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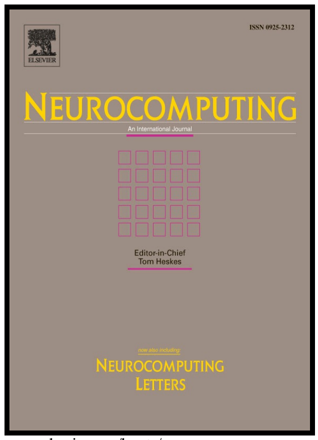

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Speed sensor fault tolerant controller design for induction motor drive in EV

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ABSTRACT

This paper deals with the problem of speed sensor fault tolerant controller (SSFTC) design for Induction Motor (IM) drive in electric vehicle (EV). First, the Takagi-Sugeno (T-S) model approach was adopted to represent the nonlinear dynamic of IM subject to speed sensor faults and unknown bounded disturbance. Next, based on $\mathcal{L}_2$ robust fault detection filter design, a Modified Field Oriented Controller (MFOC) is designed. The proposed approach requires the knowledge of the occurring faults which are estimated from a descriptor observer. The observer gains are determined by solving a set of Linear Matrix Inequality (LMI). Finally, simulation results show the effectiveness of the proposed approach evaluated on 7.5kVA Induction Motor.

***Key Words**:* Fault tolerant controller, T-S fuzzy model, electric vehicle, modified field-oriented control, disturbance, LMI.

1. Introduction

Recently, CO_2 emissions reduction in automotive transportation domain through alternative energy sources other than petroleum has received huge interest. The electrification of vehicles presents an interesting solution to achieve ambitious objective allowing reducing fuel consumption, limit environment impacts and diversify energy sources [1] In this context, several research activities are focusing on the development of more efficient drive systems for vehicles, in particular using electric machine as Induction Machine (IM), a Switched Reluctance Machine (SRM), or Permanent Magnet Synchronous Machine (PMSM) [1-4]. Currently, Because of its simplicity and properties of reliability, robustness and low cost, the induction machine is considered more viable for electric power train in electric vehicle (EV).However, EV control system is well known to be difficult due to the significantly increased system complexity, and numbers of actuators [5-6]. Furthermore, the EV control system depends on the sensor measurement. Hence, if a sensor fault occurs, it can lead to substantial damage and can even be dangerous for the human and environment. Consequently, a high degree of fault tolerance is required for the operational system. This later can be realized by using certain redundant material components, or by detecting and isolating the faults at an early stage of their development so as to perform required system operation against faults. In fact, it is necessary to develop fault tolerant control (FTC) strategies in order to maintain acceptable performance and preserve drive system stability even in failure situations. The existing strategies are classified into two classes.

The first class is called passive fault tolerant control or robust control. In this approach, the faults are treated as non-structural bounded uncertainties. The control is designed to be robust only to the specified faults. Thus, the issues of fault detection and estimation are not involved either. Contrarily to the passive FTC, active FTC requires a FDI block to detect, isolate and estimate the fault signals. The FDI block information's are used to reconfigure the controller law in order to maintain system stability, thus ensuring acceptable system performances (see e.g [7-12] and references therein). Moreover, the success of these methods mainly depends on the model complexity. Indeed, most studies have considered simple models and generally linear. The reality is far from this assumption and systems are extremely nonlinear. Nevertheless, a large class of nonlinear systems can be well approximated by Takagi-Sugeno (T-S) fuzzy models [11, 13]. This later is described by a set of linear time invariant (LTI) models and an interpolation mechanism between these models based on nonlinear weighting functions.

This paper is dedicated to the design of a fault tolerant control strategy for T-S model of an induction motor drive affected by speed sensor fault. Generally,

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