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Energy-efficient Trajectory Planning for Omnidirectional Mobile Robots with Improved WDO Algorithm

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Purpose

- Kinematics and dynamics modeling of a new Omnidirectional Mobile Robot (OMR) based on Powered Dual-Roller Caster Wheels (PDRCW)
- Energy-efficient trajectory planning with an improved WDO algorithm based on Chaotic Tent Map (CTWDO)

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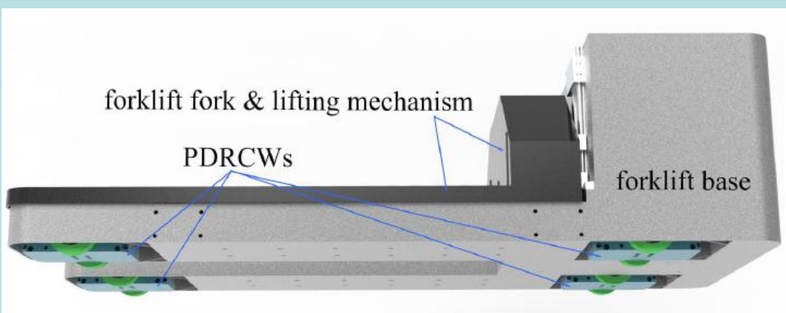
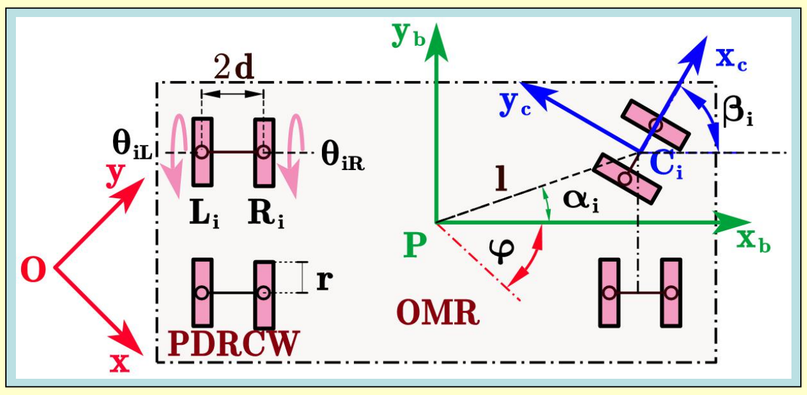
Please scan the code on WeChat to view or download the original paper

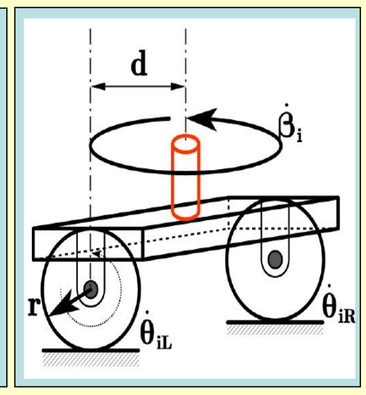
Method



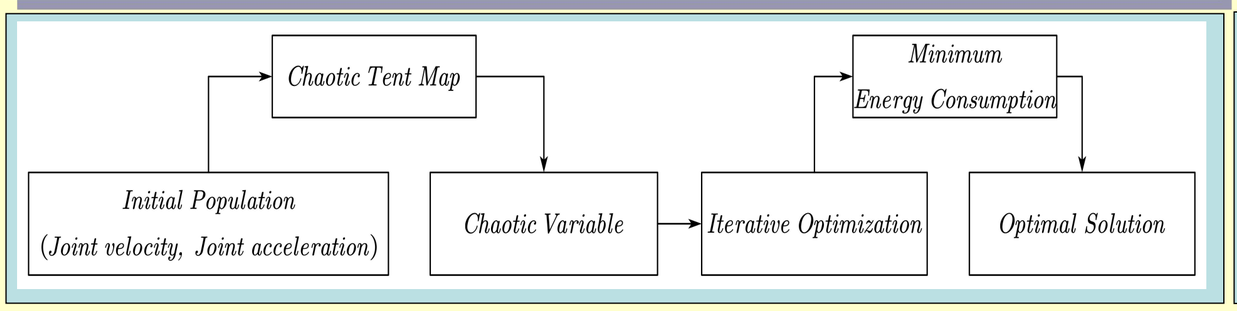
3D model of OMR and PDRCW



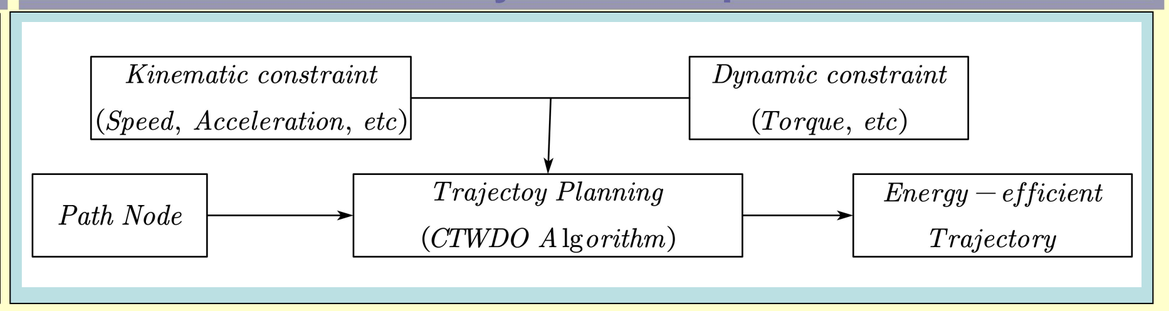
Coordinate system and parameters



CTWDO algorithm flow chart

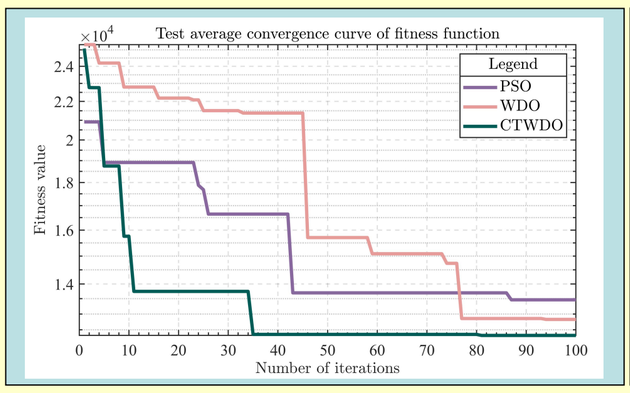


Trajectory planning flow chart

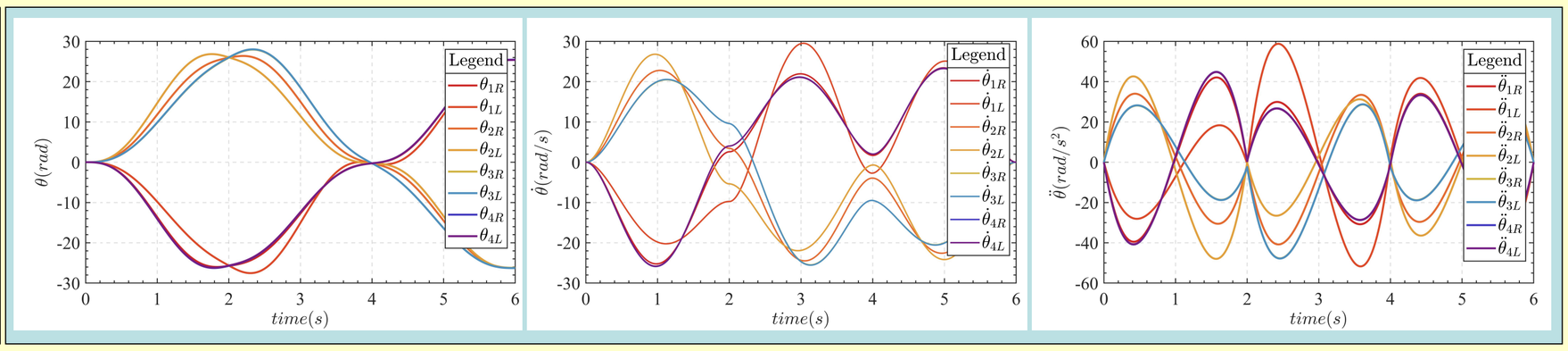


Results

Algorithm comparison



Joint space trajectory



- The convergence time of the CTWDO algorithm is 3.9% and 6.3% shorter than PSO and WDO, respectively. The energy consumption of a trajectory planned with the CTWDO algorithm is 3.9% and 8.5% lower than that of WDO and PSO algorithms, respectively.
- The trajectory planned with a fifth order polynomial and CTWDO not only passes through the set of key nodes in Cartesian space, but also generate smooth displacement and velocity profiles in joint space.

Algorithm name	Energy consumption (J)	Convergence time (s)
PSO	1.3464×10^4	301.2
WDO	1.2826×10^4	308.9
CTWDO	1.2327×10^4	289.4

Optimal energy consumption and average convergence time of CTWDO, WDO, and PSO

Summary

This paper establishes both kinematic and dynamical models for an new OMR based on PDRCWs. An energy-efficient trajectory planning method based on a fifth order polynomial and the CTWDO algorithm is proposed for the OMR. Simulation results show that the trajectory planning method is not only capable of generating energy-efficient trajectories with a high computational efficiency, but also generates continuous and smooth motions in joint space.