ICCK Transactions on Intelligent Cyber-Physical Systems
http://dx.doi.org/10.62762/TICPS.2026.133355

REVIEW ARTICLE

A Review of Wheel-Slip Control Algorithms for Wheeled Mobile Robots

Shiteng Yang [1,*]

[1] College of Engineering, Lishui University, Lishui 323000, China

Abstract

Wheeled mobile robots are prone to longitudinal slip, lateral sideslip, and combined slip when operating on wet, soft, and unstructured terrain, which degrades localization accuracy, trajectory tracking, traction performance, and energy consumption. Based on 36 studies, this paper reviews slip modeling and state estimation, trajectory compensation, slip-ratio and traction control, multi-wheel slip coordination and torque allocation, and integrated multi-constraint control. The methods are compared in terms of technological evolution, control objectives, applicable operating conditions, validation levels, and representative experimental results. Existing studies still face challenges in modeling combined slip, reliable state identification under abrupt terrain changes, and standardized cross-platform real-world evaluation. Future research should further integrate multi-source sensing, online identification, and hierarchical coordinated control to improve adaptability to complex terrain and engineering applicability.

Submitted: 08 July 2026
Revised: 12 September 2026
Accepted: 15 September 2026
Published: 25 September 2026

Vol. 1, **No.** 3, 2026.
10.62762/TICPS.2026.133355

***Corresponding author:**
Shiteng Yang
15503423773@163.com

Keywords: wheeled mobile robot, wheel slip, trajectory tracking, slip-ratio control.

1 Introduction

Wheeled mobile robots are commonly modeled under the ideal nonholonomic constraint of pure rolling without lateral slip [1, 2]. However, on low-friction or smooth surfaces and during curvilinear motion, lateral forces may induce wheel sideslip and invalidate the ideal motion constraint [2]. Soft and deformable terrain may additionally involve longitudinal slip, sinkage, and complex wheel–terrain interactions [3, 4]. A mismatch between wheel peripheral speed and the longitudinal ground speed of the robot produces longitudinal slip, whereas deviation of the actual velocity direction from the wheel rolling plane produces lateral sideslip; the two may occur simultaneously as combined slip. Wheel slip degrades trajectory-tracking performance and causes difficulties in position and attitude estimation, reduced maneuverability, and increased energy consumption.

Existing studies have developed control schemes based on kinematic and dynamic models under wheel-slip conditions and have improved trajectory-tracking performance through slip compensation [1, 2]. Some studies further incorporate lateral slip, model-parameter uncertainty, and external disturbances into a unified control system and design corresponding trajectory-tracking compensation methods [2]. Related reviews have also addressed slip estimation, sensing, and compensation in

Citation
Yang, S. (2026). A Review of Wheel-Slip Control Algorithms for Wheeled Mobile Robots. *ICCK Transactions on Intelligent Cyber-Physical Systems*, 1(3), 113–120.

off-road environments [3], but unified comparisons of applicability boundaries and validation evidence across different control levels remain limited. This paper adopts a narrative-review approach and synthesizes 36 relevant studies retrieved up to April 2026, comparing the algorithms in terms of control objectives, model dependence, applicable operating conditions, and validation levels.

2 Wheel-Slip Mechanisms, Modeling, and State Estimation

Longitudinal slip characterizes the mismatch between wheel peripheral speed and the longitudinal ground speed of the robot. Lateral slip includes vehicle sideslip, in which the vehicle velocity direction deviates from the body longitudinal axis, and wheel slip angle, in which the wheel motion direction deviates from the rolling plane. For forward motion with both $r\omega$ and v_x nonnegative, this paper adopts the slip-ratio sign convention of [1, 3]:

$$\lambda = \frac{r\omega - v_x}{\max(r\omega, v_x)}, \tag{1}$$

where r is the effective wheel radius, ω is the wheel angular velocity, and v_x is the longitudinal ground speed of the robot. $\lambda > 0$ denotes driving slip (wheel spin), whereas $\lambda < 0$ denotes braking slip. Because different studies may use different slip-ratio definitions and sign conventions [1, 3], these definitions should be unified before comparing results; the denominator and sign should be handled according to the adopted definition under low-speed and reverse-motion conditions. Control models may introduce longitudinal and lateral slip parameters separately, establish kinematic and dynamic models, and use observers and sliding-mode control for simulation-based compensation [5]. Terramechanics models show that slip ratio and slip angle jointly affect longitudinal force, lateral force, contact geometry, and sinkage [4]. Accordingly, combined-slip control should jointly consider slip ratio, sideslip states, yaw motion, and adhesion constraints. Low-friction or smooth surfaces are prone to lateral slip, causing the actual motion to deviate from the ideal no-slip model and reducing trajectory-tracking performance [2]. Soft terrain additionally involves sinkage, soil shear, changes in contact geometry, and motion resistance [3, 4].

Existing models can be broadly classified into kinematic, dynamic, wheel–terrain mechanics, and lumped-disturbance models. Kinematic models have low computational cost but are limited in describing wheel–terrain interactions [1]. Dynamic models can incorporate slip and uncertainty but require more parameters and computation. Wheel–terrain mechanics models can describe large slip ratios, slip angles, and sinkage, but their many parameters make online implementation difficult [4]. Lumped-disturbance models require fewer parameters but cannot directly characterize traction states. Therefore, relatively low-order models are suitable for motion compensation, whereas traction control and multi-wheel coordination additionally require wheel–terrain forces, wheel loads, and motor constraints to be considered.

Wheel-slip control relies on ground speed, slip ratio, sideslip states, and wheel–terrain parameters. Deep neural networks fused with filtering can estimate slip ratio on rough terrain [6], and sliding-mode observers can identify longitudinal slip parameters [17]. Qin et al. use an enhanced extended-state observer (ESO) to estimate a lumped disturbance composed of slip, sideslip, and uncertainty and design prescribed-time tracking control [7], while Li et al. investigate fixed-time tracking [18]. Under a pure-rolling assumption, Peng et al. use a nonlinear disturbance observer (NDO) and a model predictive strategy to handle external disturbances and trajectory tracking in a hierarchical structure; their classified disturbance-handling architecture is used here only as a methodological reference [19]. Liu et al. use an ESO to estimate disturbances such as sideslip and longitudinal slip and validate the method on a physical robot [20]. Explicit estimation facilitates slip-ratio feedback control, whereas lumped-disturbance estimation is more suitable for motion compensation. To unify the control objects discussed below, Figure 1 summarizes typical terrain conditions, slip forms, performance impacts, and the corresponding control stages.

3 Advances in Wheel-Slip Control Algorithms

According to the control object and actuation level, existing methods can be divided into four categories: trajectory tracking and slip compensation, slip-ratio and traction regulation, multi-wheel slip coordination and torque allocation, and integrated multi-constraint control. From an evolutionary perspective, research has progressed from slip modeling and error compensation to traction optimization, online identification and learning-based estimation, and

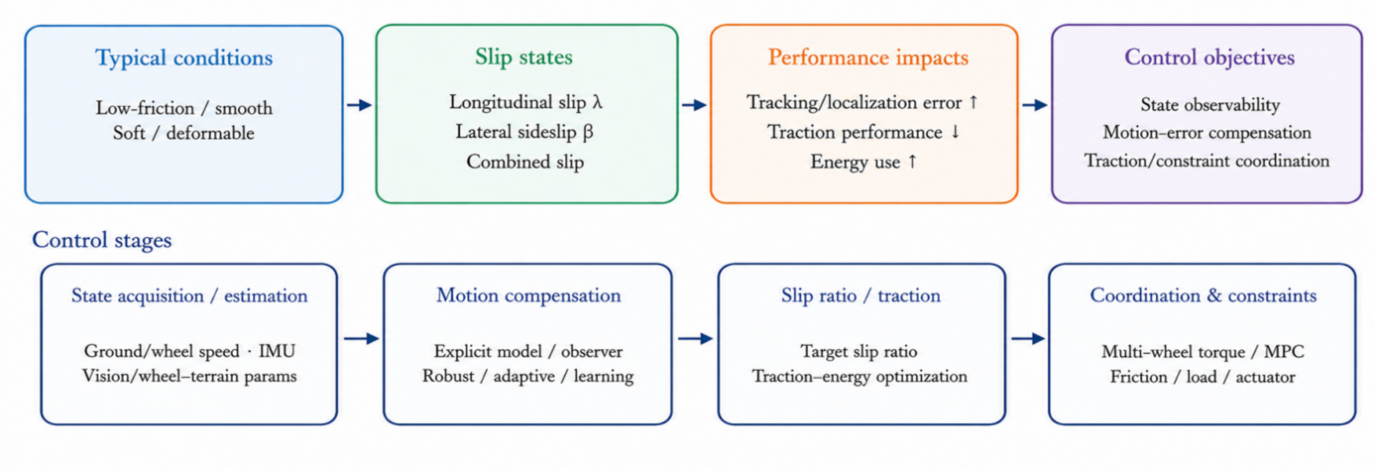

Figure 1. Relationships among wheel-slip forms, impacts, and control techniques for wheeled mobile robots[1–6].

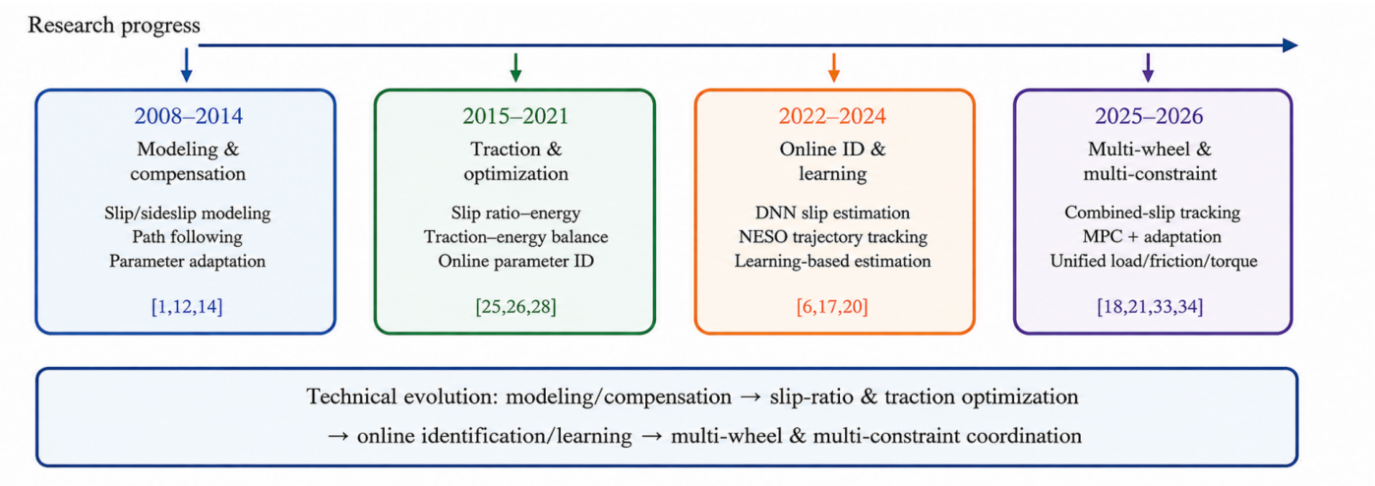

Figure 2. Technological evolution of wheel-slip control for wheeled mobile robots [1, 6–16].

finally to unified multi-wheel and multi-constraint coordination. The technological evolution is summarized in Figure 2, while representative quantitative achievements are further discussed in Section 4.

3.1 Trajectory Tracking and Slip Compensation

Trajectory tracking and slip compensation mainly employ explicit slip modeling, disturbance observation and robust compensation, as well as learning-based, fault-tolerant, and actuator-level compensation. Path following, differential-flatness-based control, and adaptation of unknown longitudinal and lateral slip parameters belong to the explicit-modeling route [8, 9, 21]. Disturbance-attenuation and fault-tolerant control address bounded slip disturbances and unknown longitudinal slip on soft terrain, respectively [22, 23], while extended-state observers, second-order sliding mode, and radial-basis-function observers are used to compensate for sideslip, longitudinal slip, and external disturbances [10, 24].

Adaptive and intelligent-learning methods can estimate unknown slip parameters [11, 25], and a sliding-mode observer has been used for online estimation of unknown slip ratios with experimental validation [26]. With the rapid development of robotics technology, various compensation control algorithms have been proposed one after another [27–29]. Neural sliding mode, backstepping adaptive control with an improved linear extended-state observer, and drive-unit modeling are used to compensate for uncertain terms, forward and lateral velocity disturbances, and actuator-level effects, respectively. Explicit methods have clear physical interpretations but depend on models and ground-speed measurements. Lumped-disturbance methods have simple structures but cannot distinguish the source of slip. Learning-based methods can approximate unknown nonlinearities, but their cross-condition generalization and interpretability remain limited. Fault-tolerant and actuator-level compensation methods depend on fault descriptions and drive models. Convergence of trajectory errors does not necessarily imply that wheel slip and traction are controlled.

3.2 Slip-Ratio and Traction Control

These methods use slip ratio as the main feedback variable and incorporate traction performance or energy consumption into the control objective, regulating wheel speed or drive torque to maintain effective traction. Representative studies include joint slip-ratio–energy optimization [12], online adjustment of the target slip ratio [13], and slip-ratio estimation with mixed H_2/H_∞ control on loose soil [30]. Online identification of traction parameters can provide a parameter basis for target slip-ratio adjustment and traction control [14]. A fixed target slip ratio has limited adaptability to terrain changes, whereas online optimization depends on ground speed, models, measurement quality, and real-time computation.

3.3 Multi-Wheel Slip Coordination and Torque Allocation

Independently driven multi-wheel platforms can coordinate the target slip ratio of each wheel or allocate drive torques to accommodate differences in wheel load and adhesion. Planetary exploration robots use multi-wheel slip-ratio coordination to improve inter-wheel traction [31]. Scalable slip control with torque vectoring from the vehicle-control domain [32] offers transferable methodological references for stability analysis and input-constraint formulation in multi-wheel mobile robot platforms, while robot-specific torque-allocation methods jointly consider wheel loads, tire utilization, and motor-torque constraints [33]. These approaches can improve traction utilization and stability, but they increase the burden of state estimation and real-time optimization.

3.4 Multi-Constraint and Integrated Coordinated Control

Model predictive control (MPC) can jointly handle trajectory, slip, and environmental constraints. Korayem et al. jointly address trajectory tracking, slip ratio, slip angle, and obstacle avoidance and conduct experiments in a slippery environment with obstacles [34]. Their subsequent work combines stable MPC at the kinematic level with adaptive sliding mode at the dynamic level and validates the scheme on a robotic platform [15]. Seo et al. consider tire slip, load transfer, and friction constraints on a four-wheel-independent-steering/four-wheel-independent-drive (4WIS-4WID) platform and jointly compute tire forces, steering angles, and wheel-end torques, with validation mainly through numerical simulations [16]. Time-varying-delay control addresses input delays under slip conditions [35], and differential-game control is used to suppress longitudinal and lateral slip disturbances [36]. These methods are suitable for combined-slip and strongly constrained tasks, but prediction, unified allocation, and game-theoretic optimization impose high requirements on models and online computation, while delay-control methods depend on assumptions regarding delay bounds and disturbances.

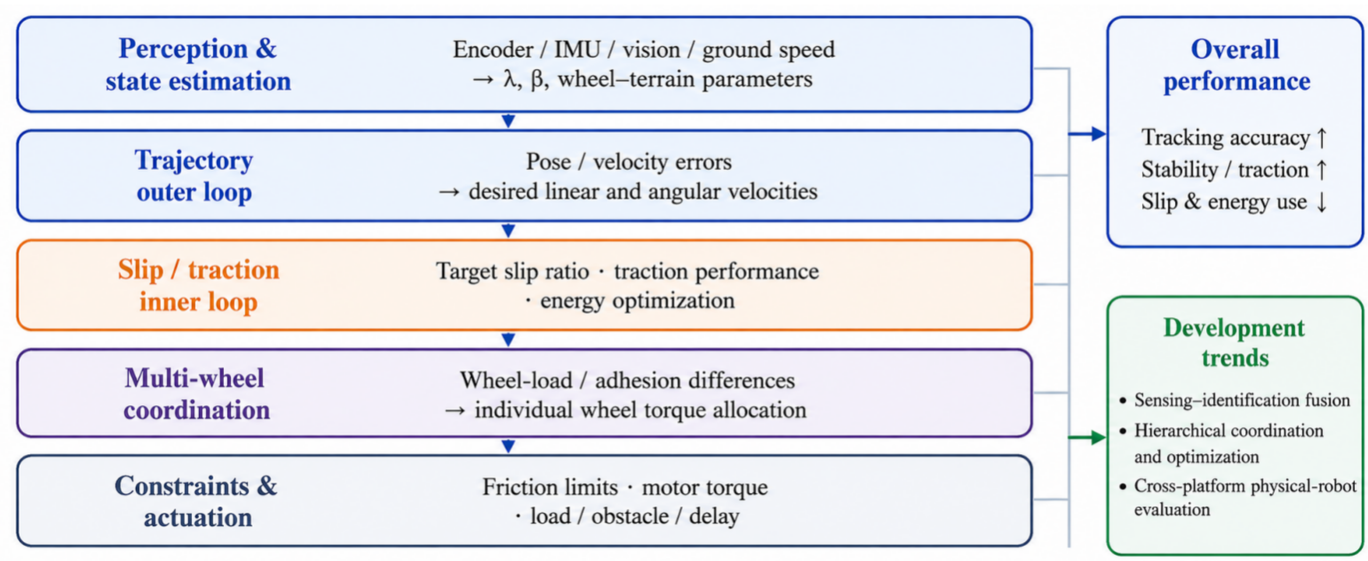

Figure 3. Hierarchical coordinated wheel-slip control framework and development trends for wheeled mobile robots [6, 12–16, 19, 24, 30–34].

Table 1. Comparison of major wheel-slip control methods for wheeled mobile robots.

Method category	Main objectives / variables	Typical techniques	Applicable conditions and validation	Representative References and Roles
Trajectory tracking and slip compensation	Pose, heading, and velocity errors	Explicit slip modeling; SMO/ESO/NESO (Sliding-Mode Observer / Extended State Observer / Nonlinear Extended State Observer); robust, adaptive, and learning-based compensation	Wet/slippery surfaces; longitudinal/lateral and some combined-slip conditions; simulation validation accounts for a substantial share, with some platform/physical-robot tests	Improves tracking accuracy and robustness, but does not directly guarantee traction control [8–11, 20–29]
Slip-ratio and traction control	Slip ratio λ; traction performance; energy consumption	Target slip-ratio optimization; H_2/H_∞; online traction-parameter identification	Soft, rough, and deformable terrain; simulation + field/platform validation	Balances traction performance and energy consumption while supporting online identification; depends on ground speed, wheel–terrain models, and measurement quality [12–14, 30]
Multi-wheel slip coordination and torque allocation	Individual wheel slip ratios; drive torques	Slip-ratio coordination; torque vectoring; constrained torque allocation	Independently driven multi-wheel platforms; uneven adhesion/wheel loads; simulation and comparative validation	Improves inter-wheel traction utilization and stability, but increases state-estimation and real-time optimization burden [31–33]
Integrated multi-constraint control	Trajectory, slip, environment, and actuator constraints	MPC/hybrid control; unified motion control; delay and game-theoretic control	Combined slip, obstacles, 4WIS-4WID, and strong constraints; platform experiments + numerical simulations	Can jointly handle multiple constraints, but has high model dependence and online computational burden [15, 16, 34–36]

Note: Validation levels are summarized according to the primary evidence reported in each study; Ref. [14] provides field validation of online traction-parameter identification, and Ref. [32] is included as a torque-vectoring reference from the vehicle-control field.

4 Method Coordination, Applicability Boundaries, and Performance Evaluation

Based on existing studies, wheel-slip control methods can be organized into a hierarchical control chain consisting of state estimation—trajectory outer loop—slip-ratio/traction inner loop—multi-wheel torque allocation—constraint management [12, 13, 15, 16, 24, 30–34]. Longitudinal slip mainly relies on slip-ratio and traction regulation [12–14, 30], while lateral sideslip is commonly addressed by parameter adaptation or disturbance observation [9, 10, 22, 24]. Unknown longitudinal slip on soft terrain can be handled through fault-tolerant control [23]. Combined slip, obstacles, and load/friction constraints are more suitable for hybrid control and unified allocation [15, 16]. Figure 3 summarizes these coordination relationships, and Table 1 compares the applicability boundaries and validation levels of the main methods.

Evaluation of wheel-slip control should simultaneously consider trajectory error, slip/traction states, energy consumption, actuator constraints, and real-time performance; numerical results obtained on different platforms and under different operating conditions should not be directly compared. Among the studies reviewed here, simulation-based validation still accounts for a substantial share, while some methods have been validated through platform or physical-robot experiments [10, 15, 20, 26, 34]. Online traction-parameter identification has been validated in field tests [14], whereas unified control with load transfer and differential-game control have mainly been evaluated numerically [16, 36].

Representative results are shown in Figure 4. Compared with integration-based localization and IEKF-based (Iterated Extended Kalman Filter) localization, the deep-neural-network–IEKF (DNN–IEKF) method [6] reduces accumulated localization error by 53.5% and 13.5%, respectively. Compared with first-order sliding-mode control, ASOSMC–NESO (Adaptive Second-Order Sliding-Mode Control with a Nonlinear Extended State Observer) [10] reduces the maximum tracking error by 89.53% for a straight-line trajectory and by 16.28% for a nonlinear trajectory. In physical-robot tests [20], the steady-state errors after lateral sideslip and longitudinal slip are no greater than 0.024 m and 0.025 m, respectively.

5 Challenges and Conclusions

In summary, wheel-slip control for wheeled mobile robots has evolved from explicit slip modeling and trajectory compensation to slip-ratio/traction optimization, online identification and learning-based estimation, and further to coordinated multi-wheel and multi-constraint control. Engineering applications remain constrained by three major issues: longitudinal/lateral slip, sinkage, and wheel–terrain

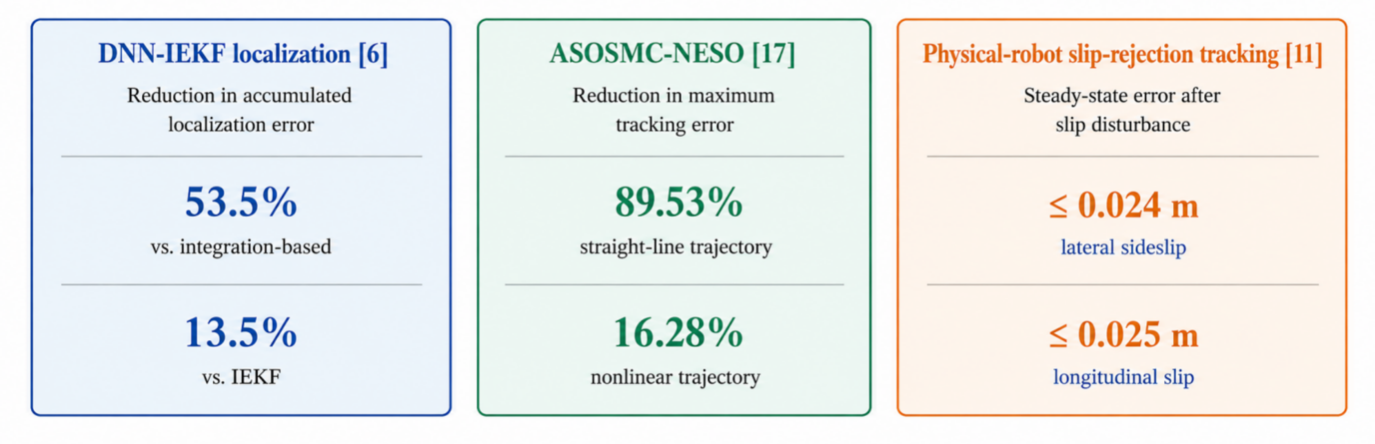

Figure 4. Representative quantitative technical achievements [6, 10, 20].

interactions are difficult to describe within a unified low-complexity model [1, 4]; the cross-terrain generalization and measurement robustness of deep networks and online identification still need improvement [6, 14]; and multi-objective coupling among traction–energy tradeoffs, wheel-load/motor constraints, obstacles, and friction boundaries increases the difficulty of real-time optimization [13, 16, 33, 34].

Future research should further integrate multi-source sensing, online identification of wheel–terrain parameters, and hierarchical observation [6, 14, 19], while incorporating slip-ratio–energy optimization, target slip-ratio adjustment, and multi-wheel coordination into a unified hierarchical control framework [12, 13, 31]. Cross-configuration and cross-terrain physical-robot validation should also be strengthened to establish a unified evaluation system that jointly considers slip, trajectory tracking, energy consumption, and real-time performance.

Data Availability Statement

Not applicable.

Funding

This work was supported without any funding.

Conflicts of Interest

The author declares no conflicts of interest.

AI Use Statement

The author declares that no generative AI was used in the preparation of this manuscript.

Ethical Approval and Consent to Participate

Not applicable.

References

[1] Wang, D., & Low, C. B. (2008). Modeling and analysis of skidding and slipping in wheeled mobile robots: Control design perspective. *IEEE Transactions on robotics*, *24*(3), 676-687. [CrossRef]

[2] Hà, V. T., Thuong, T. T., Thanh, N. T., & Vinh, V. Q. (2024, January). Research on some control algorithms to compensate for the negative effects of model uncertainty parameters, external interference, and wheeled slip for mobile robot. In *Actuators* (Vol. 13, No. 1, p. 31). MDPI. [CrossRef]

[3] Teji, M. D., Zou, T., & Zeleke, D. S. (2023). A survey of off-road mobile robots: Slippage estimation, robot control, and sensing technology. *Journal of Intelligent & Robotic Systems*, *109*(2), 38. [CrossRef]

[4] Pavlov, C., & Johnson, A. M. (2024). A terramechanics model for high slip angle and skid with prediction of wheel-soil interaction geometry. *Journal of Terramechanics*, *111*, 9-19. [CrossRef]

[5] Alipour, K., Robat, A. B., & Tarvirdizadeh, B. (2019). Dynamics modeling and sliding mode control of tractor-trailer wheeled mobile robots subject to wheels slip. *Mechanism and Machine Theory*, *138*, 16-37. [CrossRef]

[6] Kim, C. H., & Cho, D. I. (2023). DNN-based slip ratio estimator for lugged-wheel robot localization in rough deformable terrains. *IEEE Access*, *11*, 53468-53484. [CrossRef]

[7] Qin, B., Yan, H., Hu, X., Tian, Y., & Yang, S. X. (2024). Enhanced extended state observer based prescribed time tracking control of wheeled mobile robot with slipping and skidding. *International Journal of Robust and Nonlinear Control*, *34*(11), 7314-7331. [CrossRef]

[8] Low, C. B., & Wang, D. (2010). Maneuverability and path following control of wheeled mobile robot in the

presence of wheel skidding and slipping. *Journal of Field Robotics*, *27*(2), 127-144. [CrossRef]

[9] Cui, M., Huang, R., Liu, H., Liu, X., & Sun, D. (2014). Adaptive tracking control of wheeled mobile robots with unknown longitudinal and lateral slipping parameters. *Nonlinear Dynamics*, *78*(3), 1811-1826. [CrossRef]

[10] Liu, K., Ji, H., & Zhang, Y. (2019). Extended state observer based adaptive sliding mode tracking control of wheeled mobile robot with input saturation and uncertainties. *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, *233*(15), 5460-5476. [CrossRef]

[11] Korayem, M. H., Safarbali, M., & Lademakhi, N. Y. (2024). Adaptive robust control with slipping parameters estimation based on intelligent learning for wheeled mobile robot. *ISA transactions*, *147*, 577-589. [CrossRef]

[12] Gao, H., Xia, K., Ding, L., Deng, Z., Liu, Z., & Liu, G. (2015). Optimized control for longitudinal slip ratio with reduced energy consumption. *Acta Astronautica*, *115*, 1-17. [CrossRef]

[13] Kim, J., & Lee, J. (2018). Traction-energy balancing adaptive control with slip optimization for wheeled robots on rough terrain. *Cognitive systems research*, *49*, 142-156. [CrossRef]

[14] Kobelski, A., Osinenko, P., & Streif, S. (2021). Experimental verification of an online traction parameter identification method. *Control Engineering Practice*, *113*, 104837. [CrossRef]

[15] Korayem, M. H., Namdarpour, F., & Lademakhi, N. Y. (2025). Hybrid stable adaptive control approach for navigation of nonholonomic wheeled mobile robots on slippery surfaces with obstacles. *International Journal of Control, Automation and Systems*, *23*(5), 1542-1550. [CrossRef]

[16] Seo, D., Moon, S., & Kang, J. (2026). Unified motion control of 4WIS-4WID WMR with unlimited steering and load transfer consideration. *Robotics and Autonomous Systems*, 105341. [CrossRef]

[17] Bei, X., Ping, X., & Gao, W. (2018). Trajectory tracking control of wheeled mobile robots under longitudinal slipping conditions. *China Mechanical Engineering*, *29*(16), 1958-1964. https://www.cmemo.org.cn/EN/abstract/abstract7202.shtml

[18] Li, B., Liu, H., Ahn, C. K., Wang, C., & Zhu, X. (2024). Fixed-time tracking control of wheel mobile robot in slipping and skidding conditions. *IEEE/ASME Transactions on Mechatronics*, *30*(3), 1865-1875. [CrossRef]

[19] Peng, J., Xiao, H., & Lai, G. (2024). Nonlinear disturbance observer incorporated model predictive strategy for wheeled mobile robot's trajectory tracking control. *International Journal of Control, Automation and Systems*, *22*(7), 2251-2262. [CrossRef]

[20] Liu, X., Zhu, H., Shan, Z., & Su, C. (2024). Active disturbance rejection control for target tracking of wheeled mobile robot based on hyperbolic-tangent line-of-sight guidance. *Chinese Journal of Scientific Instrument*, *45*(12), 201-209. [CrossRef]

[21] Ryu, J. C., & Agrawal, S. K. (2011). Differential flatness-based robust control of mobile robots in the presence of slip. *The International Journal of Robotics Research*, *30*(4), 463-475. [CrossRef]

[22] Chen, M. (2016). Disturbance attenuation tracking control for wheeled mobile robots with skidding and slipping. *IEEE Transactions on Industrial Electronics*, *64*(4), 3359-3368. [CrossRef]

[23] Wu, H., Liang, Z., Wang, W., & Wang, Y. (2024). Trajectory tracking control method of wheeled mobile robot with uncertain slippage. *Journal of Northeastern University (Natural Science)*, *45*(6), 858-865. [Link]

[24] Bai, J., Liu, C., Zhou, S., Chen, Y., & Li, X. (2025). Trajectory tracking control for wheeled mobile robot subject to slipping and skidding. *Neurocomputing*, *638*, 130203. [CrossRef]

[25] Bai, J., Ren, M., Li, J., & Chen, Y. (2025). Trajectory tracking control for wheeled mobile robots subject to longitudinal slippage. *Asian Journal of Control*, *27*(5), 2576-2587. [CrossRef]

[26] Li, Z., Guo, J., Wang, T., Xiong, X., Feng, Y., & Li, X. (2025). Trajectory tracking control for wheeled mobile robots with unknown slip rates based on improved rapid variable exponential reaching law and sliding mode observer. *Machines*, *13*(9), 765. https://xuebao.neu.edu.cn/natural/EN/abstract/abstract12391.shtml

[27] Park, B. S., Yoo, S. J., Park, J. B., & Choi, Y. H. (2009). Adaptive neural sliding mode control of nonholonomic wheeled mobile robots with model uncertainty. *IEEE Transactions on Control Systems Technology*, *17*(1), 207-214. [CrossRef]

[28] Zhu, C., Li, B., Zhao, C., & Wang, Y. (2024). Trajectory tracking control of car-like mobile robots based on extended state observer and backstepping control. *Electronics*, *13*(8), 1563. [CrossRef]

[29] Trojnacki, M. (2025). Tracking control of a four-wheeled skid-steered robot with slip compensation and application of the drive unit model. *Electronics*, *14*(3), 444. [CrossRef]

[30] Gao, H., Chen, C., Ding, L., Li, W., Yu, H., Xia, K., & Liu, Z. (2017). Tracking control of WMRs on loose soil based on mixed H_2/H_∞ control with longitudinal slip ratio estimation. *Acta Astronautica*, *140*, 49-58. [CrossRef]

[31] Ding, L., Gao, H., Deng, Z., & Liu, Z. (2010, October). Slip-ratio-coordinated control of planetary exploration robots traversing over deformable rough terrain. In *2010 IEEE/RSJ international conference on intelligent robots and systems* (pp. 4958-4963). IEEE. [CrossRef]

[32] Degel, W., Lupberger, S., Odenthal, D., & Bajcinca, N. (2022). Scalable slip control with torque vectoring including input-to-state stability analysis. *IEEE*

Transactions on Control Systems Technology, *31*(3), 1250-1265. [CrossRef]

[33] Wang, L., Wang, S., & Wang, J. (2024). Coordinated torque control for enhanced steering and stability of independently driven mobile robots. *Industrial Robot: the international journal of robotics research and application*, *51*(4), 658-670. [CrossRef]

[34] Korayem, M. H., Namdarpour, F., & Lademakhi, N. Y. (2024). Superiority of model predictive control with robust and stable approach for sliding wheeled mobile systems in the presence of obstacles. *Optimal Control Applications and Methods*, *45*(4), 1503-1523. [CrossRef]

[35] Wang, M., Chen, H., Chen, Y., Cao, Y., & Hou, L. (2024). Trajectory tracking control of wheeled mobile robots with skidding and time-varying delay. *Transactions of the Institute of Measurement and Control*, *46*(13), 2636-2646. [CrossRef]

[36] Azimi, A., Amjadifard, R., & Ghasemzadeh, A. (2024, May). Control of a Wheeled Robot in the Presence of Wheels Sliding Using Robust Adaptive Control in Differential Game Format. In *2024 32nd International Conference on Electrical Engineering* (*ICEE*) (pp. 1-6). IEEE. [CrossRef]

Shiteng Yang obtained a bachelor's degree from Lishui University. Currently, he is pursuing a master's degree in mechanical engineering at the Graduate School of Lishui University. His research interests mainly focus on trajectory tracking control of wheeled robots, aiming to achieve more precise and stable control. (Email: 15503423773@163.com)