Preface

With the global warming and the rapid improvement of people's living standards, energy consumption by air-conditioning (AC) systems in buildings is on the rise. According to the US Energy Information Administration (EIA) and the US Department of Energy, the consumption of electrical energy by HVAC (heating, ventilation, and air-conditioning) systems in the residential, commercial, and industrial sectors corresponds to 18.62 %, 16.20 %, and 2.34 % of the total electrical energy consumed in the USA, respectively (totalizing 37.16 %). In China, building sector accounted for 23.4 % and 28 % of total energy use in 2011 and 2012, respectively, and about half of total building energy is consumed by HVAC systems. Thus, energy conservation in HVAC systems will play an important role in search of solutions to meet the growing global energy demand. Any technological measures for HVAC systems' energy consumption reduction require effective models based on which the high-performance HVAC systems and optimal control schemes for highly efficient operations can be designed.

This book mainly concerns about modeling and control in air-conditioning systems. Some advanced modeling methods including state-space method, graph-theory method, and structure-matrix method, as well as combined forecasting method, are employed for the modeling of air-conditioning systems. The virtual sensor calibration and virtual sensing methods (which will be very useful for the real system control) are illustrated together with the case study. The model-based predictive control and the state-space feedback control are introduced to the air-conditioning systems for a better local control, and the air-side synergic control scheme and the global optimization strategy with the decomposition-coordination method are developed aiming at energy conservation of the entire system. Lastly, control strategies for VAV systems including the total air volume control and the trim-and-response static pressure control are investigated with practice. The book comprises ten chapters that are summarized as below:

Chapter 1 (written by Dr. Ye Yao and Dr. Yuebin Yu) introduces background of the topic related to this book, gives a literature overview about modeling approaches in HVAC field, and presents proposed methods to be used in this book.

Chapter 2 (written by Dr. Ye Yao) illustrates in detail the modeling process for HVAC components and system with the state-space modeling method.

Chapter 3 (written by Dr. Ye Yao) presents simulation results on transient responses of HVAC components with the state-space models under different perturbations and initial conditions.

Chapter 4 (written by Dr. Ye Yao and Dr. Yuebin Yu) is related to development of graph-theory approach for modeling HVAC components and system, and introduces the structure-matrix analysis method to study control characteristics of HVAC state-space models.

Chapter 5 (written by Dr. Yuebin Yu and Dr. Ye Yao) deals with the virtual sensor calibration and virtual sensing methods.

Chapter 6 (written by Dr. Yuebin Yu and Dr. Ye Yao) is about control design based on the state-space model.

Chapter 7 (written by Dr. Ye Yao) is about forecasting models for air-conditioning load prediction. The two original forecasting models based on the combined principle are introduced.

Chapter 8 (written by Dr. Ye Yao) deals with energy models for HAVC components based on which the energy analysis program is developed and used for the energy analysis on variable-air-volume (VAV) air-conditioning systems.

Chapter 9 (written by Dr. Ye Yao and Dr. Yuebin Yu) is about optimal control of HVAC system aiming at energy conservation.

Chapter 10 (written by Dr. Ye Yao and Dr. Yuebin Yu) mainly deals with modular modeling, control strategies, and sequences as well as test script for VAV system.

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