Canonical transformation and feedback linearization of state-dependent coefficient nonlinear systems

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Abstract: This report is devoted to a feedback linearisation problem for a nonlinear system with state-dependent coefficients:

$$\dot{x}(t) = A(x)x + B(x)u,\ x(0) = x_0, \tag{1}$$
$$x \in R^n,\ u \in R^1.$$

Here $A(x), B(x)$ are state-dependent matrices of the dimensions $n \times n, n \times 1$ correspondingly.

The problem is to find a non-singular similarity transformation $z = T(x)x$ such that the system (1) can be transformed to a quasi-linear canonical form

$$\dot{z}(t) = A_c(z)z + B_c(z)u,\ z(0) = z_0, \tag{2}$$

where $A_c(z),\ B_c(z)$ is a canonical pair in the form of Brunovskiy. This canonical transformation significantly simplify feedback linearization problem for transformed system (2), and knowing the inverse transformation $x = T^{-1}(z)z$, one can obtain a feedback linearization control for original system (1).

There are several techniques for designing such canonical transformation [1,2]. In this paper we introduce another approach based on the concept of state-dependent transfer function and controllability matrix for nonlinear system (1).

Keywords: state-dependent coefficient, nonlinear system, feedback linearisation, canonical transformation

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