Modeling and Analysis of Omnidirectional Wheeled Vehicles Using Velocity-based Impedance Control

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Abstract. This paper presents the velocity-based impedance control that would account for the inertia forces acting on the omnidirectional wheeled vehicle during cornering motions. As favorable omni-vehicle, omnidirectional mecanum wheeled vehicle (OMWV) was selected as a platform in this study. Concerning the problem statements in the dynamic analyses, the control design has considered the difference in vehicle forces because the vehicle's interaction forces were indirectly controlled by the vehicle's velocities. The axial velocities control of the OMWV, vertical and horizontal axial motions on cornering periods were highlighted in this research. The simulation results show that with velocity inputs, the different forces on the OMWV axial motion of the vehicle could be reduced. Furthermore, the reduction in vehicle velocity influenced the overall kinetic energy of the system, which reduced the inertia effect.

Keywords: Cornering Stability, Omnidirectional Wheeled Vehicle, Motion Control, Inertia Control, Compliance, and Impedance Control

1 Introduction

An omnidirectional mecanum wheeled vehicle (OMWV) is equipped with a fully actuated mechanism, which necessitates a different control perspective than a steering wheeled vehicle equipped with an underactuated mechanism. Several studies have been conducted in order to determine a better control for motion planning of the OMWV in order to increase the capability of this type of omnidirectional vehicle. According to Chang et al., the speed of each omniwheel can be mathematically defined for control system design based on its orientation angle and direction [1]. Furthermore, according to Adamov et al., the contribution of each motor was calculated by multiplying the velocities by the cosine angle at the desired direction projected on each omni-wheel driven direction [2]. Oo et al., on the other hand, stated that omniwheel selection contributed to the increased flexibility of the wheeled vehicle when the vehicle platforms could move freely in a two-dimensional (2D) space rather than acting like a conventional vehicle [3]. Numerous efforts and research have been made

6 References

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