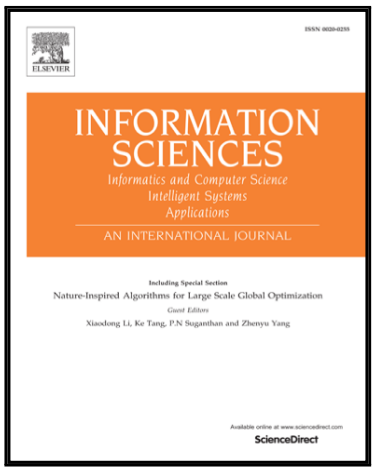

Robust Adaptive Fault-tolerant Control of Nonlinear Uncertain Systems Tracking Uncertain Target Trajectory

Dong Zhang, Zhixi Shen, Yongduan Song

PII: S0020-0255(16)31131-8
DOI: 10.1016/j.ins.2017.06.023
Reference: INS 12945

To appear in: *Information Sciences*

Received date: 1 October 2016
Revised date: 4 June 2017
Accepted date: 19 June 2017

Please cite this article as: Dong Zhang, Zhixi Shen, Yongduan Song, Robust Adaptive Fault-tolerant Control of Nonlinear Uncertain Systems Tracking Uncertain Target Trajectory, *Information Sciences* (2017), doi: 10.1016/j.ins.2017.06.023

Available online at www.sciencedirect.com

ScienceDirect

Information Sciences (2017) 1–16

Information Sciences

Robust Adaptive Fault-tolerant Control of Nonlinear Uncertain Systems Tracking Uncertain Target Trajectory ☆

Dong Zhang[a,b], Zhixi Shen[a,b,*], Yongduan Song[a,b]

[a] *Key Laboratory of Dependable Service Computing in Cyber Physical Society of Ministry of Education, Chongqing University, Chongqing 400044, China.*

[b] *College of Automation, Chongqing University, Chongqing 400044, China.*

Abstract

The problem of enabling nonlinear uncertain dynamic systems to track a moving target with uncertain trajectory is of theoretical and practical importance. The underlying problem becomes further complicated if there involve unexpected actuation failures. In this paper, a robust adaptive fault-tolerant tracking control approach is proposed for unknown multi-input multi-output (MIMO) nonlinear systems without a priori precise knowledge of the desired target trajectory. To account for the impact of the uncertain desired trajectory, a mathematical model based on the extended Kalman filter (EKF) for reconstructing desired trajectory is proposed, which is then integrated into the development of tracking control algorithms to cope with modeling uncertainties and actuation faults. The matrix decomposition technique and the concept of deep-rooted information are used to facilitate the control design and stability analysis. The effectiveness of the proposed method is verified via computer simulation.

Keywords: MIMO systems, uncertain desired trajectory, extended Kalman filter (EKF), fault-tolerant control

1. Introduction

The problem of tacking control (TC) for dynamic systems has attracted considerable attention among the control community during the past decades, mainly because an enormous amount of engineering control problems can be treated or formulated as tracking. For instance, aerospace vehicle flight control, auto-driving, missile interception and formation of unmanned (aero, ground) vehicles, etc [3, 7, 12–14, 30]. As one of the most extensively studied topics in linear and nonlinear control systems, TC has archived fruitful results [3, 4, 17, 21, 23, 25, 29, 31, 32, 41, 44, 45] (just to name a few). The early works on TC can be found in [29, 31, 32, 41] and the references therein. In [17, 25], efficient TC-based methods are proposed for linear systems. State-feedback TC for MIMO nonlinear systems in strict-feedback form is developed via backstepping technology [3, 4, 21]. Based on adaptive TC, some feasible controllers are designed for uncertain nonlinear discrete-time systems [23] and switched nonlinear systems [44, 45]. Note that the common practice of these studies is the assumption that the desired trajectory is precisely known/available a priori.

However, the reference trajectory to be tracked might be difficult to obtain precisely in practice, for example, in missile interception, the trajectory of the enemy missile might be disguised intentionally (i.e., hidden or stealthy attacker), making the desired trajectory unavailable for interceptor guide. Also in adversary's target destruction at

☆This work was supported in part by the Technology Transformation Program of Chongqing Higher Education University under Grant KJZH17102

*Corresponding author

Email addresses: zhangdong@cqu.edu.cn (Dong Zhang), shenzhixi@cqu.edu.cn (Zhixi Shen), ydsong@cqu.edu.cn (Yongduan Song)