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Mecanum Wheel Robot

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Abstract: *In this paper a literature review concerning practical applications for mobile robotic platforms based on special wheels (in this case, Mecanum wheel) is presented. Mobile robots equipped with four Mecanum wheels have the omnidirectional property, which means, they have the ability to move instantaneously in any direction, from any configuration. Therefore, compared to conventional platforms, these vehicles possess multiple advantages in terms of their mobility in narrow spaces or crowded environments. They have the ability to easily perform certain tasks in congested environments foreseen with static obstacles, dynamic obstacles or narrow areas. Usually, such environments are found in factory workshops, warehouses, hospitals, etc. Hence the resulting needs to create this kind of robotic platforms to satisfy the requirements of various fields, such as: industrial, military, naval, medical and last but not least, the educational field (as the basis for research). The characteristics of the Mecanum wheel, a short comparison between this type of wheel and a conventional wheel, as well as the constructive and design solutions previously developed are described in the first part of this paper.*

Keywords: Mecanum Wheel

I. Introduction

Omnidirectional wheels have been used in robotics, in industry, and in logistics for many years. By reviewing and analyzing systematically the existing literature concerning this type of wheels, it was revealed that systems based on Mecanum wheels detain omnidirectional capabilities, whereas systems based on conventional wheels do not. Specifically, these capabilities make the vehicle extremely maneuverable, which could be very helpful in different indoor and outdoor applications. Therefore, compared to conventional vehicles, omnidirectional robotic vehicles possess multiple advantages in terms of their mobility in narrow spaces and crowded environments. They have the ability to easily perform certain tasks in congested environments foreseen with static obstacles, dynamic obstacles or narrow areas. Usually, such environments are found in factory workshops, warehouses, hospitals, etc. Hence the resulting needs to create this kind of robotic platformsto satisfy the requirements of various fields, such as: industrial, military, naval, medical and last but not least, the educational field.

Furthermore, to prevent the shortcomings presented by Mecanum wheel, researchers have focused on its optimization, developing new constructive solutions, thus allowing their implementation in new applications, such as planetary explorations, mine operations.

II. Mecanum Wheel Characteristics

Mecanum wheel was designed and invented in Sweden, in 1975, by Bengt Ilon, an engineer with the Swedish company Mecanum AB [1]. Mecanum wheel is based on the principle of a central wheel witha number of rollers placed at an angle around the periphery of the wheel. The angle between rollers axis and central wheel axis could have any value, but in the case of conventional Mecanum wheel it is 45° (Figure 1). The rollers are shaped such that the silhouette of the omnidirectional wheel is circular. The angled peripheral rollers translate a portion of the force in the rotational direction of the wheelto a force normal to the wheel direction. Depending on each individual wheel direction and speed, the resulting combination of all these forces produces a total force vector in any desired direction, thus allowing the platform to move freely in direction of the resulting force vector, without changing the direction of the wheel.

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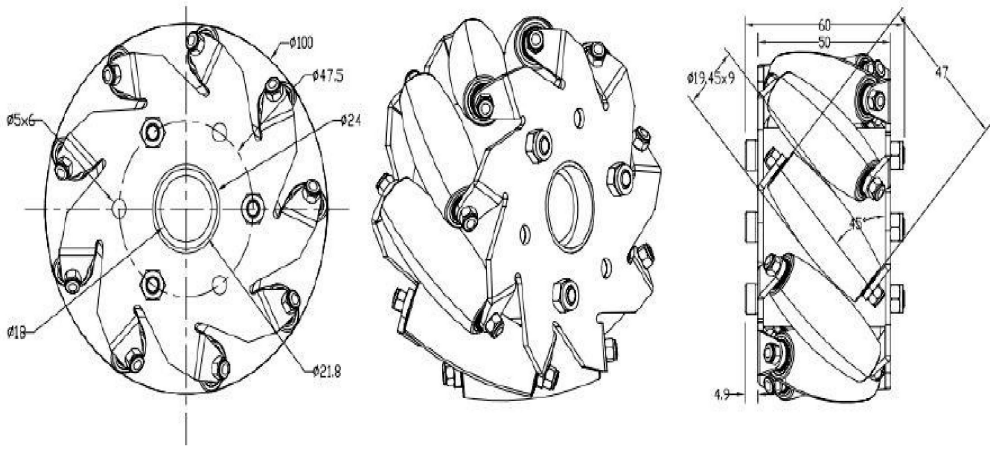

Figure 1

III. Mecanum Wheel Degree of Freedom

A Swedish omnidirectional wheel has 3 DOF's composed of **wheel rotation, roller rotation and rotational slip** about thevertical axis passing through the point of contact (Figure 2).

In the omnidirectional wheel, the wheel velocity can be divided into the components in the active direction and in the passive direction. The active component is directed along the axis of the roller in contact with the ground, while the passiveone is perpendicular to the roller axis [2]. When the wheel rotates, a force vector along the wheel and a force vector perpendicular to the wheel are created. By a simple control ofeach wheel rotation, the vehicle moving direction can be changed instantaneously

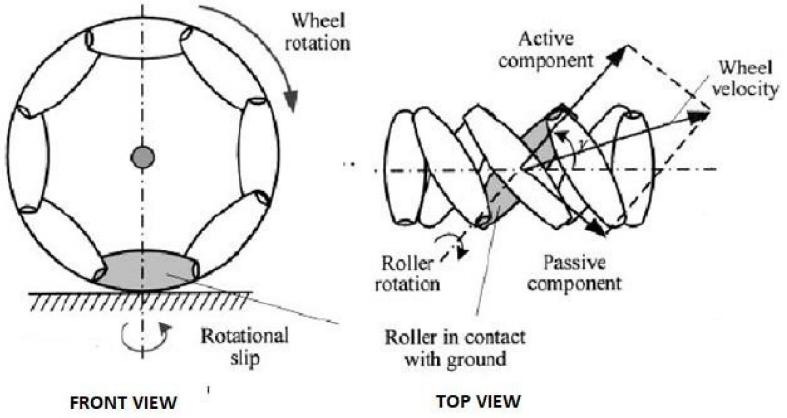

Figure 2

When a Mecanum wheel is rotating, at least one roller (maximum two rollers) is (are) in contact with the ground. Only a small surface (theoretical, one point) of the roller is in contact with the ground. The area of this surface traverses the roller from one side to another, depending on the sense of wheel rotation. The direction of the traction force will be done by the traversing sense of contact surface. It means, if we look to the wheel from the top side, the traction force will be perpendicular to the roller axis.

3.1 Node MCU ESP8266

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit). The term "Node MCU" strictly speaking refers to the firmware rather than the associated development kits. Both the firmware and prototyping board designs are open source. The firmware uses the Lua scripting language. The firmware is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as lua-cjson and SPIFFS. Due to

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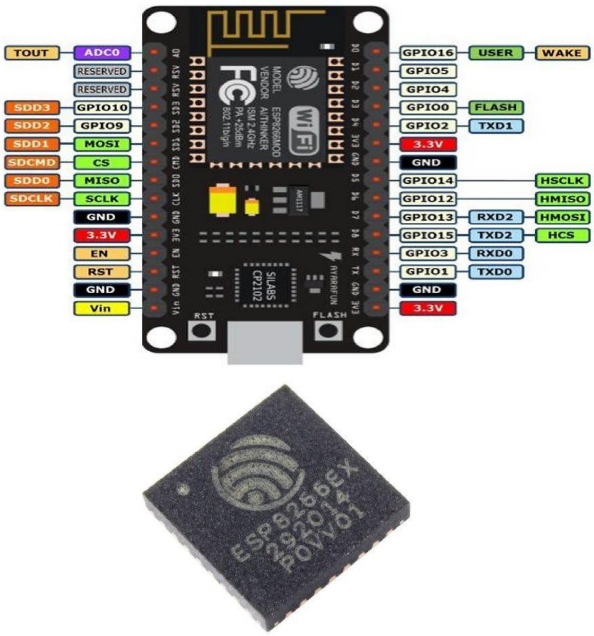
resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially based on the ESP-12 module of the ESP8266, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications (see related projects).



- The NodeMCU (***N***ode ***M***icro***C***ontroller ***U***nit) is an open- source software and hardware development environment builtaround an inexpensive System-on-a-Chip (SoC) called the ESP8266.
- The ESP8266, designed and manufactured by EspressifSystems, contains the crucial elements of a computer:
- CPU, RAM, networking (WiFi), and even a modern operatingsystem and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.
- However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering iton or sending a keystroke to the “computer” on the chip
- . You also have to program it in low-level machine instructions that can be interpreted by the chip hardware.
- This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics.

It is a huge burden for hobbyists, hackers, or students whowant to experiment with it in their own IoT projects.

3.2 Specification of Node MCU

	Official Node MCU	Node MCU Carrier Board	LoLin Node MCU
Microcontroller	ESP-8266 32-bit	ESP-8266 32-bit	ESP-8266 32-bit
NodeMCU Model	Amica	**Amica**	Clone LoLin
NodeMCU Size	49mm x 26mm	49mm x 26mm	58mm x 32mm
Carrier Board Size	n/a	102mm x 51mm	n/a
Pin Spacing	**0.9" (22.86mm)**	**0.9" (22.86mm)**	1.1" (27.94mm)

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Clock Speed	80 MHz	80 MHz	80 MHz
USB to Serial	CP2102	**CP2102**	CH340G
USB Connector	Micro USB	Micro USB	Micro USB
Operating Voltage	3.3V	3.3V	3.3V
Input Voltage	4.5V-10V	4.5V-10V	4.5V-10V
Flash Memory/SRAM	4 MB / 64 KB	4 MB / 64 KB	4 MB / 64 KB

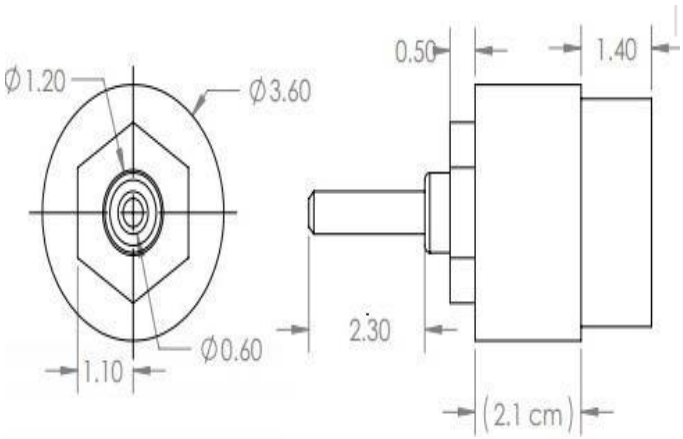
3.3 Gearmotor

- These motors are simple DC Motors featuring gears for the shaft for obtaining the optimal performance characteristics. They are known as Center Shaft DC Geared Motors because their shaft extends through the center of their gearbox assembly.
- These standard size DC Motors are very easy to use. Also, you don't have to spend a lot of money to control motors with an Arduino or compatible board. The L298N H-bridge module with an onboard voltage regulator motor driver can be used with this motor that has a voltage of between 5 and 35V DC.
- This DC Motor – 300 RPM – 12 Volts can be used in all- terrain robots and a variety of robotic applications. These motors have a 3 mm threaded drill hole in the middle of the shaft thus making it simple to connect it to the wheels or any other mechanical assembly.
- Nut and threads on the shaft to easily connect and internally threaded shaft for easily connecting it to the wheels.
- These DC Geared motors with robust metal/Plastic gearbox for heavy-duty applications, available in the wide RPM range(Check the list below) and ideally suited for robotics and industrial applications.

3.4 Specification

- RPM: 100 at 12V
- Voltage: 4V to 12V
- Stall torque: 32Kg-cm at stall current of 4.1A@12V
- Shaft diameter: 8mm
- Shaft length: 17.5mm
- Gear assembly: Spur
- Brush type: Carbon
- Motor weight: 350gms
- Dimension: Refer to diagram below

3.5 Motor Dimension



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3.6 Chassis

This Aluminium 4WD Chassis is a simple yet versatile robot chassis designed specifically for students to make various robotics purpose. Featuring a heavy-duty chassis designed with large internal volume, numerous holes, and mounting points, providing plenty of space to carry a PCB board and any additional components that you choose.

A. Features

- Designed for 4 Motors, 4 Wheels, 4 wheels Robotics purpose / Platform DIY Kit
- DC Motor can be directly mounted
- The metal body has holes for mounting motors and wheels
- High-quality metal robot chassis for making DIY robots
- Chassis material: Aluminium
- Wheels: 4
- Suitable motor: DC geared motor
- Color: Black
- Dimension: 19cm x 10.5cm x 4cm

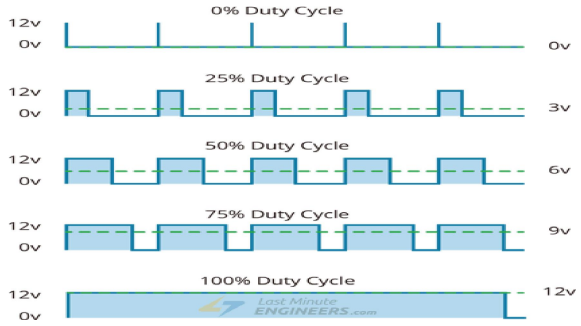
3.7 L298n driver Controlling a Gear Motor

In order to have a complete control over DC motor, we have to control its speed and rotation direction. This can be achieved by combining these two techniques.

- PWM – For controlling speed
- H-Bridge – For controlling rotation direction

PWM – For controlling speed

- The speed of a DC motor can be controlled by varying its input voltage. A common technique for doing this is to use PWM (Pulse Width Modulation)
- PWM is a technique where average value of the input voltage is adjusted by sending a series of ON-OFF pulses.
- The average voltage is proportional to the width of the pulses known as Duty Cycle.
- The higher the duty cycle, the greater the average voltage being applied to the dc motor (High Speed) and the lower the duty cycle, the less the average voltage being applied to the dc motor (Low Speed).
- Below image illustrates PWM technique with various duty cycles and average voltages.



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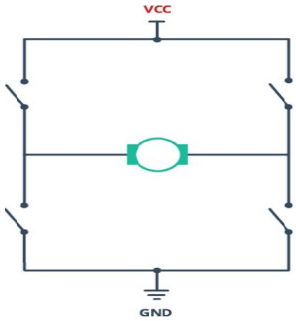
H-Bridge – For Controlling Rotation Direction

- The DC motor's spinning direction can be controlled by changing polarity of its input voltage. A common technique for doing this is to use an H-Bridge.
- An H-Bridge circuit contains four switches with the motor at the center forming an H-like arrangement.
- Closing two particular switches at the same time reverses the polarity of the voltage applied to the motor. This causes change in spinning direction of the motor..

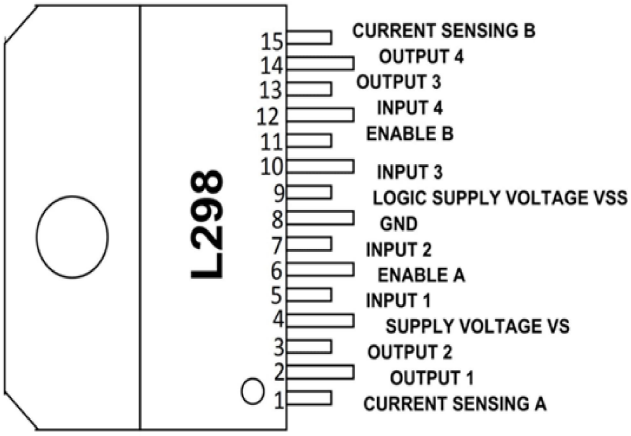
L298N Motor Driver IC

- At the heart of the module is the big, black chip with chunky heat sink is an L298N.
- The L298N is a dual-channel H-Bridge motor driver capable of driving a pair of DC motors. That means it can individually drive up to two motors making it ideal for building two-wheel robot PLA



L298N Module Features & Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heat sink for better performance
- Power-On LED indicato



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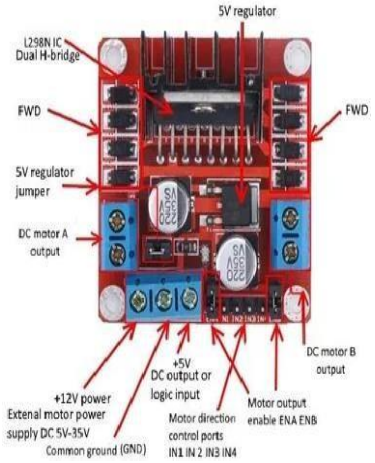
L298N Module Pin Out Configuration

Pin Name	Description
IN1 & IN2	Motor A input pins. Used to control the spinningdirection of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinningdirection of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 &OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitryinside L298N IC
GND	Ground pin



3.8 Battery

A rechargeable battery is an energy storage device that can be charged againafter being discharged by applying DC current to its terminals.

Rechargeable batteries allow for multiple usages from a cell, reducing wasteand generally providing a better long-term investment in terms of dollars spent for usable device time. This is true even factoring in the higher purchase price of rechargeables and the requirement for a charger. A rechargeable battery is generally a more sensible and sustainable replacement to one-time use batteries, which generate current through achemical reaction in which a reactive anode is consumed.

The anode in a rechargeable battery gets consumed as well but at a slower rate, allowing for many charges and discharges. In use, rechargeable batteries are the same as conventional ones. However, after discharge the batteries are placed in a charger or, in the case of built-inbatteries, an AC/DC adapter is connected.

While rechargeable batteries offer better long term cost and reduce waste, they do have a few cons. Many types of rechargeable cells created for consumer devices, including AA and AAA, C and D batteries, produce a lower voltage of 1.2v in contrast to the 1.5v of alkaline batteries. Though thislower voltage doesn't prevent correct operation in properly-designed electronics, it can mean a single charge does not last as long or offer the samepower in a session. This is not the case, however, with lithium polymer and lithium ion batteries. Some types of batteries such as nickel cadmium and nickel-metal hydride can develop a battery memory effect when only partially discharged, reducing performance of subsequent charges and thus battery life in a given device.

Rechargeable batteries are used in many applications such as cars, all mannerof consumer electronics and even off-grid and supplemental facility power storage.

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IV. SOFTWARE DETAIL

4.1 Arduino IDE

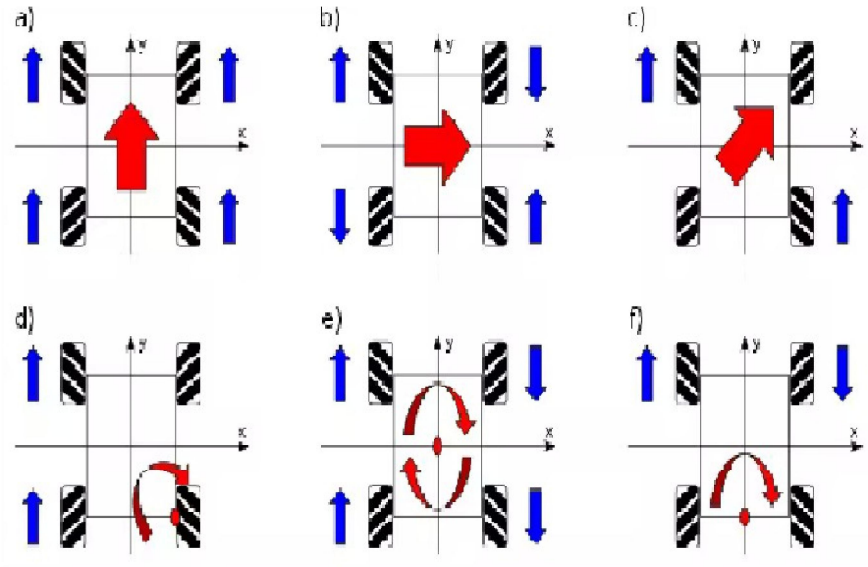
The Arduino integrated development environment (IDE) is a cross-stage application (for Windows, macOS, Linux) which is written in the well-known programming language Java. It is utilized to compose and transfer programs to Arduino compatible boards, yet besides, with the assistance of outsider centers, other merchant advancement boards. Arduino IDE is a lightweight, cross-stage application that acquaints programming with beginners. It has both an online editor and an on-premise application, for users to have the option of whether they want to save their sketches on the cloud or locally on their computers.

While Arduino IDE is profoundly evaluated by users as indicated by usability, it is additionally fit for performing complex processes without burdening computing resources. With Arduino IDE, users can without much stretch access contributed libraries and get modern help for the most recent Arduino boards, so they can make portrays that are sponsored by the freshest form of the IDE

4.2 Android Studio

Android Studio is the official integrated development environment (IDE) for Android application development. Every project in Android Studio has one or more modalities with source code and resource files. These modalities include Android app modules, Library modules, and Google App Engine modules. With help of it we create an app that can control the robot which is act as anremote and modify the speed and movement can change into different mode

V. DIRECTION OF WHEELS



5.1 Movements to Any Directions

Blue wheel drive direction ; red vehicle direction

a) Moving straight ahead, b) moving sideways, c) moving diagonal, d) moving around a bend, e) Rotation, f) Rotation on around the central point of one axle. The picture above shown how and where the direction of the carcan move with the combination of rotating wheels.

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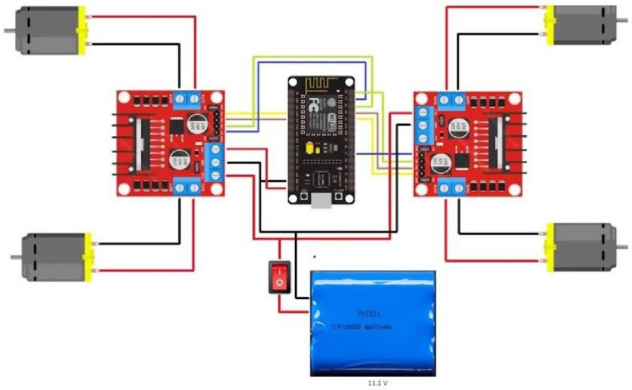
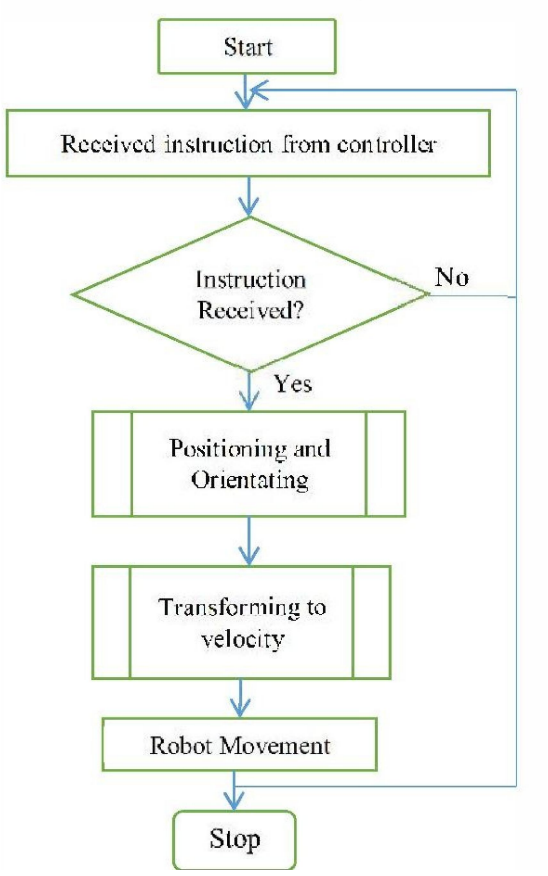
VI. CONTROL SYSTEM

1. First The Vehicle Configuration Should Be Installed In The Node MCU
2. Then The Android App (Mechninja) Was Installed In The SmartPhone.
3. The Mobile Hotspot Should Be Connected To The Node Module.
4. The Node Module Will Run The Program Stored In It.
5. The Node Module Was Connected With The Motor Driver.
6. The Motor Driver Will Give The Required Power To The Motor ToRun.
7. Now Open The Android App In The Phone.
8. The Joy Stick Formatted Controller Will Appear.
9. Then The Instruction Was Given By The App To The Node Module.
10. Based On The Instruction The Mecanum Wheel Robot Moves.





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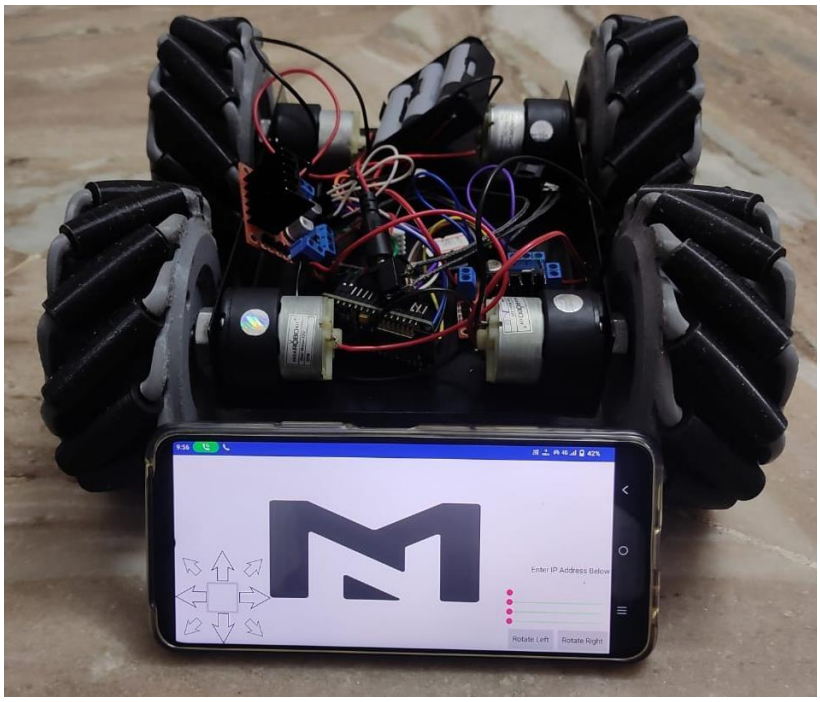
VII. RESULT

The output we have achieved is the mecanum Robot succeeding in the moving of required direction and able to avoid slight mistake in all direction. Unlike other robot which is way more costly than our project so as mentioned by using better quality components we used to reduce the overall robot cost which is less than other robot which can bought in market. The outcome of our project is to make the robot move 360*movable direction.

Which operates through lithium ion batteries which can energize through an ordinary module charger. This robot gives an easier maneuverability and canbe moved to any direction..



VIII. CONCLUSION

In this paper, an overview over the Mecanum wheels and their practical applications is presented. The main advantage of this type of wheel is represented by the omnidirectional property that it provides, allowing extreme maneuverability and mobility in congested environments. Also, some research that was carried out in Mecanum wheel mobile robots in order to improve the wheel design is described. The manoeuvrability provided by omnidirectional vehicles can be utilized and can be very important in both outdoors applications, such as search and rescue missions, military activities, planetary explorations and mine operations, long loads transportation, and indoor applications, like small goods transportation, powered robotic wheelchairs or shopping carts.

8.1 Features

- The robot carries tone hundred and fifty Kg
- The robot is equipped with ultrasonic sensor to keep safety distance between anything and robot.
- The robot has line follower application.
- The robot is driven by a mobile application.
- This is compact in size.
- In future this can be developed in robotic wheelchair, transfer vehicle etc.

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