Article

**DESIGN AND CONTROL MOBILE ROBOT USING OMNIDIRECTIONAL WHEELS**

**NGUYEN BA PHAT, NGUYEN CONG QUY, NGUYEN QUOC VIET, NGUYEN TAN HOANG**

Department of Mechatronics Engineering, Ho Chi Minh City University of Technology and Education (HCMUTE), Ho Chi Minh City, Vietnam.

**Abstract:** This paper concentrates on controlling of a four- Mecanum mobile robot and presents detailed kinematics and controller architecture of a robot. The Mecanum wheels are known as the wheels provide a practical way of providing simultaneous vehicle motion in all the directions, longitudinal, lateral, and yaw, without singularities because they work based on slipping. During such a slip condition, Mecanum wheeled robot moves in unexpected path. In order to reduce this error, four incremental encoders are utilized. Then the fuzzy PID controller is described. Our model is implemented on a hybrid predictive controller and tested in simulations and real-world applications. The robot has two modes of controlling: auto and manual. When auto mode is active, the velocity can be controlled to increase or decrease. And when the robot is on the manual mode, an app is set up on smartphone to control the directions of robot. The controller uses the model to follow a planned trajectory and avoid obstacles in the state space with reasonable computation time. The paper will give the information about the model of dynamics of robot and the controller design. Moreover, the programs Matlab-Simulink was chosen to solve the models equations. The computer simulations performed were used to determine the vehicle cornering behavior in various driving conditions.

**Keywords:** Mobile Robot, Mecanum wheels, Omnidirectional Wheels.

# 1. Introduction.

The technology of autonomous vehicles is rapidly growing in quantity and quality. And the ability of omnidirectional movement is very essential for autonomous vehicles. This is the reason why the mobile robots using omnidirectional wheels are developing more and more significantly. These robots are capable of moving to any direction without changing its orientation and also they can change their orientation to any desired position while its moving. Omni directional motion for a robot is very useful because its abilities such as, avoid any obstacle while keeping its orientation unchanged, capability to move in constrained spaces and track a target while moving in an arbitrary trajectories etc. Because of these capabilities, robots are used in applications like robot soccer games and mobile robot manipulations. Most of these designs except power caster wheel design are not very suitable for the outdoor environments. All the swedish wheel designs and most other type designs have discontinuous wheel contact points which cause vibrations of the mobile base. And also discontinuous wheel velocities are required for the smooth base movement. Most of the ball wheel designs are subjected to ground clearance problems and suffer from dust and sand problems between ball wheel and the driving mechanisms. Only suitable currently available design for outdoor operations is the powered caster design. This also suffers from wheel slip problems that are inherent for the castors when motions perpendicular to the rotating plane are execute. In this paper we present a development of a design of controller that minimize these problems.

Nowadays, omnidirectional mobile robots have been developed for research purposes and played main role in both academia and industry. In comparison with many kinds of omnidirectional wheels, Mecanum wheels have been shown more to be effective in driving vehicles to achieve omnidirectional capability. These wheels are utilized in service robot such as intelligent wheelchairs, nursing-care robots and mobile manipulator. In spite of the advantage such as the omnidirectional motion property, the Mecanum wheel has the unavoidable vibration due to its structural shape. These vibrations can reduce the positioning accuracy. However, new applications in Mecanum wheels cause they are demanding more due to its additional maneuverability and efficiency.

Generally the Mecanum wheel is constructed from several passive rollers, forks, and a hub or disk. The hub is connected to the actuating motor. It supports the forks and rollers. The passive rollers generate the driving force by the contact with the ground. These features are gained at the expense of increased mechanical complexity (kinematics and dynamics analysis) and increased complexity in control. The issues of kinematics and dynamics of Mecanum wheel are studied in. These mathematical models will be utilized to achieve optimum control of the mobile robot as a service robot. When the robot moves, the wheels often slip. During such slips, the real position and orientation deviate from the planned. To overcome this problem, many researches attempt to detect the slippage and control the robot position. Viboonchaicheep et al. Used a novel methodology of position rectification for Mecanum-wheeled omni-directional vehicles. They used the formulation of unique kinematics equation, dynamics equation and state equation. Chang et al. Derived nonlinear stable adaptive control law based on complete dynamics model of a four-Mecanum-wheeled robot using the back stepping method via Lyapunov stability theory. Finally, we decided to use Fuzzy measure.

The rest of the paper is organized as follows. In Part 2, the structure of a wheel arrangement and the component structure of the robot is introduced. Part 3 introduces the kinematics of the robot. Section 4 presents the simulation and results and discussion. Finalize and draw conclusions.

# 2. Mobile Robot.

## 2.1. Omni wheels.

Giới thiệu kĩ phần bánh xe omni

## 2.2. Robot Structure.

Giới thiệu sơ Thành phần của robot bao gồm mạch arduino, sensor ulatrasonic, motor shiled của arduino, modul blutooth

# 3. Kinematic

# 4. Result And Discussion

# 5. Conclusion.