Observer Design for a Class of Nonlinear Systems with Non-Full Relative Degree

K. Röbenack

Abstract: The paper proposes a method for observer design for a class of nonlinear systems. We decompose the system using a weaker concept than the relative degree. We provide sufficient conditions for global asymptotic stability of the error dynamics. The observer design is carried out by means of a change of coordinates combined with a high gain technique. In particular, our approach results in an observer gain vector field which is extraordinarily easy to compute.

Keywords: Nonlinear system; coordinate change; observer design; Moore-Penrose inverse.

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1 Introduction

We consider the problem of observer design for nonlinear single-input single-output systems. A particularly interesting class of design methods use differential geometric concepts. These design methods are based on various normal forms. In [19, 3], the observer canonical form consisting of a linear output map and linear dynamics driven by a nonlinear output injection is used. The resulting observer has exactly linear error dynamics, i.e., nonlinearities are compensated exactly. The approaches suggested in [13, 9, 10, 5] rely on the observability canonical form, which has significantly weaker existence conditions than the observer canonical form. In the observability canonical form, the observer is designed by a high-gain technique with a constant observer gain, i.e., the nonlinearities are not compensated but dominated by a linear part. For an implementation of the