Available online at www.sciencedirect.com

ScienceDirect

Journal of the Franklin Institute 354 (2017) 257–276

Journal of The Franklin Institute

www.elsevier.com/locate/jfranklin

Admissible consensus for descriptor multi-agent systems via distributed observer-based protocols

Lixin Gao*, Yulong Cui, Wenhai Chen

Institute of Intelligent Systems and Decision, Wenzhou University, Zhejiang 325035, China

Received 9 February 2016; received in revised form 27 August 2016; accepted 10 October 2016
Available online 17 October 2016

Abstract

In this paper, the admissible consensus problem of descriptor multi-agent systems via distributed observer-based protocols is considered. The dynamics of agents is modeled by the general form of continuous-time linear descriptor systems, and the interaction topology among the agents is modeled by a directed graph. It is assumed that the output information but not the state information of the agents is available. To achieve control objective, two types of state observers are adopted for the agents to estimate its states and the related state disagreements respectively, by which two different architectures of connecting observers and controllers are proposed. Based on the generalized Riccati equation and Lyapunov admissible theory, a sufficient admissible consensus condition is established for the descriptor multi-agent systems. The full-order and reduced-order observer-based consensus protocols can be unified in our proposed framework. Based on the special solutions of the established condition, some full-order and reduced-order observer-based consensus protocols can be obtained. Finally, a simple simulation example is provided to illustrate our established result.

1. Introduction

In the past few decades, a huge and rapidly growing literature on multi-agent systems due to its numerous potential applications [1]. Although the practical multi-agent systems have different backgrounds, the fundamental idea in coordination control of multi-agent systems is that while

*Corresponding authors.
E-mail address: lxgao@wzu.edu.cn (L. Gao).

http://dx.doi.org/10.1016/j.jfranklin.2016.10.017

each agent can only access to the information of its neighbor and itself, a goal of the whole system can be achieved without centralized controller. It is well-known that consensus problem is one of the most important and fundamental issues of coordination control, whose main task is to design the distributed protocols based on the local relative information so that the states of a group of agents can reach an agreement [2]. Till now, numerous interesting results have been established for the multi-agent consensus problems with different system dynamics, including first-order system [2,3], second-order system [4,5], general linear system [6–8], descriptor system [9,10], discrete-time system [12,11], and non-linear system [13–15].

Most of the existing approaches to solve consensus problem are based the state information. But, in many practical systems, some state variables can not be obtained directly due to the technical constraints or economic cost. To achieve control aim in this case, the observer-based consensus protocols are proposed by adopting the state observers to estimate those unmeasurable state variables. The observer-based consensus problem with first-order dynamics was first addressed by [16], whose protocols based on a velocity observer to estimate the velocity of second-order leader. Furthermore, to track the leader with general linear dynamics, a distributed observer-based consensus protocol was proposed in [17], and its communication delay case discussed by [19]. In [18], the H^{∞} consensus problem was addressed based on estimation of uncertain systems via dissipativity theory. To track the leader with acceleration motion, a distributed acceleration observer based consensus protocol was provided by [4]. The second consensus problem via sampled-data and observer-based control was investigated by [11]. For multi-agent systems with general linear dynamics, [6] introduced a unified framework to design the distributed observer based consensus protocols, and three kinds of consensus protocols based on different connected architectures of controllers and observers were proposed by [7]. Then, the reduced order and functional observer based consensus protocols were investigated by [8,20,21] and [22,23] respectively. In [12], two kinds of distributed observer-based consensus protocols were proposed to solve the consensus problem with discrete-time general linear dynamics.

The descriptor system is also referred to as singular state-space system, generalized system, or implicit system [24], which is more general than normal physical systems and especially suitable for modeling many engineering systems, such as robotic system, mechanical system, power system, and so on. Actually, the descriptor system is characterized by the differential-algebraic equations, which may be more complicated and challenging to deal with than normal systems. Till now, the related control problem, such as stability, admission, observer-based control, robust control, for descriptor systems is still attracting, and a great number of useful results have been obtained [25–29]. The applications of descriptor multi-agent systems can be found in practical, such as the multi-agent supporting systems are wildly adopted in earthquake damage prevention in buildings, large-diameter parabolic antennae or telescopes and water-floating plants. It is worth to noted that the multi-agent supporting systems can be described by descriptor systems when they consist of many independent blocks and each block is supported by several pillars, more details can be found in [30]. Usually, each subsystem (i.e., agent) has three types of modes which are finite-dynamic modes, impulse modes and non-dynamic modes. Recently, the coordination control problems for descriptor multi-agent systems have been drawing increasing attention. In [31], the network-based control problem was addressed for a class of discrete-time descriptor systems with random delays. The necessary and sufficient conditions of consensusability with respect to a set of admissible consensus protocols were