheels movement results in better performance in controlling and safety for driver. Variation in the potentiometer reading cause required rotation of servomotor.

IX. FUTURE SCOPE

The Steer by Wire system we build can be improved a lot, but the main problem seems to be with the choice of controllers and motors. For a future project, given better equipment, this system could be implemented in a small model car and can be used for control theory demonstrations. New control systems, such as state-space controls, can be implemented to enhance the performance of the system. Although not in the near future, given enough resources, this system can be implemented in real road cars and perhaps be combined with regular steering to take advantage of the safety benefits of a steer-by-wire system. Someone may use Other Programming Source instead of Arduino Uno Which result in the Good and quick Performance. In the future, system structure without mechanical backups may be developed and evaluated when reliability is improved on component level, including the power supply system.

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