MEM 637 Nonlinear Control II, Spring Project 1

Professor Harry Kwatny

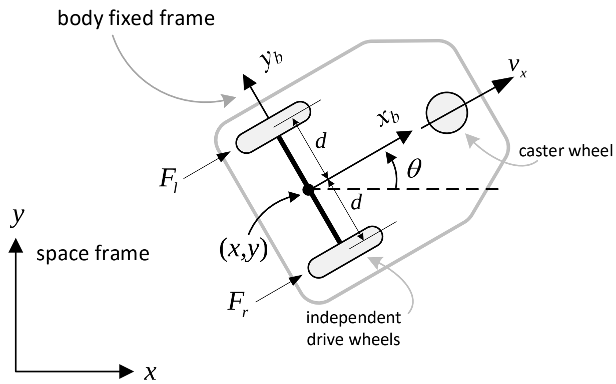

Figure 1. Simple wheelset.

Consider the wheelset used to model a simple wheeled robot as shown in Figure 1. The system is represented by the differential equations

$$
\begin{aligned}
\dot{x} &= v_x \cos\theta \\
\dot{y} &= v_x \sin\theta \\
\dot{\theta} &= \omega \\
M\dot{v}_x &= F \\
J\dot{\omega} &= T
\end{aligned}
$$

The driving force *F* and the steering torque *T* are generated by coordinating the independent wheel torques.

Part 1: Controllability

Compute the controllability distribution Δ_{C_0}. Determine its generic rank. Determine its rank at states with $v_x = 0$.

Part 2:

Now, design a feedback controller that will steer the robot to a prescribed equilibrium configuration in the state space (e.g. $x=0, y=0, \theta=0$ and $v_x = 0, \omega = 0$) and will stabilize the equilibrium point.

This problem is nontrivial. References [1] and [2] illustrate two different approaches. Discuss the essential difficulty and the two approaches.

Try to implement one of them, or an alternative of your own design, and discuss your results. You can use the Simulink model provided.

[1] G. Oriolo, A. D. Luca, and M. Venditteli, "WMR Control via Dynamic Feedback Linearization: Design, Implementation and Experimental Validation," *IEEE Transactions On Control Systems Technology,* vol. 1, pp. 833-852, 2002.

[2] V. Sankaranayanan and A. D. Mahindrakar, "Switched control of a Nonholonomic Robot,," *Communications in Nonlinear Science and Numerical Simulation,* vol. 14, pp. 2319 -- 2327, 2009.