

# Preface

It is well known that most plants in the industry show significant nonlinearities, which usually make the analysis and controller design difficult. In order to deal with such difficulties, various schemes have been developed in the past two decades, among which a successful approach is the fuzzy control. In recent years, one of fuzzy methods which is also called Takagi–Sugeno (T–S) fuzzy models has been proved to be effective in terms of the stabilization for a wide class of nonlinear systems. This approach enables one to define a representation of some nonlinear systems by means of a collection of linear models which are interconnected by nonlinear functions. Within the general framework of T–S fuzzy model-based control systems, there has been a flurry of research activities in the analysis and design of fuzzy control systems based on the linear matrix inequality (LMI) technique. On the other hand, state estimation problems have attracted wide attention from scientists and engineers, essentially because the state variables in control systems are not always available. So far, different methodologies have been used to design the filter. One approach is  $H_\infty$  filtering, and the advantage is that the noise signals in the  $H_\infty$  filtering setting are arbitrary signals with bounded energy, and no exact statistics are required to be known, which is more general than classical Kalman filtering. With the development of digital electronic technology, the implementation of digital filter devices brings new problems, such as signal quantification, stability of numerical algorithms and so on. Further, these factors will lead to inaccuracies or uncertainties in the implementation of a designed filter. However, many previous works on the filtering problem are often on an implicit assumption that the filter will be implemented exactly. Therefore, how to design a non-fragile filter that is insensitive to some amount of errors is a meaningful issue. For linear systems, there have been some significant results on non-fragile  $H_\infty$  filtering. Unfortunately, the problem of designing non-fragile  $H_\infty$  filter for nonlinear systems still remains as open research subject.

This monograph aims to present some new results on non-fragile  $H_\infty$  filtering for T–S fuzzy systems. It is primarily intended for graduate students in control and filtering, but can also serve as a valuable reference material for researchers wishing to explore the area of fuzzy control and filtering of nonlinear systems. Moreover,

it lists some useful and less conservative matrix transformation techniques, and the main results of this monograph are expressed in a unified LMI framework, which will provide an effective foundation for the future research.

China, January 2012

Xiao-Heng Chang