Experimental Analysis to Optimize The Mecanum Wheels Based On Mobile Robot

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ABSTRACT

Omni-directional mecanum wheel is used to describe the ability of a system to move without any delay in any direction from any configuration. Mecanum wheel directional robotic platforms have more advantages over a omni-directional robotic platform in terms of mobility in congested environments. These mobile robot are suitable of easily performing tasks in environments narrow space with static and dynamic obstacles and narrow aisles. These kind of robotic platform are mostly found in factory, warehouses, workshops, hospitals, offices, and shopping trolley etc.

This paper will focus on study an omni-directional mobile platform using four mecanum wheels which is required further capacity being programmed to achieve various motion behavior and intelligence

1. INTRODUCTION

1.1 Mecanum wheel:

This project invented the Mecanum wheel design devloped in 1973 by Mecanum AB., s Bengt Ilon. Mecanum wheel is consist of a central wheel with a number of rollers placed at an angle around the circumference of the hub. The angled peripheral roller translate of the force in the rotational direction into force normal to the wheel directional. Combination of wheel speed and direction resulting into total force vector in any direction thus allowing the platform to move freely in direction of resulting force vector, without changing the direction of the wheel.

Mecanum wheel is a central wheel with carrying a number of free rollers placed at an angle 45 degree about the hub circumference. Fig 1 shows mecanum wheel based on Ilon, four mecanum wheels are used provides holonomic movement for a vehicle without needing a any steering system. It has only one roller contact with ground at point contact that time.

Fig. 1: Mecanum wheel based on Ilon's concept[1]

Mecanurn wheels mobile robot is a kind of omni-directional robot, so it can move instantaneously in any direction. When robot wants driving forward or backward, all four of the wheel will rotate forward or backward. When robot

sliding to the left, wheel number 1 and 4 will rotate backward and wheel number 2 and 3will rotate forward. If robot wants sliding to the right side, wheel number 1 and 4 will rotate forward and wheel number 2 and 3 will rotate backward. Moreover, when the robot turning clochse, wheel number 1 and 3 rotate forward, wheel number 2 and 4 will rotate backward. If robot want turning counter clockwise, wheel number 1 and **3** will rotate backward, wheel number 2 and 4 will rotate forward.

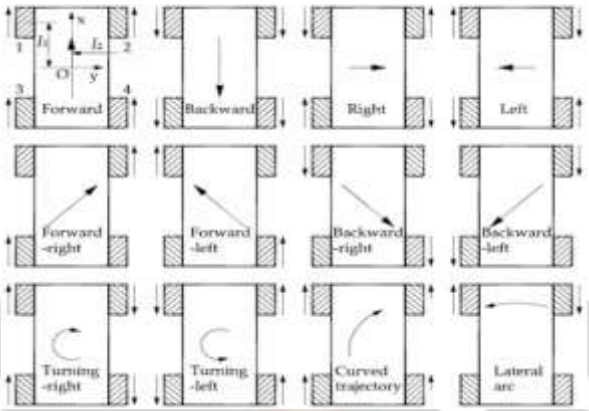

Fig-2 Mecanum wheel motion

Omni wheel : Omni wheels is like to Mecanum wheels, are wheels small discs around the hub circumferences. In omnidirectional wheel they are perpendicular to the surfaces. Deu to surface contact between wheel and surfaces more force required to drive the wheel. These wheels are often employed in holonomic drive systems.

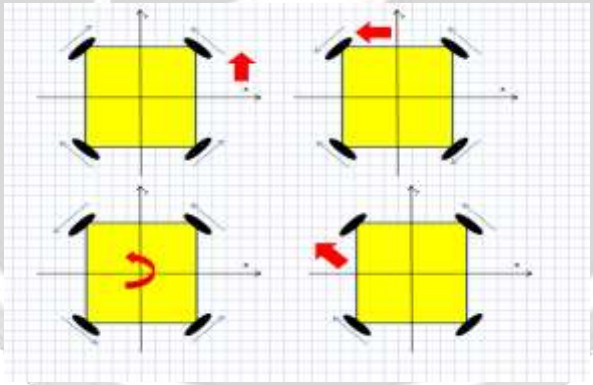

Fig 3- Omni Wheel motion

Most special wheel designs are based on a concept that achieves traction in one direction and allow passive motion in another. The universal wheel is an example of the special wheel design that has a number of small passive rollers mounted on the periphery of a normal wheel. The axes of the rollers are perpendicular to that of the wheel. The wheel is driven in a normal fashion, while the rollers allow for a free motion in the perpendicular direction. The Mecanum wheel design is based on similar concept. It has angled passive rollers around the periphery of the wheel. By controlling the four wheels attached to a platform, omnidirectional mobility can be achieved.

Experimental Setup

Fig. 4- Mecanum wheel

Fig. 5-mecanum wheel based mobile robot

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 2and 3 forward.

MATERIALS AND METHODS

This project completely depends on mechatronics system .Mechatronics is branch of science and it is a combination of mechanical and electronic system. Although it was physically possible to use other means to develop the core areas independently, a synergistic approach tends to be more efficient. Even though this parallel design approach was used, the areas of development shall be discussed in sections assuming that other sections have already been completed to a certain level and are referenced where necessary.

DEVELOPMENTS AND IMPLEMENTATION:

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

MECHANICAL DESIGN:

The mecanum wheel have been develop consist of eight roller with diameter of 60 mm. Each roller diameter is 10 mm at the center and 8 mm at each end. Roller are manufacturing by engineering plastic. The material in which

circumference are made by mild steel and the hub was made by nylon. The mecanum wheel roller also used in omni wheel. In mecanum wheel two disc are attach opposite to each other. These disc are manufacturing from engineering plastic. On each disc having mounted on eight rollers are. Each wheel having separate DC motor mounted and the wheel or motor assemblies were mounted directly to the robot platform. Mobile robotic platforms are square, attach on roller to wheel with +45º roller and wheel with -45º roller on each side for mecanum wheel.

Fig. 6: Design structure of the mecanum wheel

ELECTRONIC DESIGN:

Four channel bi-directional motor driver been design to drive all four mecanum 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 HB ridge drivers for bi-directional motion.

* Each H-Bridge driver circuit must be capable of providing suitable continuous current at 12V DC.The prototype motor driver was develop using 2 units of LMD18200 IC manufactured by National Semiconductor that capable of 3 amps continuous current at up to 55V DC and also had extra integrated features including current sensing and thermal overload shutdown. Figure 5 show the single motor driver circuit.

The DC motors used in this platform have built-in 40:1 gear reduction and speed at 65 RPM at 12VDC. 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 shows the connections between hardware components of the mobile robot platforms.

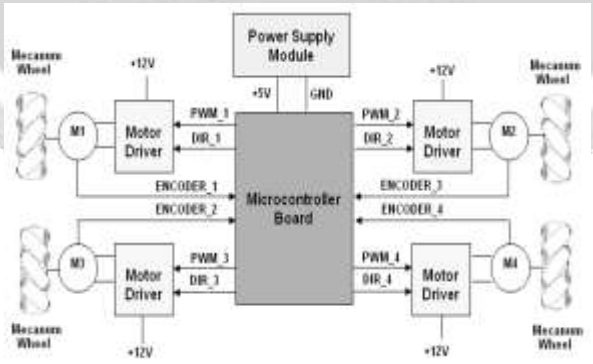

Fig. 7: System hardware architecture

MICROCONTROLLER:

microcontroller is a heart of robot. Microcontroller is in compact in size. In microcontroller kit consist of hardware feature like that UARTS, I/O lines. Microcontroller has less power consume. In this mecanum wheel mobile robot microcontroller used to moving the robot in forward, backward or any ware in 360 degree. Microcontroller also used for increase or descries the speed of robot. Basic Stamp micro-controllers have been chosen this project for well-

known for their ease of use, comfortable programming language and easy debugging using a PC. Figure8 show the Basic Stamp (BS2) microcontroller board.

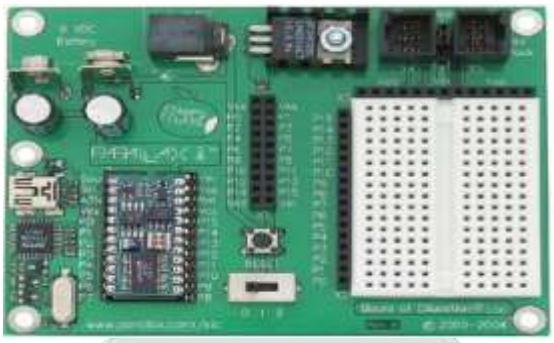

Fig. 8: Basic Stamp microcontroller board

ADVANTAGES

i. Full 360 degree rotation

ii. Mecanum drive require less skill

iii. Less friction low torque

iv. Better performance

v. Speed moving Forwards, sideway or at arbitrary angles.

CONCLUSION

This paper presents an overview of the development of mecanum wheel mobile robot over the omni-directional robot. The strength of this wheel is rotating in any configuration with 360 degree in congested environment. Mecanum wheel drives less force or starting torque is required as compared to omni wheel drive because mecanum wheel contact between roller and surface are point contact. After performing Mecanum wheel mobile robot due to arises many problems such as sensor integration, actuator and sensor control, path planning and navigation, task-level planning and the control of the robotic system as a whole. Moreover, building mecanum wheels mobile platform consist of in both mechanical design for mecanum wheel, mobile robot chassis and also the design for electronic hardware and software. This design and development of an omnidirectional platform, using mechatronics system and mecanum wheel to implement intelligent behaviours and movement, with the help of a microcontroller interfaced with sensors.

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