Abstract

Autonomous wheeled mobile robots used in a variety of outdoor applications such as farming and mining must traverse terrains with varying wheel tractions, resulting in wheel slip and deviations from desired trajectories. In this work, a novel differential torque controller is proposed. Inspired by a mechanical differential gearbox, the proposed model-based dynamic controller can drive the robot through surface changes without losing the desired velocities. This, coupled with an outer-loop kinematic controller, is used to demonstrate good tracking of trajectories under varying surface tractions. The ability of the controller to compensate for the surface change is tested by suddenly changing the surface under one or both wheels. The simulation results have shown that the dynamic controller compensates for the change in the surface, and the resulting position errors are driven to zero using the kinematic controller.

As the proposed dynamic controller uses a velocity feedback. a camparitive study is conducted on various methods of estimating the linear velocities from noisy sensor data. In perticular estimation using direct integration of noisy accelerometer data, model driven observer using less noisy encoder data, and Kalman based sensor fusion using relaiable LiDAR data and noisy accelerometer data have been explored. The simulation results have shown that the model driven observer and the Kalman based sensor fusion model offer appreciable results.

However, the estimation using model driven observer, requires accurate estimation of the friction coefficient. The errorneous friction coefficient estimate in the observer results in the velocity estimation error. By using the estimation error in the observer, a friction coefficient estimator is proposed. The simulation results shows that proposed estimator can independely predict the sudden surface change of the individual wheels.