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SLIDING MODE ROBUST CONTROL FOR TWO-WHEELED MOBILE ROBOT WITH LOWER CENTER OF GRAVITY

Ming Yue[1], Wei Sun[2] and Ping Hu[1]

[1]School of Automotive Engineering
[2]School of Mechanical and Engineering
Dalian University of Technology
Dalian City, Liaoning Province 116024, P. R. China
{ yueming; sunwei }@dlut.edu.cn

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Abstract. *Two-wheeled mobile robots (2WMRs) with lower center of gravity exhibit more practicality and operability because their mass center locates on the bottom of the configuration center. By analyzing motion behaviors of the vehicle body, we present the underactuated property and give the dynamics equation of this kind of robot. The system matrices and nonholonomic constraint change drastically because of the unavoidable oscillation companying with underactuated vehicle body. Considering this fact, we propose a sliding mode robust controller based on the nominal models of the system matrices to realize the trajectory planning. The tracking performances can be achieved by adaptively regulating the coefficients of this control law. Simulation results verify the proposed controller is simple, practical and effective for the 2WMRs with lower gravity of center.*
Keywords: 2WMRs, Lower gravity of center, Underactuated, Sliding mode robust controller

1. **Introduction.** The 2WMRs demonstrate more superiority to some other robots with three, four or more wheels. For example, 2WMRs can perform steering motion with zero radiuses easily; without traditional chassis and brake, their vehicle bodies become light weighted and their configurations become slim; with lower energy consumption, relative small wheel-terrain contact area assures long-time detection operation. Therefore, 2WMRs have potential application prospects in many areas especially in complex unstructured circumstances, such as seismic ruins, battle field and even planetary surface.

The most common 2WMR with mass center on the top of the configuration center, which is initially used to verify the self-balanced control techniques, is named as two-wheeled self-balanced robot [1-3]. However, because the robot is naturally similar to an instable inverted pendulum system with multivariable, nonlinear and strong-coupling characteristics, it is difficult to apply this kind of robot in complicated, changeable and unstructured environment [4,5].

In contrast, the 2WMRs, whose mass center locates on the bottom of its configuration center, have aroused attentions of some researchers [6-8]. In this case, the system of this kind of robot changes into a stable one. With this structure improvement, the 2WMRs significantly enhance the autonomous capability and maneuverability, which will make the robots more suitable to explore the unstructured environments. Considering these benefits, some researchers had proposed the two-wheeled robot based on lower center of gravity structures. For example, Abbott [9,10] had designed a new 2WMR with these special characters and its control algorithms about its rolling ahead motion had been investigated; unfortunately, the steering motion had not been mentioned which is necessary for the robot's trajectory planning. Salerno [11-13] had developed a two-wheeled robot