Vehicle-applicable robots controlled byMobile

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Abstract—In this paper Omnidirectional robot is discussed with both autonomous capacities and the ability to receive instruction from mobile control. This paper presents an inventive concept of an omnidirectional robot designed with 4 custom-made mecanum wheels and can be controlled by using a mobile phone. The mecanum wheel that was created has nine rollers. Four units of BO motors are used to separately power each mecanum wheel.

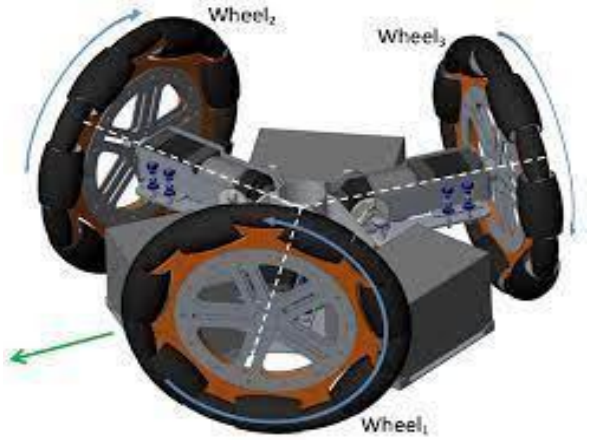
Keywords—Omnidirectional, Robot, Mecanum Wheel

1. Introduction:

Lately, a vast number of innumerable mobile robots have to gain access to human life in a variety of indoor&outdoor situations like technical and industrial utilization of mobile-controlled robots are constantly climbing in importance. They are frequently employed for transportation and surveillance activities. [1]Distinct mobile robots were designed on the basis of their uses, locomotion, and maneuverability mechanisms. Depending on the uses, several processes and locomotion mechanisms may be activated to provide navigation, which is a crucial component of mobile robotics. One of the most important needs for a mobile robot is the capacity to navigate across operational space by preventing complications and discovering its way to further locations.OMR("Omnidirectional Mobile Robot") evolved and is manufactured in different forms. Intractable wheels and omnidirectional wheels are two common wheel types that are capable of perceiving omnidirectional movement. Both of these were applied to fully developed products. The steerable wheel includes a rotating mechanism that could actively vary its steering angle while the omnidirectional wheel and the Mecanum wheel both employ unique wheel structures to allow for flexible mobility. [2]Generally, a WMR ("Wheeled Mobile Robot") was unable to achieve holonomic drive, which combines simultaneous rotational and translation motions. OMR could conduct holonomic motion, i.e., it could function in any direction without necessitating a change in the robot's heading direction. OMR can navigate in small and complicated spaces because of its potential. Mecanum wheels are more suitable for moving big items in an industrial setting because oftheir flawless pushing power, simple mechanism, and effortless control capabilities. However, Mecanum wheels also have a number of drawbacks. The unique wheel construction enables the lateral movement DOF ("Degree of Freedom"), however, the rollers' rotation around the Mecanum wheel would affect the mobile robot's slippage. This slippage is tough to be Sensors model and computed. The gap between the 2 adjacent rollers causes the moving platform to periodically vibrate, which plainly impacts movement stability and precision. Many attempts have been made to integrate exteroceptive sensors and use data fusion algorithms to get precise localization findings to address the accumulating motion defects and evaluate the positions of mobile robots. To set the particular motion for the robot MateuszFiede and Jacek Bałchanowski [9] designed an algorithm the robot will independently follow the motion for every track. The ability of mobile robotic systems to navigate autonomously is being improved via ongoing research in this area. Omnidirectional robots generally have two types of mechanical configurations: three and four wheels in which four-wheel robots have more acceleration as compared to three-wheeled robots. Four-wheeled robots are anticipated to have more traction considering that each wheel makes equal contact with the ground. This article introduces the most engrossing methods that have an influence on the direction of investigates to anticipate the readers with an effective quality of understanding of omnidirectional wheel variations and swings of investigations that mayassiststudies to effectively comprehend the subject and compare their selection of wheels and their direction of research towards constructing uses depending on OMR. There are also some problems faced by Yanfei Leu, and Josh Apple[8]that owing to less speed because of bulky weight.

2. Vehicle applicable robots:

For our project, we chose to employ four wheeled mecanum wheel rather than the Omni wheel as the mecanum wheel. Fig. 1 shows 3 wheeled omnidirectional robots while Figure2 shows four- wheeled Omnidirectional robots[3].



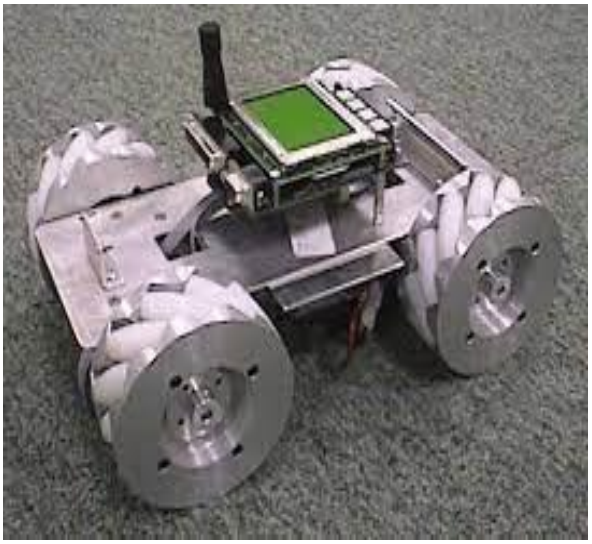


Fig.1)three-wheeled robot

Fig. 2) four-wheeled robot

Robotic vehicles are designed to operate on the road, on the warehouse floor, and so on. In 2D space, a body has 3 DOF. These are:

1) Wheel rotation (1st DOF)

2) Roller rotation (2nd DOF)

3) Rotational slip via the point of contact (3rd DOF) on a vertical axis

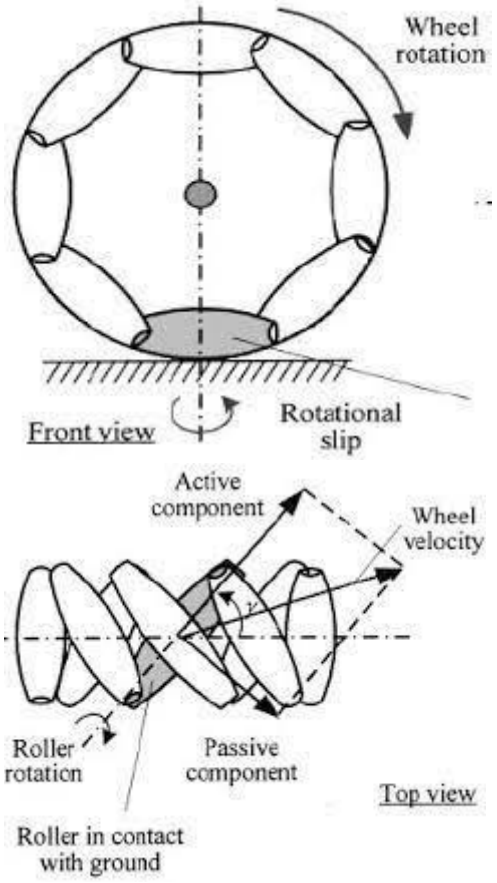


Fig 3) Degrees of Freedom

It has the potential to spin around its center of gravity and translate in both directions. However, most traditional robots do capable to control each DOF separately. Omnidirectional vehicles have the ability to turn immediately, crab sideways, and follow complex trajectories. The following benefits of mecanum wheels are low pushing power, low speed, ease of control, as well ashigh load capacity while moving diagonally. In demerits, we may mention complex design, discontinuous contact, and highly sensitive to an irregular surface. Wheeled mecanum mobile robots are sometimes fitted with suspension systems. When making a robot with four mecanum wheels, it is necessary to make sure that the center of gravity of the robot coincides with the center of rotation of the robot.

There is numerous research has been carried out in this field. Each research has different objectives but the main objective for all of them is to make a robot that will work in leaner and more complex spaces without getting any disturbance from surrounding objects. This purpose will assist most of the vast industries who has compact space in their warehouses and this will result in avoiding obstacles.

3. Methodology:

This section initiates with the mechanism of the mecanum wheel for the robot, which is then followed by designing of the mecanum wheel. After that, the components for manufacturing of robot are defined in detail. Lastly, the result of the performance of the robot is mentioned.

3.1 Omni-directional wheel mechanisms :

Numerous distinct systems in disparate areas of mobile robotics were developed to achieve omnidirectional motion. This form of motion has been used in many other domains and venues, for instance, ground robotics including a wheeled, legged humanoid,train-based, and animal-like, air-flying robots such as helicopters and drones. Minor rollers on the periphery of an Omni wheel rotate fully perpendicular to the wheel itself. With this kind of wheel, they need to be climbed up perpendicular to the robot's center. The Mecanum is a well-known kind of Omni-wheel, which is different in that the little rollers are at a 45^{o} angle. This gives them the ability to be installed such as regular wheels while also providing Omni-wheel- like motion. The platform may be moved in any direction without altering the direction of the wheel while in use since a complete force vector in any desired direction is generated[6]. The process behind this arrangement is more complicated. Discovering the wheels around the robot's periphery is a well-known configuration. Due to its placement, the wheels of the robot may now be used to rotate its frame. Each wheel may be driven by a DC/BO motor.

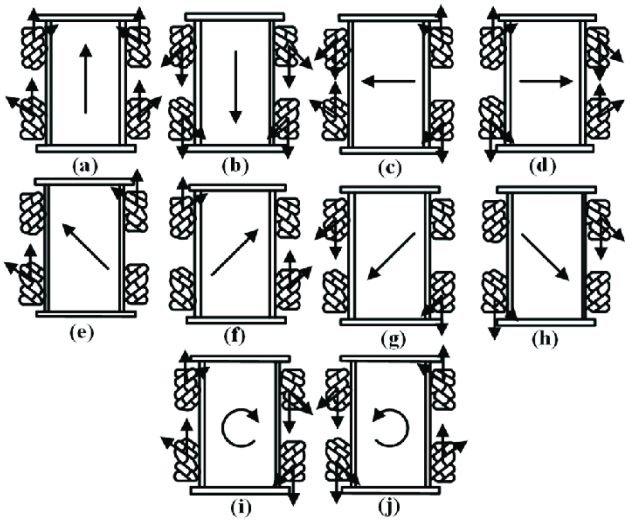


Fig. 4) Mechanism of omnidirectional robot

The wheels constantly generate a forward or backward force and an outward or inward force, created from angled periphery rollers, based on the direction of the motors. The platform may be manipulated to move in any direction based on the combination of these forces. A number of additional movements are possible by changing the wheels' speed and direction. The typical Mecanum wheel has an inappropriate side effect that significantly reduces its effectiveness even if it is improbably flexible. Its broad variety of mobility is caused by the "peripheral rollers" ability to convert a part of the motor force into a force perpendicular to or at an angle from the motor's force. This indicates that a significant amount of the force applied in one direction is wasted as a consequence of the rollers' translation of that force into a resultant force. An extreme illustration of this inefficiency is when the platform moves diagonally, only the front, as well as rear opposing wheels, are spinning while the rollers on the other 2 wheels create direct drag that the motors must overcome.

3.2 Conventional Wheel Design :

Caster wheels and steering wheels are the two categories of traditional wheel designs utilized for mobile-controlled robots with properties of omnidirectional. Compared to particular wheel designs, they are able to handle enormous loads and have a better tolerance for uneven ground. However, owing to their non-holonomic character, they are not Omnidirectional wheels when a move with a curve of non-continuous is encountered. For the majority of applications, it is expected that this process time constant is substantially quicker than gross vehicle dynamics[4]. As a result, it is assumed that it is capable of zero-radius trajectories and upholds the term "Omnidirectional". Most platforms use standard wheels and omnidirectional mobility must have at least 2 independently propelled and steered wheels. Active castor wheels same as the one shown in Fig. 5

Fig. 5) Castor wheel robot

3.3 Mecanum Wheel Design :

This robot is using mecanum wheel to achieve omnidirectional movement. Bengt Ilon, a Swedish inventor, developed the concept in 1973 while working as an engineer for the business "Mecanum AB". In recent years, a different variety of Mecanum wheel designs were created to improve the mobility and usefulness of the robots. The wheeldesign includes a circular frame, circular shaft, cylindrical rollers, roller brackets, nuts, and bolts. The shaft is surrounded by 8 rollers. The shaft, as well as rollers, are the mecanumwheel's primary parts. These rollers are mounted at 45°regarding the axis of the frame as the wheel has only one contact point with the locomotive surface at any particular period, sliding is a general issue avoided with this type of wheel. [5]As a result, for rotation of the wheel, the "longitudinal travel" distance differs from the "transversal travel" distance. The locomotion surface affects the ratio of longitudinal to transverse travel distance.

All the components are designed in Solidworks. The design of the outer diameter of circular 60 mm. The diameter of the two inner circles is 24 mm and 18 mm respectively. These two inner circles are used to hold circular shafts. This is a sheet metal drawing. By using a sketch bend at 45 degrees, it can create a slot to fit the rollers. For cylindrical rollers, the inner diameter is 3mmandthe outer diameter is 12mm. For a circular shaft, the outer diameter is 32 mm and the innermost diameter is 15 mm also there is a slot for the bolt at 45 degrees from the center point. In the case of roller brackets, the inner diameter is 3mmandthe outer diameter is 7.5mm. For the design of the bolt, the length is considered 37 mm and the radius is 2.85 mm. Fig. 1 indicates the mecanum wheel design and Fig. 2 shows a 3D-printed mecanum wheel.

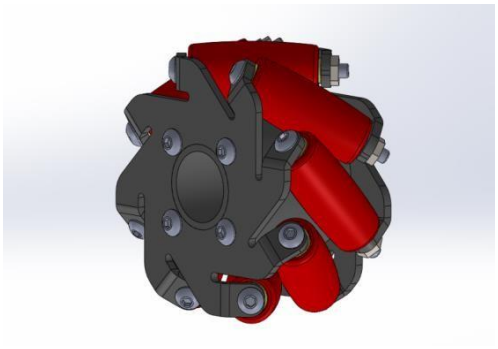


Fig.6) Mecanum wheel design

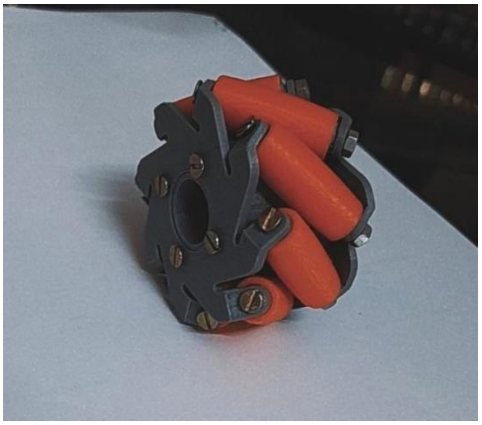


Fig. 7) 3D printed mecanum wheel

4. The Development of Omni-directional Robot :

The Omni-directional robot exhibited in the presentarticle has a simple shaped design. The robot is driven by four BO motors with gearing. The capacity of each BO motor is 60 rpm. The main components are a servo shield/L293D motor driver for Arduino, one advanced metal chassis, and Arduino Uno. The shaft of the motor is directly linked to the circular shaft of the Mecanum wheel. Greater performance on uneven surfaces is made possible by this design, which enables the rollers to remain in constant contact with the locomotive surface.

L293D Motor Driver Shield: One of the easiest methods for controlling a servo motor, DC motor, and other motors on a single board is the L293D motor driver shield. It could regulate the direction and speed of rotation L293D Driver's Motor Shield for four BO motors[7]. The use of an Arduino UNO is convenient. An H-bridge motor driver with two channels is called the L293D. It is intended to provide peak output currents of 1.2A per channel and bidirectional driving currents of up to 600mA at voltages ranging from 4.5V to 36V.

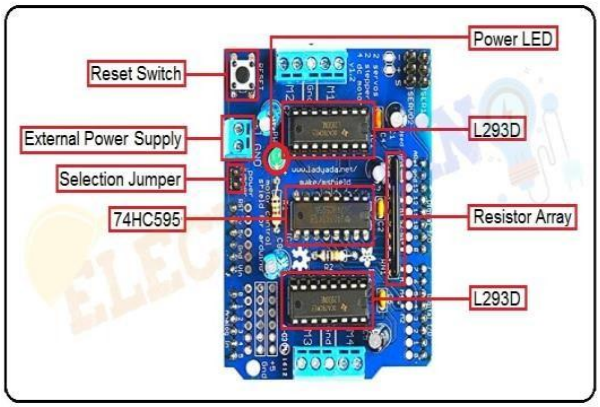


Fig. 8) L293D Motor Driver Shield

HC-05 Bluetooth Module: The device is intended to replace cable connections HC-05 communicates serially with its electronics. Typically, a wireless short-range connection is used to exchange data between small devices such as mobile phones. It operates in the 2.45GHz range. Data transport rates might vary by up to 1Mbps over a range of ten meters. The HC-05 module may function with a power source between 4 to 6 volts. It may be controlled primarily in master-slave mode, which prevents it from sending or receiving data from outside sources. There are 2 operating modes:

1) Command mode: Contacting with Bluetooth module via AT commands for configuring several settings and module parameters.

2) Data mode: Utilize to communicate with another Bluetooth device.

Fig. 9) HC-05 Bluetooth module

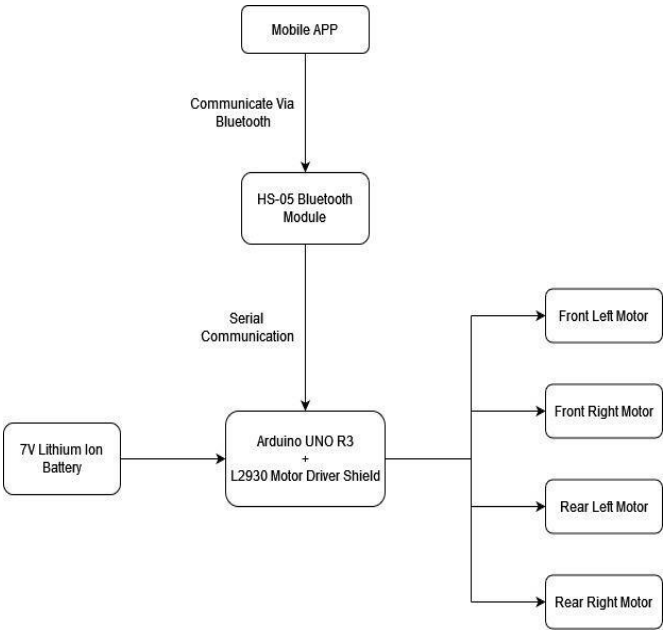


Fig. 10) Flow chart of the control system

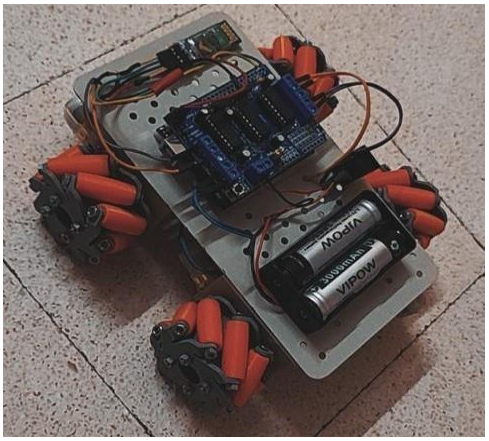


Fig. 11) Mobile-controlled Robot with Mecanum Wheels

5. Results and Discussion:

In the end, the robot was working smoothly on the surface, though it had some problems. The biggest problem was the movement on the surface. As the wheels are 3D printed it was not working properly on rough surfaces. Besides this problem, the robot was working quite well. Another thing is that as we have used Bluetooth for connection with mobile it had covered only a certain area. If sensors are added to this, it will be good for surveillance. Wheels are a well-known system that has served as a foundation for several investigations on locomotion methods. Omnidirectional wheels as dominating wheel forms offer "multidirectional" drive and enable the capacity to drive in complicated, constrained situations where the robot may move in any direction. Mecanum wheels provide a variety of benefits that make them an attractive option for the building of omnidirectional platforms. The power of this wheel is the improved mobile robot's-maneuverability which requires extreme "maneuverability" in a crowded environment.

6. CONCLUSION:

The fundamental design step of an OMRemploying a mecanum wheel is discussed in this article. Robot navigation is the primary feature of mobile robotics, and the locomotion system is the essential component of navigation. Mecanum wheel mobile robot study covers a number of issues in robotics like sensor incorporation, navigation, and planning of path sensors as well as actuator control. Moreover, constructing a mobile robot with mecanum wheels supplies a rigorous testing bed for current notions and perspectives in the design for electronic software and hardware as well as mechanical design for the "mecanum wheel"[10] and general mobile robot chassis. The omnidirectional robot described in this work may be utilized as a platform for research and education because of its capabilities.

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