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Experimental Analysis of Mecanum wheel and Omni wheel

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Abstract: Omni-directional mecanum wheel is used to describe the ability of a system to move instantaneously in any direction from any configuration. Omni directional robotic platforms have vast advantages over a conventional design in terms of mobility in congested environments. They are capable of easily performing tasks in environments congested with static and dynamic obstacles and narrow aisles. These environments are commonly found in factory workshops offices, warehouses, hospitals and elderly care facilities.

Omni-drive systems operate by having individual typical Omni wheels apply torque in one direction in the same way as a regular wheel, but are able to slide freely in another direction (often perpendicular to the torque vector). The key advantage of Omni drive systems is that translational and rotational motion are decoupled for simple motion. However, in considering the fastest possible motion this is not necessarily the case.

Finally, we show that for four-wheeled Omni-drive transport systems and certain ranges of trajectories and starting conditions, a curved path can be traversed faster than a straight-line path, we confirm this result experimentally.

Keywords: Omni drive, Mecanum wheel, Direction, Motion

1. Introduction

1.1 Mecanum wheel : This project utilized the Mecanum wheel design pioneered in 1973 by Mecanum AB„s Bengt Ilon. 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 angled peripheral roller translates a portion of the force in the rotational direction of the wheel to force normal to the wheel directional. Depend each individual wheel direction and speed, the resulting combination of all these forces produces A total force vector in any sired direction thus allowing the platform to move freely in direction of resulting force vector, without changing the direction of the wheel.

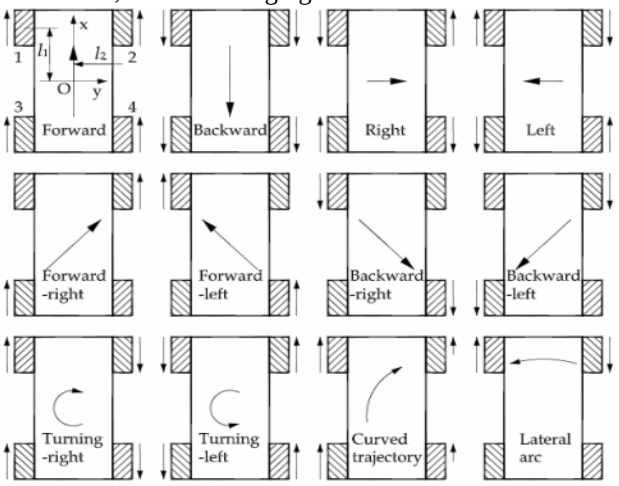

Fig-1 **Mecanum wheel motion**

Figure shows a traditional Mecanum wheel design by ion with peripheral roller with 45 degree slope held in place from the outside. Sing four of mecanum wheels provides Omni directional movement for a vehicle without needing a conventional steering system slipping is a common problem in wheel as it has only one roller with a single point of ground contact at any one time. Due to the dynamics of the mecanum wheel, it can create force vectors in both the x and y – direction while (two mirror pairs), allows net forces to be formed in x-y and rotational difficulty with this strategy is that there are four variables to control three degrees of freedom. In this case the system is said to be over determined and it is possible to create conflicts in the actuation. As a result of the constraints associated with the mecanum wheel some of controller is required to produce satisfactory ion.

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1.2 Omni wheel : Omni wheels or poly wheels, similar to Mecanum wheels, are wheels with small discs around the circumference which are perpendicular to the rolling direction. The effect is that the wheel will roll with full force, but will also slide laterally with great ease. These wheels are often employed in holonomic drive systems. Many robots use these wheels to have the ability to move in all directions. Omni wheels are also sometimes employed as powered casters for differential drive robots to make turning faster. However, this design is not commonly used as it leads to fishtailing.

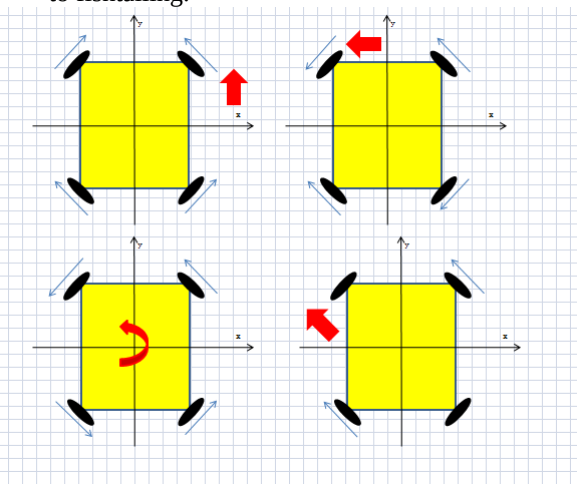

Fig 2- Omni Wheel motion

Omni-wheels are designed on the concept of a normal wheel that has the ability to roll or 'slip' sideways. So although no drive can be applied in the lateral direction, the wheel is still able to be moved in that direction. This is accomplished be placing many smaller wheels or cylinders on the edges of the main wheel as can be seen in figure 1a. The angle of the smaller wheels relative to the main wheel also gives the wheels the name Swedish 90°Wheel. To prevent awkward situations where a roller may not be in the desired place and to minimize friction in lateral movement, two wheels are often combined to form a wheel which has a more complete surface. This can be seen in fig

2.EXPERIMENT SETUP

With the use of the prototype motor driver board and test software to programming the microcontroller output as list in the basic mobility control was gained via programming the basic motion software to the microcontroller. This setup allowed the following motions.

* Forward - all four wheels forward in
* Backward - all four wheels move backward at the same speed
* Right slide - wheel 1 and 4 forward, wheel 2 and 3 backward
* Left slide - wheel 2 and 3 forward, wheel 1 and 4 backward.
* Clockwise - wheel 1 and 3 forward, wheel 2 and 3
* Counter-Clockwise - wheel 1 and 3 backward, wheel 2 and 3 forward The following list in Table 2, show the basic motion of mobile robot with their corresponding wheel direction. By varying the individual motor/wheel speed we can achieve driving direction along any vector in X-Y axis. The actuation required for these movements can be seen.

2.1 MATERIALS AND METHODS

PVC and Nylon raw material used for omni wheel drive and base of the robot were made by steel sheet which have dimension of 16 guage. As this was a complete Mechatronic project incorporating mechanical, electronic and software development, the different areas were developed synergistically thus allowing interactions between the disciplines to be viewed and managed. It also meant that all core disciplines needed to be developed to a certain stage before any one area could be further worked on. Although it was physically possible to use other means to develop the core areas independently, a synergistic approach tends to be more efficient.

2.2 Developments and implementation

The development for this project can be divided into the major process, the mechanical design for Mecanum wheel and Omni wheel for mobile robot chassis, electronics design for 4 channel motor driver and interfacing with Basic Stamp controller board and software development for motion control.

2.2.1 Mechanical design

The mecanum wheel been develop consist of eight roller with diameter of 110 mm. Each roller diameter is 20 mm at the center and 16 mm at each end. All rollers are made by engineering plastic. The roller was hold by roller holder made by mild steel and the center hub was made by nylon.

The Omni wheel also use same roller that use in mecanum wheel. There are two circumference disc are attach opposite to each other. The discs are made from engineering plastic. On each disc four rollers are hold. Design structure of the mecanum wheel and Omni wheel show All wheels are independently powered using four units of precisian gear DC motor and the wheel/motor assemblies were mounted directly to the robot platform. Mobile robot platforms are square, attach with wheel with +45º roller and wheel with -45º roller on each side for mecanum wheel.

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Fig 3- Experimental analysis of Mecanum wheel robot

The Omni-directional capabilities of the platform depend on each wheel contact firmly with the surface. For simplicity our mecanum wheel or Omni wheel and motor assembly are mounted directly on the platform. Platform made completely from PVC form sheet.

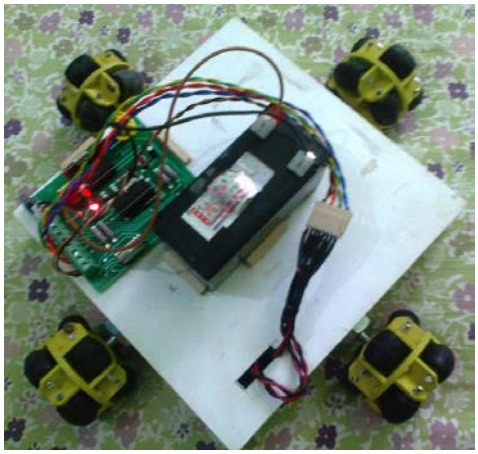

Fig 4- Experimental analysis of Mecanum wheel robot

2.2.2 Electronic design:

Four channel bi-directional motor driver been design to rive all four wheels. The specifications developed for the necessary driver board were:

The circuit should be compatible with a single logic-level PWM input signal for speed control of each wheel and a single logic-level input line for the direction of motor rotation for each wheel. The circuit should be able to operate with a high PWM carrier frequency from the microcontroller (20 MHz) to provide inaudible operation. The circuit would require four independent H Bridge drivers for bi- directional motion. Each H-Bridge driver circuit must be capable of providing suitable continuous current at 12V DC. The DC motors used in this platform are provide 200 rpm is 12V DC motor. The optical encoders provided velocity information on each wheel to the micro-controller. A four channel high power H-bridge driver board was interfaced to a Basic Stamp (BS2) micro-controller board. The overall system hardware architecture of the connections between hardware components of the mobile robot platforms.

RESULTS AND DISCUSSION

The testing gave a qualitative view of the system‘s mobility performance. The forward and reverse motion as acceptable but did not utilize any function of the mecanum wheels and Omni wheels. Likewise with rotational motion, the system performed as would be expected of a standard differential drive platform. The translational motion in X-axis, however, was not acceptable as the platform would tend to wander in the y-direction when attempting to traverse sideways. A qualitative view of the platform‘s basic mobility for translational analysis was required to review further minor modifications to the system especially on the mecanum wheel design or Omni wheel design and close-loop speed control on each motor.

The accuracy of direction and movement of the mobile robot depend much on slip rate of the wheel on floor‘ various conditions. As are result, the real position and orientation of the mobile robot deviate from the original planned course or path. The other parameters that influence the accuracy of movement of mecanum wheel mobile robot are surface contact and traction. Because of slippage problem, motion analysis for mecanum wheel type vehicle is complicate. Visual dead reckoning for motion control and odometer are the method to reduce the motion error. The combination of these two speeds gives the actual speed and more importantly direction of the robot.

Conclusions

This paper presents an overview over the primary design stage of Omni-directional mobile robots using mecanum wheel and Omni wheel. The strength of theses wheels are the enhanced maneuverability of the mobile robot that needs extreme maneuverability in congested environment. Moreover, building mecanum wheels and Omni wheel mobile robot provides a stringent test bed for new concepts and approaches in both mechanical design for mecanum wheel or Omni wheel and overall mobile robot platform and also the design for electronic hardware and software. This design and development of an Omni directional platform, using mechatronics system and Omni directional wheel to implement intelligent behavior and maneuvers, with the help of a microcontroller interfaced.

Future work: These mobile robot provided a convenient platform for continued development. The combination of

mechanical design on the wheel and chassis, motion control and multiple input/output sensors allow the exploration of large number of control algorithm and software to be implemented to the robot for practical application.

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Third Author I had completed BE automobile engineering from government engineering college modasa. I also gives contribute my knowledge during experimental set up of this project.