הטכניון מכון טכנולוגי לישראל TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, July 10, 2024, at 13:30, D. Dan and Betty Kahn Building Room 217.
Online: ZOOM LINK

Dynamics of an Underactuated Twistcar Robotic Vehicle: Experimental and Theoretical Analysis

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Adviser: Assoc. Prof. Yizhar Or

The Twistcar is an underactuated toy vehicle composed of two segments: a primary segment on which the child sits, and a secondary segment on which the steering wheel is mounted. Each segment has an axle with wheels. This vehicle is propelled by periodically varying the relative angle of the steering segment. The vehicle is inherently underactuated, as the input changes the shape of the vehicle rather than directly affecting the vehicle's variables. In this study, which extends previous research on the same vehicle, the scope of Twistcar's movement has been expanded. Previous studies examined ideal cases without slipping, with non-holonomic constraints on the vehicle's velocity perpendicular to the wheels, and assumed zero mass and moment of inertia for the secondary segment. When simulating without any dissipation, results showed unbounded speed and diverging oscillations of the vehicle body angle, which is not physical and has been proven to not match reality in previous experiments. In this research, the vehicle's movement was theoretically examined through simulations, considering both rolling and sliding dissipation. A viscous rather than Coulomb friction was chosen to avoid hybrid dynamics and excessive sensitivity to numerical results. Additionally, the model was examined without assuming zero mass and moment of inertia for the secondary segment. The simulation results eliminated the unbounded growth of speed and orientation angle and better matched reality. As part of the research, a dedicated robot adapted for experiments was built, and experiments were conducted at different frequencies to examine the agreement of measured motion with the simulations. This research focused on direction reversal phenomenon resulting from changes in the robot's center of mass position, demonstrating this effect experimentally. After the series of experiments, the fit of model's damping parameters to simulations was examined, and adjustments were made for optimal agreement. The experimental setup included noise that interfered with the robot's movement, but despite this, the results showed good alignment with the simulation outcomes. This work proved that tight comparison between theoretical analysis and experiments is crucial for successful investigation of under-actuated wheeled robots.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Gal Shmuel