

# Overconstrained Wheeled Vehicles: A Simpler Rocky 7–The Kinematic Car

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## Abstract

This paper examines an application of the controllability theory to the case of MMDA systems where the individual models are essentially nonlinear. First, the concepts are more easily illustrated in this nonlinear setting in the context of an example of the Mars Rover. The Mars Rover is itself an important engineering application, and this paper contributes to understanding how to design an appropriate control structure. This paper examined in detail the controllability of a simple model of the Rocky 7 Mars Sojourner. Some initial steps towards a motion planning have been outlined and preliminary results for control of such vehicles are given. The extension of Chow's theorem is used to show conditions under which vehicles like the Mars rover are controllable. Moreover, variations of the rover are used to illustrate that controllability of the individual models, which make up a multiple model driftless affine system, is not sufficient to guarantee controllability of the overall multiple model driftless affine system. Section 3.1 discusses the full input space for a six-wheeled, fully actuated system. The potential importance of the vehicles discussed in Section 3 in future planetary exploration missions indicates the need for more in-depth analysis of stabilization. Future work will investigate algorithms for stabilizing the multiple model systems of Definition 3.2.

**Index Terms**— Mobile robots, nonholonomic motion planning, overconstrained vehicles, obstacle avoidance, path tracking, vehicle control, *MMDA systems*

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