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Mecanum Grounded Vehicle with Robotic Arm

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Abstract: *Last few decades witnessed a rapid development in robotic technology different type of intelligent machines which facilitate various task in industries environment becoming popular this paper focus on design in a compactable auto guided mecanum vehicle robot with robotic arm kinematics and motion of robot designed by referring by to the omni wheel mechanism the frame design, mecanum wheel and the parts are designed by 3D print using PLA material. Mecanum wheel robot carare any other vehicle that has a mecanum wheelis drivable in any direction known as omni directional drive. It has four mecanum wheels and four gear motor locomotion of the robot achieved using four motor .this robot has a4 wheel drive which means you can control each wheel direction and RPM independently so you can move your vehicle in any direction without change of the its face. the mecanum wheel have numerous roller the attached 45 degree to the wheel this gives special features of 360 degree moving direction. In this blog we make a mecanum wheel robot car with node MCU and L298 motor drivers. The other part is a robotic arm for pick and place operations .the robotic arm is attached on the top of the body .the operation of the pick and place operation is controlled by android phone .the robot is automated using wi fi module ,motor drivers ,servo motors and other supporting circuits .the pick and place and motion of the robot is controlled by app in smart phone through wifi control we make specific app for this control process through this we can control this robot in all direction like forward .backward ,sideways ,diagonal without change the face of the robot so it can be very efficient in all fields this robot can be fully automatic and partially manually controlled .this paper taken into the account of the safety ,reliability and the ease of use .A locomotion algorithm is developed to provide the robot with an autonomous capability for work.*

Keywords: Mecanum

I. INTRODUCTION

Robotics is a branch of engineering and science that includes electronics engineering, mechanical engineering and computer science and so on. This branch deals with the design, construction use to control robots, sensory feedback and information processing. These are some technologies which will replace humans and human activities in coming years. These robots are designed to be used for any purpose but these are using in sensitive environments like bomb detection, deactivation of various bombs etc. Robots can take any form but many of them have given the human appearance. The robots which have taken the form of human appearance may likely to have the walk like humans, speech, cognition and most importantly all the things a human can do. Most of the robots of today are inspired by nature and are known as bio-inspired robots.

Robotics is that branch of engineering that deals with conception, design, operation, and manufacturing of robots. There was an author named Issac Asimov, he said that he was the first person to give robotics name in a short story composed in 1940's. In that story, Issac suggested three principles about how to guide these types of robotic machines. Later on, these three principle were given the name of Is sac's three laws of Robotics. These three laws state that:

• Robots will never harm human beings.
• Robots will follow instructions given by humans with breaking law one.
• Robots will protect themselves without breaking other rules.

Omni directional 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

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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 platforms to 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 operation

Using robots over human labor to perform accurate and precise work is becoming more preferable, due to its better performance and minimal risks. An articulated robotic arm consists of links that connect a certain number of rotary joints in series to an end effector. The number of joints represents the number of Degrees of Freedom (DOF) of the robotic arm. The joints are usually actuated using servomotors, which provide the necessary torque to rotate the attached links. Microcontrollers are used to send the electrical signals required for controlling the angular motion of the servomotor shafts. In order to construct a robotic arm capable of performing the intended tasks accurately and efficiently, proper design and simulation are deemed necessary.

The forward and inverse kinematics of the three DOF robotic arm was established. The former describes the position and orientation of the end effector for given rotation angles. The latter, the inverse kinematics, determines the joint angles required to reach the desired position and orientation of the end effector. Furthermore, the static torques, the most appropriate link cross sections, and the workspace were determined. The robotic arm consists of three joints; the waist joint represented by rotation of the rotary table, the shoulder joint represented by the rotation of Link (1) and the elbow joint represented by Link (2)'s rotation. Each joint employs a specific servomotor to provide the torque required for the motion. Each motor receives the shaft position controlling signal from a Matlab code, through an Arduino microcontroller. The Cartesian position of the object to be picked up, which is identified by its color, is detected by using a mobile camera and an available Matlab plug-in. The inverse kinematics equations are then used to find the required joint angles corresponding to the aforementioned coordinates

II. METHODOLOGY

Mecanum Wheel

Mecanum wheel was designed and invented in Sweden, in 1975, by Bengt Ilon, an engineer with the Swedish company Mecanum AB . Mecanum wheel is based on the principle of a central wheel with a 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 is45°.

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 wheel to a force normal to the wheel direction.

Depending on each individual wheel direction and speed, there sulting combination of all these forces produces a total force vector in any desired direction, thus allowing the plat form to move free lying direction of the sulting force vector, without changing the direction of the wheel.

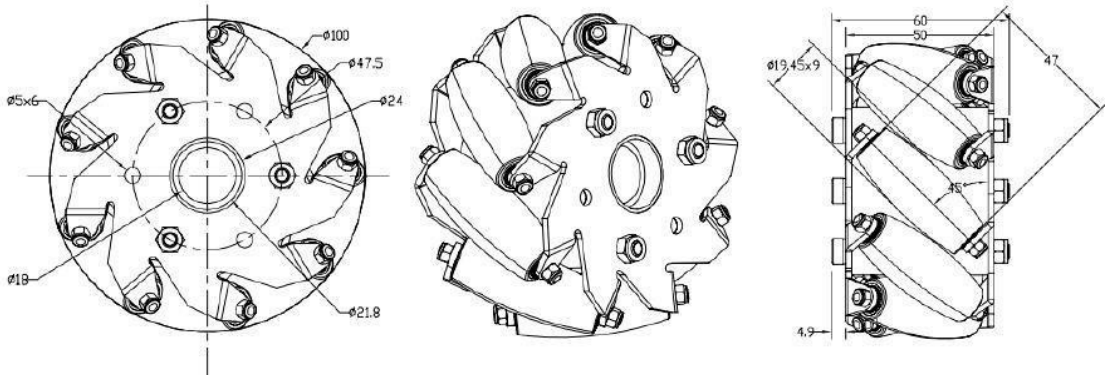

Figure: Mecanum Whee

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Mecanum Wheel Degree of Freedom

A Swedish omnidirectional wheel has 3 DOF's composed of wheel rotation, roller rotation and rotational slip about the vertical axis passing through the point of contact (Figure2).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 passive one is perpendicular to the roller axis. When the wheel rotates, a force vector along the wheel and a force vector perpendicular to the wheel are created. By a simple control of each wheel rotation, the vehicle moving direction can be changed instantaneously

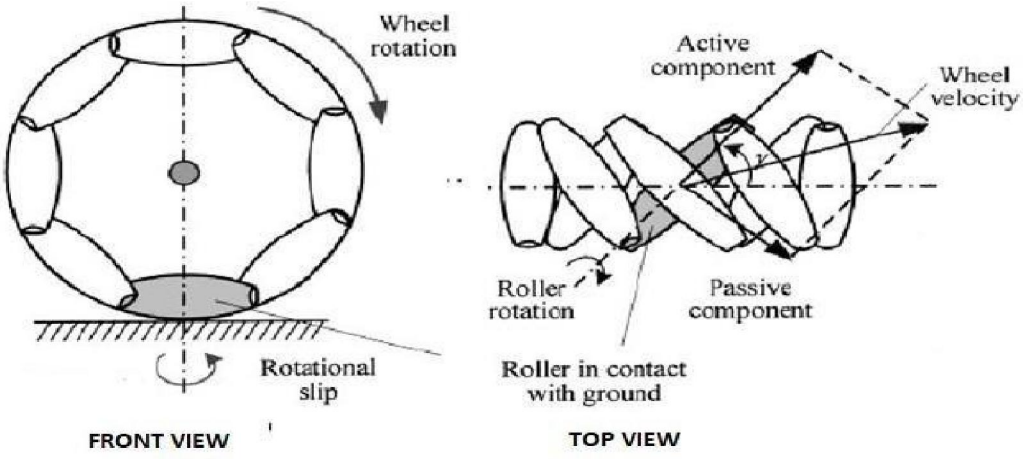

Figure: Wheels Degree Of Freedom

When a Mecanum wheel is rotating, at least one roller (maximum two rollers) is (are) in contact WITH the ground. only.a.small.surface(theor.etical,onepoint)oftherollerisincontactwiththeground.The area of this surface traverses the roller from one side another,dependingonthesenseofwheelrotation.Thedirectionofthetraction 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.

Robotic Arm

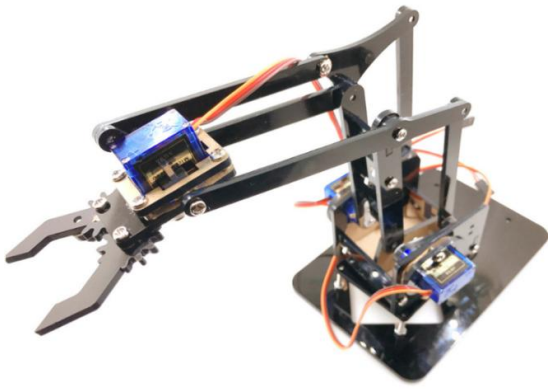

Figure: Robotic Arm

Robot claws are one of the simplest types of gripper. They are popular among hobbyists, who are attracted to the simple design and functionality of these gripper types. Typically, robot claws (sometimes known as 'robot claw grabbers') consist of two claws (also known as 'jaws') that come together on opposite sides of an object in order to grasp it. In this article we will use the term "claw" in its widest sense; i.e.

Referring to any type of gripper that incorporates fingers or jaws that grasp items by closing around the outside of an object. These fingers can be hard or soft, with soft grippers finding many uses in food production and in handling delicate objects. Robots support a variety of end-effectors, including claw-style grippers.

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Robotics have found numerous uses for robot claws based on this simple design. Robot claws are popular end effectors in manufacturing environments, where, for example, they can be used to perform applications for robots arms such as assembly, pick & place and packaging & palletizing. Robot claws can also be seen in space;

The number of joints represents the number of Degrees of Freedom (DOF) of the robotic arm. The joints are usually actuated using servomotors, which provide the necessary torque to rotate the attached links. Microcontrollers are used to send the electrical signals required for controlling the angular motion of the servomotor shafts An example of the use of a robotic arm similar to the one considered in this paper is to color sort objects such as test tubes in medical biology laboratories. The forward and inverse kinematics of the three DOF robotic arm was established. The former describes the position and orientation of the end effector for given rotation angles. The latter, the inverse kinematics, determines the joint angles required to reach the desired position and orientation of the end effector. Furthermore, the static torques, the most appropriate link cross sections, and the workspace were determined. The robotic arm consists of three joints; the waist joint represented by rotation of the rotary table, the shoulder joint represented by the rotation of Link (1) and the elbow joint represented by Link (2)'s rotation. Each joint employs a specific servomotor to provide the torque required for the motion

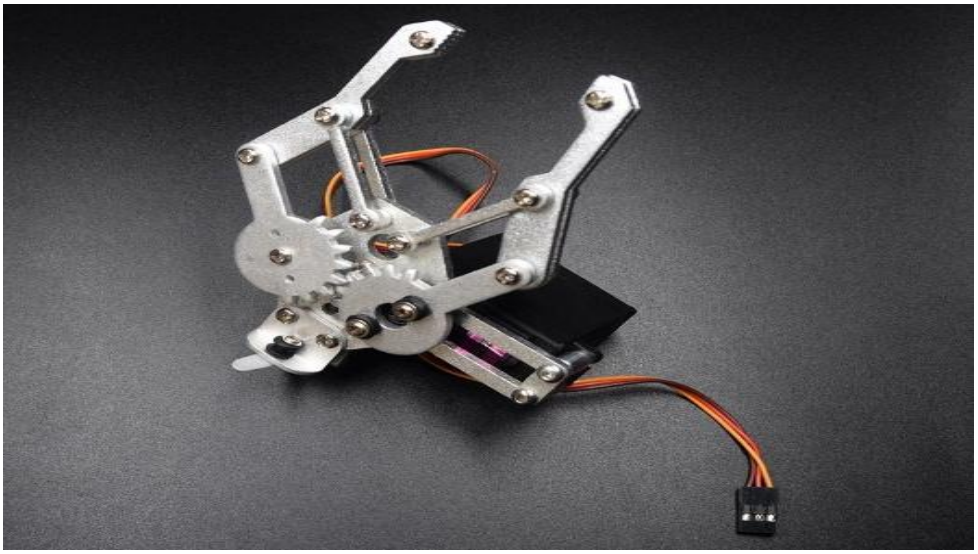

Figure: Robotic Claw

Assembly

1. First, you need to assemble the Mecanum wheels, you can check the previous blog on printing and assembling mecanum wheels for a guide.
2. After that use a nose plier or any other tool to lose the nut of the motor mount and slide the motor in a slot of chassis for the motor now tight the nut.
3. Do the same procedure for others motors.
4. When you are done using the M3 screw and nut connect both Left and Right parts of the chassis.
5. After that, your chassis build is finished but you need to do one more thing to give it a rigid structure.
6. Add two supporting bars on the top of the chassis.
7. After we assembled the mecunam vehicle we planned our next objective is to assemble and implant the robotic arm in the top of the RC vehicle.
8. The robotic arm consists of a gripper which uses an MG90s servo motor for contraction and retraction and MG995 heavy gear servo motor for up, down, forward and backward motion

Connecting All Electronics Parts:

For connecting the electronic follow these steps:

• First connect the female DC jack positive pin to Switch then connect other pin of switch to both driver +12v Input pin.

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• Now Connect both ground of motor driver to node mcu ground and DC jack ground to and motor driver ground.
• Connect any one of motor driver 5v output to node mcu VIN Pin.
• Place a jumper to turn on Motor driver 5v regulator.
• . Now connect Left back motor to Left Motor driver pin OUT 1 and OUT 2.
• Left Front motor to Left motor driver pin OUT 3 and OUT 4.
• Right Front motor to Right motor driver pin OUT 1 and OUT 2
• After connecting the motors to the respective signal and power connections, check the working and correct the errors after uploading the code to the node mcu board.
• Now for the connection for the robotic arm , the MG90s servo motor ,MG995 gear servo for (up ,down) and MG995 gear servo (forward and backward) are connected to the D5,D6 and D8 pins in the NodeMCU respectively

III. SOFTWARE DETAIL

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 program to Arduino compatible board, yet besides,
With the assistance of outsider centers, other merchant advancement boards .Arduino
IDE is a lightweight, cross-stage application beginners.
It has both an online editor and an on-premise application, for users to have the option of whether they want to save the ir 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 them obstruent Arduino boards, so they can make portrays that are sponsored by the freshest form of the IDE.

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 a remote and modify the speed and movement can change into different mod

IV. IMPLEMENTATION

Control System

1. First The Vehicle Configuration Should Be Installed In The Node Mcu.
2. Then The Android App (Mechninja) Was Installed In The Smart Phone.
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 To Run
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 and the robotic arm is controlled with the signal.

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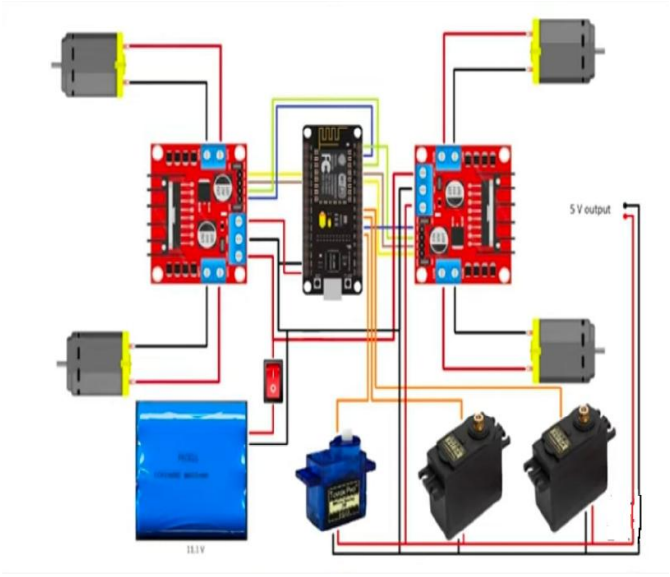

Figure: Control Circuit

Direction of Wheels

Drive system

The drive subsystem uses four DC motors, each geared down using epicyclic gearing and equipped with an IRC encoder for rotational speed measurement. A complete block scheme of the drive subsystem is shown in \. Similar control structures are discussed in. The output torque of the gearbox is 10 Nm. Each motor is controlled by a dedicated microcontroller unit, where a proportional-sum-derivative (PSD) control algorithm is applied for speed control and a PS regulator for absolute position control. These controllers enable control of the motors with great precision and a smooth movement of every wheel without jerking when accelerating or slowing down. The robot's maximum speed is 0.5 m/s.

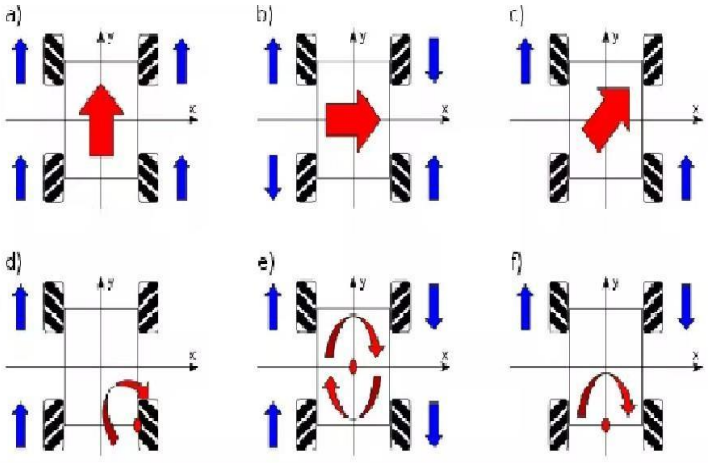

Figure: Wheel Direction

Wheel directions

Blue wheel drive direction vehicle direction

A) Moving straight ahead

B) Moving side ways

C) Moving diagonal

D) Moving around a bend

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E) Rotation
F) Rotation on around the central point of one axle
The picture above shown how and w here the direction of the car can move with the combination of rotating heels

V. RESULT

The project has been assembled successfully and the trials have been made successfully. The project could successfully rotate 360 degree and moving all direction without any interference we made a custom android application through which can we control the mecanum wheel robot in any direction also using the slider in the app we can control the speed of movement. We added one cooler feature in the app through which we can program the robot to move automatically
We also added one robotic arm.it has three degree of freedom.it used for pick and place operation.it also controlled by wifi control through android mobile app.it efficiently worked .it correctly pick and place the object. it has been operated by three servo motors .it can lift up to 500 gms.so it can be used in home applications

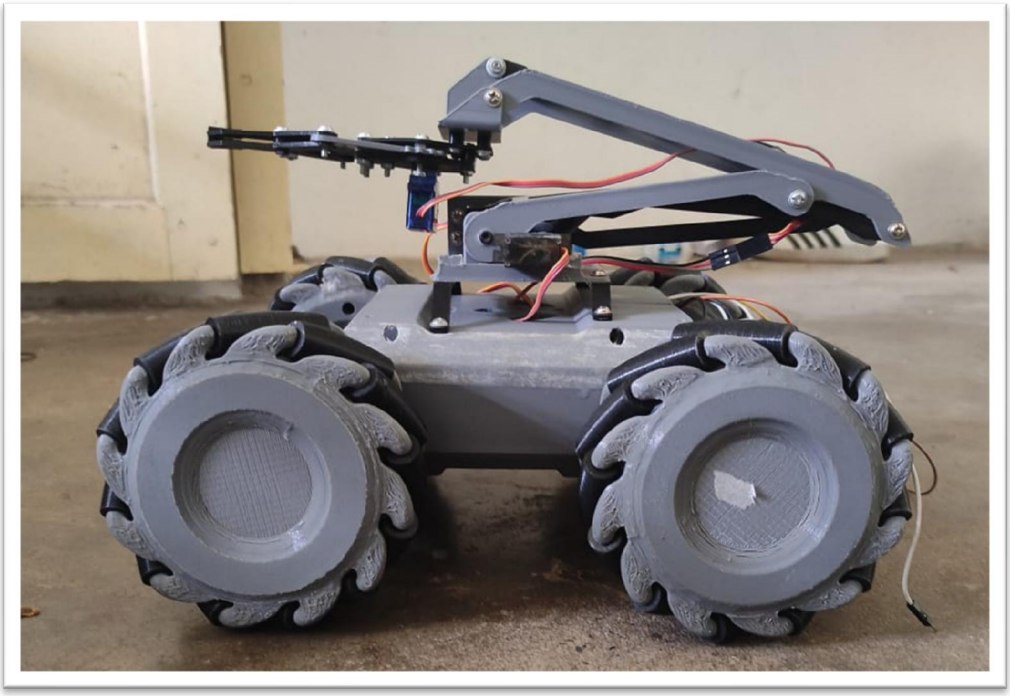

Figure: Output

VI. CONCLUSION

In this paper, an overview over the Mecanum grounded vehicle with an robotic arm and the practical applications is presented .The main advantage of this type of wheel is represented by the omni directional property that it provides, allowing extreme maneuverability and mobility in congested environments .In order to improve the wheel design is described. The maneuverability provided by omni directional vehicles can be utilized and can be very important both out door applications, such as search and rescue missions, military activities, planetary explorations and mine operations, long loads transportation, and indoor applications, like small good s transportation, powered robotic wheel chairs or shopping carts. The robotic arm purpose is solely focused on the storing capability that is for lifting heavy loads and placing it in the storage section in the industrial work environment. When coupled with omni directional mobility the storing capability and efficiency in industrial section may increase drastically. The main advantage in using this type of vehicle is the it requires a very small area for its turning of a full 360

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VII. FUTURE SCOPE

• As far as the future scope of the project is concerned, we could replace the camera with an IR camera and an IR torch for enabling night vision
• We also added some special material for the wheel strength
• Due to its all direction movement it can be used in future automobile industries and also replace the normal tires
• We could also add some important sensor for better usage sensors like motion, thermal, ultrasonic etc.
• It can be used in future in space mission because it can work all direction and the robotic arm also help to pick and save the object
• It also can be efficiently used in manufacturing industries and companies for loading and unloading process
• We could also add some medical program so it can be efficiently used in medical field .it can replace the self-care workers
• We make small model so it can be efficiently used in home applications

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