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OBSERVER DESIGN USING NORMAL FORMS: ANALYTICAL APPROACHES AND EXTENDED LINEARIZATION

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Abstract. For nonlinear single output systems, we consider observer design methods based on differential-geometrically motivated normal forms in connection with gain scheduling. Gain scheduling methods such as extended linearization can be used to loosen restrictive existence conditions and to simplify computational aspects of observer design.
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1 Introduction

The observer problem is to estimate the state for a given plant only with output (and possibly input) information. We consider observer design for plants modeled as a nonlinear single-output state-space system

$$\dot{x} = f(x), \quad y = h(x) \tag{1}$$

with smooth maps $f : \mathbb{R}^n \to \mathbb{R}^n$ and $h : \mathbb{R}^n \to \mathbb{R}$.

The problem of observer design for nonlinear systems has attract significant attention during the last decades, see [33] and references cited there. One approach introduced in [29] is the construction of an observer whose error dynamics are linear in a particular coordinate system. To carry out the observer design, the system is transformed into observer canonical form. The resulting observer is called *normal form observer*. However, the change of coordinates required by the design procedure exists if and only if a certain non-generic integrability condition is satisfied [24]. Unfortunately, many systems of engineering interest fail this condition. Moreover, the design procedure requires an analytical solution of partial differential equations, which is rather difficult to find.

From a practical point of view, observer design for nonlinear systems is often approached by linearizing the system about a typical operating point. To take a wider range of operation into consideration, this process is repeated at several operating points. The use of linear controllers and observers,