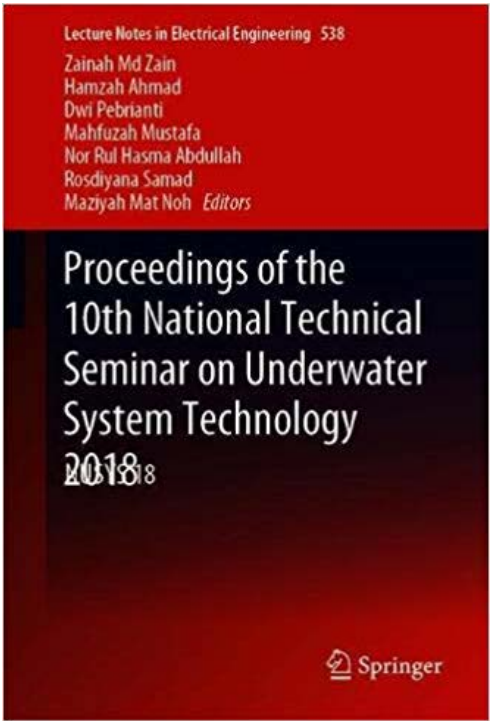

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Contents

Backstepping Control of Nonholonomic Car-Like Mobile Robot in Chained Form

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Abstract. This project is attempts to stabilize an underactuated system based on the backstepping approach. The discontinuous time-invariant state feedback controller is designed for exponential stabilization of underactuated nonholonomic systems in chained form. System dynamic of the car-like robot with nonholonomic constraints were employed. The validity of the proposed approaches is tested through simulation on a car-like vehicle using Matlab software.

Keywords: Backstepping control, Underactuated system, Mobile robot

1 Introduction

The motion control of nonholonomic wheeled mobile robot (WMR) has received a great attention from researchers over the last few years. Most of the researches are focused on the fact that the WMR does not meet Brockett's necessary condition for smooth feedback stabilization [1]. It is accepted that the larger the gap between the controllable and total degrees-of-freedom (DOF) of the WMR, the harder it is to control the robot [2]. The WMR cannot be stabilized to a point using the familiar smooth static-state feedback control laws due to this nonholonomic constraint.

The dynamic equations of a car-like vehicle mobile robot can be written in chained form as:

$$\begin{aligned} \dot{x}_1 &= u_1 \\ \dot{x}_2 &= u_2 \\ \dot{x}_3 &= x_2 u_1 \\ &\vdots \\ \dot{x}_n &= x_{n-1} u_1 \end{aligned} \tag{1}$$

where $x = (x_1, x_2, \cdots, x_n)^T \in IR^n$ represents the state vector and $u = (u_1, u_2)^T \in IR^2$ represents the input vector.

Such a class of nonlinear systems cannot be stabilized via continuous based time-invariant system [1], which driven the search of other stabilizing controls for this