

Preface

The considerable boost in energy consumption and greenhouse gas emissions, mainly derived from human activities, is a problem of great concern which should be dealt with in an appropriate way. Energy consumption in buildings (residential and non-residential) represents almost half of the total world energy consumption, mainly attributed to Heating, Ventilation and Air Conditioning (HVAC) systems and, moreover, it is also responsible for approximately 35 % of CO₂ emissions. For these reasons, the energy consumption reduction associated with the construction and use of buildings, together with the increase of energy efficiency in their climatic refurbishment, are topics widely analysed by academia and industry. As most of the time people develop their daily activities inside buildings this energy saving cannot be obtained by putting users' welfare to risk, since their productivity is directly related to their comfort. Thus, it is necessary to look for a tradeoff between users' comfort and energy saving. In order to achieve this compromise, the construction of bioclimatic buildings which incorporate passive strategies and make use of renewable energies is one of the most applied approaches. Nevertheless, in some cases, and mainly due to the typical climate of the place where the building is located, it may be insufficient. In these cases, it is required, together with innovations in structural designs, to perform specific control actions on HVAC systems and other building's actuators, oriented to provide comfortable environments from thermal, visual and indoor air quality points of view, and with the minimum energy consumption.

This book contains results from a bioclimatic building, the CDdI-CIESOL-ARFRISOL building located inside the Campus of the University of Almería in the south-east of Spain, where several advanced control systems have been developed and implemented with the aim to maintain users' comfort (from a thermal and indoor air quality points of view) minimising, at the same time, energy consumption. For this, some specific objectives have to be satisfied, such as the study of methodologies to evaluate comfort inside buildings, analysis and modelling of the main environmental variables which affect users' comfort, and the design, development and test of control algorithms for these environmental variables. The book is mainly aimed at practitioners, from both the control engineering community and the architecture community, although it can be followed by a wide range of readers, as only basic knowledge of control theory is required. The text is

mainly composed from material collected from articles written by the authors, and from technical reports and lectures given to graduate students.

The book is organized as follows: Chapter 1 is devoted to establishing the scope and the main objectives of this book, including the regulation and main figures regarding CO₂ emissions and total energy consumption in the European Union and the Spanish cases which are used as motivating examples. Chapter 2 presents a complete description of the bioclimatic CDdI-CIESOL-ARFRISOL building which has been used to test the developed control systems. Chapter 3 reviews the basic concepts and terminology of comfort for buildings' users from three points of view: (i) thermal, (ii) visual and (iii) indoor air quality. Moreover, a comfort analysis to evaluate the performance of the CDdI-CIESOL-ARFRISOL building without the use of any control strategy is reported. Chapter 4 explains different techniques which allow to develop dynamic models for the indoor climate of a typical office room. These kinds of models are a keystone to develop control strategies helping to obtain high comfort levels as well as to evaluate the energy performance in buildings. In Chap. 5, several control strategies developed aimed at obtaining an optimal comfort situation for the users of a room, minimising, at the same time, the energy consumption are presented. More specifically, hierarchical, linear model-based predictive control, nonlinear model predictive control and multivariable model predictive control strategies are presented. Finally, Chap. 6 presents new trends for comfort control in buildings together with some suggestions for building technicians about comfort control, which are based on the experience and knowledge presented in this book.

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María del Mar Castilla
José Domingo Álvarez
Francisco Rodríguez
Manuel Berenguel

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Castilla, M.d.M.; Álvarez, J.D.; Rodríguez, F. de A.;
Berenguel, M.

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