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DESIGN AND FABRICATION OF 360 DEGREE ROTATING VEHICLE MECHANISM

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ABSTRACT:

The 360-degree rotating vehicle mechanism using Arduino Uno, remote control, and 8 DC motors, with 4 dedicated to mobility and 4 for turning, is a novel design that enables a vehicle to achieve omni directional movement with enhanced control and flexibility. The mechanism utilizes an Arduino Uno microcontroller to control the operation of all eight DC motors, ensuring synchronized and precise movement. The control system can be operated manually using a remote control or integrated with an autonomous navigation system for enhanced functionality. The four DC motors dedicated to mobility are placed to provide forward, backward, and sideways movement, allowing the vehicle to navigate various terrains and confined spaces with ease. The four DC motors dedicated to turning control a set of wheels independently, enabling the vehicle to rotate in any direction, make precise turns, and execute complex mobility.

The 360-degree rotating vehicle mechanism using Arduino Uno, remote control, and 8 DC motors offers numerous advantages, including improved stability, increased maneuverability, and efficient operation in tight spaces. It has potential applications in industries such as robotics, material handling, and transportation, where precise movement and agility are crucial.

This mechanism provides a versatile and efficient solution for achieving omni directional movement. Its unique design and capabilities open up possibilities for advancements in mobility and automation in various fields.

I. Introduction

The project aims to design and fabricate a vehicle that can move in all directions at the same position. This mechanism utilizes eight DC motors, with four dedicated to facilitating rotation and the remaining four to enable forward, backward, and lateral movement.

The system in corporate an Arduino Uno Board, which serves as the central processing unit, coordinating the activities of the motors and interpreting commands received via the HC-05 Bluetooth module. This wireless communication module allows for seamless control of the mechanism, ensuring efficient and flexible operation.

A motor driver is integrated into the system to facilitate the smooth and precise control of the motors. The entire setup is mounted on an aluminum frame, providing structural integrity and durability to withstand the hardships of various environments and applications.

The 360-degree Rotating Vehicle Mechanism offers a powerful solution for a wide range of industries, including robotics, automation, surveillance, and logistics. Its universal design and strong construction make it a reliable and efficient choice for any task requiring precise and quick movement.Overall, this mechanism revolutionizes the way vehicles move and open new possibilities for transportation and mobility in various industries.

II Literature

[1].Jaishnu Moudgil Proposed 360 degree rotating vehicle to beat the matter of parking zone. the vehicle turning at the same place, where it's standing. No extra space is required to revolve the vehicle, so vehicle is to be turned within the space like to the length of the vehicle itself.

[2].Sudip kachhia, Proposed the idea of all electric concept of vehicle is that if it becomes a reality would prove to be a lot of fun to drive in the city. The vehicle works on 8 electric motors, four motors attached uniquely to each wheels and it can rotate 360 degrees.

[3].Mr. Sharad P. Mali Presented zero turn four wheel mechanisms, in this project people have used DC motor and wheel to vehicle rotate 360 degree at a same position. So in this task, the initiative is to organize of DC motor and wheel.

[4]. Arunkumar S M, Chandan Kumar Sahu, Yubaraj G M, Jahangeer A B[18] Proposed a system. In this system first the vehicle is stopped and wheels are then turned within the required direction with help of steering mechanism and DC motor.

[5]. K. Lohith, Dr. S. R. Shankapal, M. H. Monish Gowda, They Presented a four wheel steering mechanism for a car. In four wheels steering the rear-wheels revolve with the front wheels thus raising the effectiveness of the vehicle.

[6]. S. Nithyananth, a. Jagatheesh, k. Madan, b. Nirmalkumar "Convertable four wheels steering with three mode operation":[10]The most conventional and general steering arrangement is to turn the front wheels using a hand– operated steering wheel which is positioned in front of the Driver. The steering column, [11]which contain a universal joint which is part of the collapsible steering column which is designed to allow it to deviate from a straight line according to the Roadmap. In convertible four wheel steering with three mode operation three steering modes can be changed as needed which assists in parking at heavy traffic conditions, when negotiating areas where short turning radius is needed and in off road Driving.[12]

[7]. Arun Singh, Abhishek Kumar, Rajiv Chaudhary, R. C. Singh "Study of 4 Wheel Steering Systems to Reduce Turning Radius and Increase Stability":[13]In this report, the performance eoff our wheelssteered vehicle model is considered which is optimally controlled during a lane change maneuver in three type of condition which is low speed maneuver, medium speed maneuver and high speed maneuver.[15- 17] Four-Wheel Steering – Rear Wheels Control.For parking and low speed maneuvers,therearWheelsteerintheoppositedirectionofthefrontwheels,allowingmuchsharper turns.[18]

[8]. Dr. Amitesh Kumar, Dr.Dinesh. N. Kamble "Zero Turn Four Wheel Steering

System": Conventional steering mechanism involves either the use of Ackerman or Davis steering systems. The disadvantage associated with these systems is the minimum turning radius that is possible for the steering action. This difficulty that is associated with the conventional methods of steering is eliminated by employing a four wheel steering system.

[9]. Shir sath Sachin and Jadhav Kiran "Study of zero turn vehicle" The most important characteristics of a vehicle, such as steerability and handling that create an alternative to tradition al two-wheel steering systems, have become an integral part of today's world. Traditional steering uses the Ackermann or Davis steering system, both of which have the disadvantage of not being able to turn with a small radius. The ability to provide zero-turn steering without sacrificing vehicle steerability and handling is an major challenge for automotive. The main goal is to improve the vehicle's zero-turn mobility while avoiding wheel wobble problems.

[10]. Vivek singhrai and Deepti kushwaha, Zero-turning steering system A car with an easy-to- use steering mechanism and a reasonable price has been introduced. The car has been introduced asa battery- operated, low-noise, environmentally friendly vehicle. At low speeds and on wet or slick road surfaces, The cornering movement of the vehicle becomes more stable and controllable. Vehicle manuring on tight roadways and when parking become less of a problem. This technique decreases the amount of time spent parking and turning. In tight places, a vehicle can do a U-turn with a turning radius of half its length. The turning round radius of the vehicle was considerably reduced be directing the rear wheel. The vehicle's steering ability is simple. In city situations, this vehicle is ideal.

III Objectives

- ✓ To design and fabricate a model of 360 degree rotating vehicle mechanism.
- ✓ To rotate the vehicle with out leaving its center.

- ✓ The mechanism is designed to provide users with the ability to control the vehicle's movement and rotation in all direction.

IV Methodology

4.1 Design and Assembly:

Begin by designing the chassis and mechanicals structure of the vehicle, considering the use of a metal alloy frame and the placement of the 8 DC motors.Determine the configuration of the wheels and their connection to the motors for both mobility and turning. Assemble the metal alloy frame, wheels, and motors according to the design.

4.2 Arduino Uno Programming:

Set up the Arduino Unoboard and connect it to the necessary components, such as motor drivers and remote control receiver. Use the code to control the motors based on the input from the remote control.Implement the logic for controlling the mobility motors to achieve forward, backward, and sideways movement.Implement the logic for controlling the turning motors to achieve rotation in any direction.

4.3 Motor Control:

Connect the 4mobility motors to their respective motor drivers and Arduino pins.Connect the 4 turning motors to their respective motor drivers and Arduino pins.Configure the motor drivers to control the speed and direction of the motors.

4.4 Remote Control Integration

Connect the remote control receiver module to the Arduino Uno board.Program the Arduino to receive and interpret the signals from the remote control.Map the remote control buttons or joystick movements to specific motor control command.

4.5 Testing and Refinement

Test the functionality of the vehicle by operating it using there motor control. Verify that the mobility motors enable forward, backward, and sideways movement as intended. Verify that the turning motors allow the vehicle to rotate in any direction smoothly. Make any necessary adjustment refinements to the code, wiring,or mechanical components based on the testing results.

4.6 Finalization:

Once the vehicle is functioning correctly ,finalize the wiring and secure all connections.Ensure that the metal alloy frame and mechanical components are sturdy and well-assembled.Conduct thorough testing to ensure the vehicle operates reliably and achieves the desired 360- degree rotating movement.

V Hardware Requirements:

Arduino UNO
Motor driver
HC-05Bluetoothmodule
Eight Motors
LI-ion Battery

ArduinoUNO

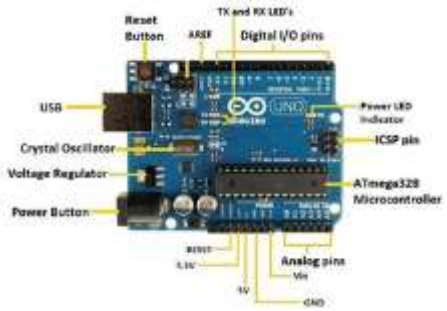

Fig.4.1a) Arduino UNO with its components[11](Courtesy)

The Arduino UNO is a standard board of arduino. Here uno means 'one' in **italian.** It was named as UNOto label the first release of Arduino Software. It was also the first USB boardreleased by arduino.It Is considered as the powerful board used in various projects.Arduino.cc developed the arduino uno board.[11]

Arduino UNO is based on an at mega328p microcontroller. It is easy to use compared to other boards, such as the arduino mega board, etc. the board consists of digital and analog input/Output pins (I/O), shields, and other circuits.[11]

The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for integrated development environment. It can run on both online and offline platform.

ATmega328 Microcontroller- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.[11]

5.1 Motor driver:

A motor driver is an electronic device that controls the speed, direction, and torque of an electric motor. It serves as an interface between a microcontroller or a control system and the motor, providing the necessary signals and power to drive the motor effectively. The motor driver plays a crucial role in controlling the movement and functionality of the motors in the Smart Surface Cleaning Robot.

Here are some key details about the motor driver:

5.2 Purpose:

The motor driver is used to control the movement of the four DC motors attached to the robot's wheels.

It receives commands from the robot's control system or microcontroller and translates them into appropriate signals to drive the motors.

5.3 Motor Control Features:

Speed Control: The motor driver allows precise control over the rotational speed of the motors. It can vary the voltage or current supplied to the motors to regulate their speed.

5.4 Direction Control: The motor driver can change the polarity of the motor's terminals to control the rotation direction. This enables the robot to move forward, backward, and make turns as required.

5.5 Torque Control: Depending on the motor driver's capabilities, it may offer torque control features to adjust the motor's power output for different tasks and surface conditions.

5.6 Communication and Control

The motor driver receives control signals from the control system, which may be a microcontroller or a dedicated motor control board.

The control signals can bein the form of digital signals (such as PWM – Pulse Width Modulation) or analog signals, depending on the motor driver's input requirements.

The motor driver interprets these signals and generates the necessary outputs to control the motors' speed, direction, and torque.

HC-05Bluetoothmodule:

The HC-05 Bluetooth module is a commonly used module for wireless communication and data transmission between electronic devices. Here are some details about the HC-05 Bluetooth module:
Purpose:
The HC-05 Bluetooth module enables wireless communication between the Smart Surface Cleaning Robot and external devices such as smartphones, tablets, or computers.
It allows the vehicle to establish a Bluetooth connection and exchange data with a remote device, enabling control, monitoring, and communication functionalities.

Bluetooth Version:

TheHC-05modulesupportsBluetoothversion2.0+EDR(EnhancedDataRate).It is backward compatible with devices that support previous Bluetooth versions.
Communication range is approximately 10 meters, depending on environmental conditions and obstacles.

Communication Protocol:

The HC-05 module uses the Serial Port Profile (SPP) to establish a virtual serial communication link with the connected device.
It emulates a serial port over Bluetooth, allowing devices to communicate through standard serial communication protocols (such as UART).

Configuration and Pairing:

The HC-05 module can be configured with various settings, such as the communication band rate and Bluetooth device name, using AT commands. Pairing the HC-05 module with the external device typically involves setting the module in a discoverable mode and initiating the pairing process from the device's Bluetooth settings.

Security Features:

The HC-05 module provides basic security features such as PIN code authentication for secure pairing and data encryption during transmission.

Integration and Application:

The HC-05 module can be integrated into the Smart Surface Cleaning Robot's control system, allowing wireless control and data exchange with external devices.

Compatibility:

The HC-05 module is compatible with various operating systems and platforms, including Android, iOS, and Windows.

Fig.4.1b)HC-05Bluetoothmodule

Four Motors:

- Themotors are typically designed for easy integration and mounting on to the metallic frame.
- They may have pre-drilled holes or brackets for secure attachment to the robot's chassis or motor mounts.
- While selecting DC motors for the project, factors such as the robot's weight, desired speed, torque requirements, and power supply limitations should be taken into account.
- The motors should be capable of providing sufficient torque to move the robot effectively across different surfaces.

Fig.4.1c) DC motor

Proper measures should be taken to prevent overloading or over heating of the motors.

LI-ion Battery:

Purpose:

- TheLi-ion battery is use das the primary power source for the robot.
- It provides the necessary electrical energy to drive the motors, operate the control system, and power other electronic components of the robot.

Voltage and Capacity:

- Li-ion batteries come in various voltage ratings, such as 3.7V, 7.4V, or 11.1V, depending on the specific requirements of the vehicle.
- The capacity of the battery is measured in milli ampere-hours (mAh) or ampere- hours (Ah) and indicates the amount of charge the battery can store. The capacity chosen should be sufficient to power the robot for the desired operating duration.

Safety Considerations:

- Li-ion batteries should be handled and stored with proper care, following the manufacturer's guidelines and safety precautions.
- Overcharging or discharging beyond safe limits can lead to damage, reduced battery life, or safety hazards.
- It is advisable to use a battery management system (BMS) or protection circuitry to monitor and control the charging and discharging process, protecting the battery from over voltage, over current, or over temperature conditions.

Integration:

- The Li-ion battery needs to be integrated on the frame, considering factors such as size, weight, and placement within the frame's structure.
- Proper mounting and secure connections should be established to ensure reliable and stable power supply during vehicle movement.

Length of the vehicle	38.5 cm
Width of the vehicle	27cm
Height of the vehicle	20cm
Motor type	DC12Vmotor
RPM of the motor	60rpm
Material used for vehicle	Light weight aluminum

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Fig.4.1d)LI-ionBattery

VI . Software Requirements:

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards.The IDE application is suitable for different operating systems such as Windows, MacOSX, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software.

VII Calculations

The specifications serve as crucial parameters for designing and implementing the 360 degree wheel rotating car, ensuring that the dimensions and motor characteristics are compatible with the intended functionality and requirements of the car.

The specification of the vehicle are given below:

Motor calculation Specification and calculation 60rpm □18W□12V□

Torque of motor:T=P×60÷2×3.14=18×60÷2×3.14× N = 2.866Nm

Load apply on the vehicle is 4kg and length 385mmwidthofvehicle270mm. Find the reaction developed by each wheel and find the torque of each Wheel.

Weight=4kg

Length=385mm Width=270mm

To find the reaction force on wheels R=√(L/2)^2+√(B/2)^2 R=√(385/2)^2+√(270/2)^2

R=236N-mm

Reaction per wheel=W/4=4/4=1 Weight=Mg=1*9.81

R=9.81N

Torque on each wheel(T) T= R*r

T=(9.81*236)/1000

=2.315N-m

Calculation of Motor Specification and calculation N=10rpm Voltage =12 volt;I=2 Amp

Power = V× I Power= 12×2 VA Speed ratio N1=10 rpm,T1=15N2=?,T2=38

N1/N2=T2/T1 10/N2=38/15

N2=3.94rpmP

=2πNT/60 24 = 2π4T/60 T =57.29Nm T=57.29×103N.mm

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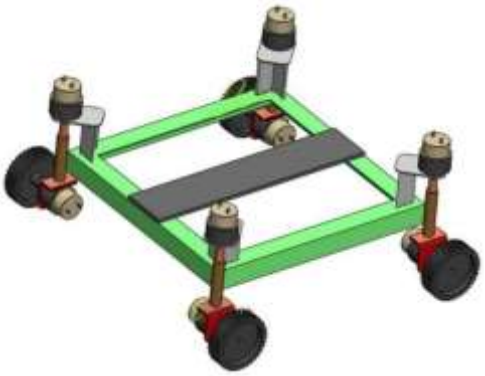
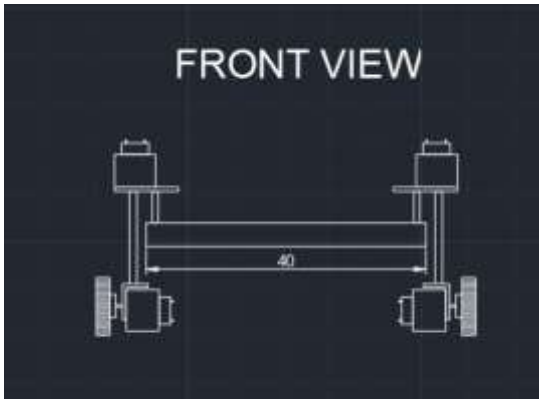
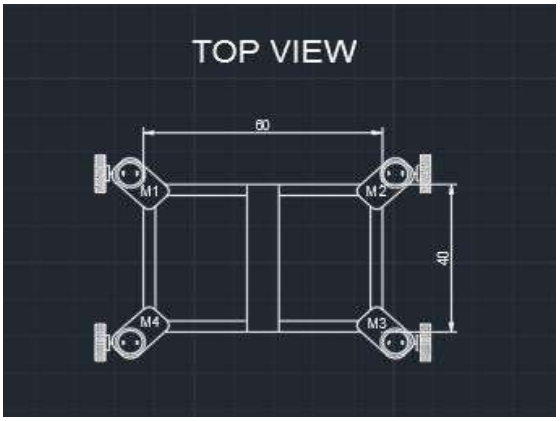
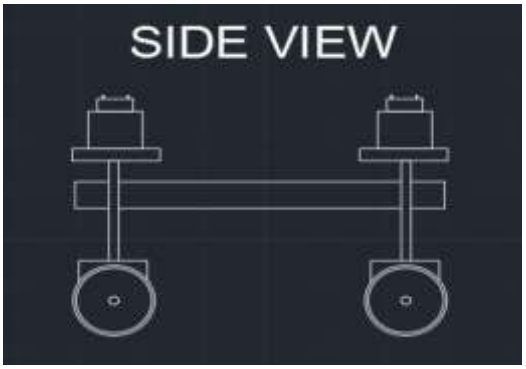
Schematic Diagram



VIII Project model and various views







IX Expected Outcomes

1. 360 rotating vehicle mechanism allows for greater mobility in making it easier to navigate tight spaces, make sharp turns and change directions quickly.
2. Vehicles with a 360 rotating mechanism can access areas that would otherwise be difficult to reach, such as narrow streets, crowded parking lots, or confined workspaces.
3. The ability to rotate 360 degrees can improve safety by providing better visibility and reducing blind spots. This can be particularly useful in industries such as construction, mining, or emergency services.
4. Vehicles equipped with a 360 rotating mechanism can facilitate easier loading and unloading of goods or passengers, reducing the time and effort required for these tasks.
5. The versatility of a 360 rotating vehicle mechanism allows it to be used in various industries and applications, including transportation, logistics, construction, agriculture, and more.

X Results and Discussions

The vehicle demonstrated smooth rotation in all directions. The aluminum frame provided the necessary stability and support for the mechanism, ensuring its structural integrity during operation. The motor driver successfully managed the power distribution and control signals for all the motors, enabling precise movement and rotation. The Arduino Uno acted as the central control unit.

The remote control functionality via the mobile application allowed for convenient and user-friendly operation, providing effective control over the vehicle's rotation. The vehicle exhibited accurate response to commands, effectively executing the desired movements. Fine-tuning of motor speeds and control logic maximized performance and enhanced user experience.

Overall, this 360-degree rotating vehicle mechanism showcased the successful integration of multiple components, resulting in a robust and versatile vehicle with remote control capabilities.

XI Conclusion

The 360-degree rotating vehicle mechanism is an advanced automated system designed to provide a high degree of flexibility and control. This system is powered by eight DC motors, with four dedicated to rotation and four for movement. This allows for precise and fluid motion in all directions.

The Arduino Uno Board, a microcontroller board, is used for programming and controlling the system. It's user-friendly and widely used in the maker community. The HC-05 Bluetooth module is incorporated for wireless connectivity, allowing for remote operation and monitoring. The motor driver is a critical component that controls the speed and direction of the motors, ensuring smooth and responsive movement.

Overall , this 360-degree rotating vehicle mechanism is a sophisticated and versatile system that can be applied in various industries for tasks that require precise control and Movability.

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