Appl. Comput. Math. 1 (2002), no. 2, pp. 131-141

STEERING OF NONHOLONOMIC MOBILE ROBOTS BY USING DIFFERENTIAL GEOMETRIC APPROACH

FAZAL-UR-REHMAN

ABSTRACT. Employing the example of a class of wheeled mobile robots, a simple and systematic approach to the construction of stabilizing feedback control for nonholonomic systems is presented. Two types of robotic models are considered: models with the degree of mobility $\delta_m = 1$, and the degree of steeribility $\delta_s = 1$, and the models characterized by $(\delta_m, \delta_s) = (1, 2)$, and for both models, the controllability Lie algebras are infinite dimensional. For feedback design purposes, the original models are first approximated by ones whose respective controllability Lie algebras are finite dimensional. A time varying stabilizing feedback law is constructed for each of the simplified models by employing their respective Lie bracket extensions. The resulting feedback laws can be regarded as compositions of standard stabilizing feedback control laws for the extended systems and periodic continuations of parameterized solutions to certain open-loop, finite horizon trajectory interception problems, stated in logarithmic coordinates of flows. An adequately large stability robustness margin for the extended controlled systems can always be insured, and is shown to guarantee that the constructed feedback laws are stabilizing not only for the approximate but also for the original models. This approach does not rely on a specific choice of a Lyapunov function, and does not require transformations of the models to chained forms.