



Optimal Control of GREENHOUSE CULTIVATION

Gerit van Straten • Gerard van Walbeek
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CRC Wageningen

Optimal Control Of Greenhouse Cultivation

Eric Lichtfouse

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Optimal Control of Greenhouse Cultivation Gerrit van Straten, Gerard van Willigenburg, Eldert van Henten, Rachel van Ooteghem, 2010-11-08 Greenhouse control system manufacturers produce equipment and software with hundreds of settings and while they hold training courses on how to adjust these settings there is as yet no integrated instruction on when or why. Despite rapid growth in the greenhouse industry growers are still faced with a multitude of variables and no unifying frame

Modeling and Control of Greenhouse Crop Growth Francisco Rodríguez, Manuel Berenguel, José Luis Guzmán, Armando Ramírez-Arias, 2014-11-01 A discussion of challenges related to the modeling and control of greenhouse crop growth this book presents state of the art answers to those challenges. The authors model the subsystems involved in successful greenhouse control using different techniques and show how the models obtained can be exploited for simulation or control design they suggest ideas for the development of physical and or black box models for this purpose. Strategies for the control of climate and irrigation related variables are brought forward. The uses of PID control and feedforward compensators both widely used in commercial tools are summarized. The benefits of advanced control techniques event based robust and predictive control for example are used to improve on the performance of those basic methods. A hierarchical control architecture is developed governed by a high level multiobjective optimization approach rather than traditional constrained optimization and artificial intelligence techniques. Reference trajectories are found for diurnal and nocturnal temperatures climate related setpoints and electrical conductivity fertirrigation related setpoints. The objectives are to maximize profit fruit quality and water use efficiency these being encouraged by current international rules. Illustrative practical results selected from those obtained in an industrial greenhouse during the last eight years are shown and described. The text of the book is complemented by the use of illustrations tables and real examples which are helpful in understanding the material. Modeling and Control of Greenhouse Crop Growth will be of interest to industrial engineers academic researchers and graduates from agricultural chemical and process control backgrounds

Greenhouse Engineering V.P. Sethi, 2025-08-19 The comprehensive software based approach in this book provides an in depth exploration of the latest innovations in greenhouse engineering thus transforming the existing Controlled Environment Agriculture CEA to a futuristic Greenhouse Smart Agriculture GSA aiding the reader to optimize crop yields reduce environmental impact and enhance farm profitability through software decision support systems. From renewable energy solutions and software driven sustainable practices to AI powered optimization and integrated smart greenhouse design it covers the entire spectrum of GSA including practical knowledge global case studies and real world examples. Key features: Explores innovative renewable energy solutions for Greenhouse Smart Agriculture. Implements software driven sustainable solutions for optimized crop yields and reduced environmental impact. Develops innovative control strategies for Greenhouse Smart Agriculture using artificial intelligence the Internet of Things and advanced techniques. Optimizes greenhouse

production through modelling and simulation techniques for enhanced sustainability Designs and implements sustainable greenhouse climate control systems for heating cooling and energy efficiency Creates integrated smart greenhouse systems that combine automation renewable energy and sustainable design Harnesses the power of artificial intelligence the Internet of Things and data driven approaches to enhance greenhouse optimization and sustainable agriculture Integrates smart soilless greenhouse agriculture and aquaponics using a design to software approach This book is aimed at university and greenhouse industry researchers agricultural engineers and graduate students in fields such as agriculture agricultural and biosystems engineering horticulture environmental science and renewable energy as well as professional agricultural policymakers

Mathematical and Control Applications in Agriculture and Horticulture W. Day, Yasushi

Hashimoto, 2014-07-04 This title provides a general overview of recent developments and research into types of systems and their uses in the agricultural and horticultural industry 64 papers are included containing both theoretical models and applied examples for greenhouse systems harvesting technology and plant factory systems

The Computerized

Greenhouse Bozzano G Luisa, 2012-12-02 The aim of this book is to open up research areas in automatic control engineering for crop production systems in horticulture and agriculture and to explain the principle ideas of advanced automatic control in plant production The text includes detailed discussions of Fundamental systems engineering concepts Modeling Control for agricultural systems Optimal control and its applications Artificial intelligence for agricultural applications

Greenhouses Joe J. Hanan, 2017-11-22 A greenhouse provides an essential means of livelihood to its owner and must be economically practical for the particular climate in which it stands Greenhouses Advanced Technology for Protected Horticulture addresses the major environmental factors of light temperature water nutrition and carbon dioxide and features extensive discussions of greenhouse types construction and climate control The book highlights technology such as hydroponics computer control of environments and advanced mathematical procedures for environmental optimization Greenhouses Advanced Technology for Protected Horticulture is the definitive text reference for the science of greenhouse engineering and management The author Dr Joe J Hanan Professor Emeritus of Colorado State University is the recipient of the Society of American Florists SAF 2000 Millenium Alex Laurie Award for Research and Education The Alex Laurie Award is presented annually to an individual who has made broad scope long lasting contributions to the floriculture industry through research or education The award is named for Alex Laurie a professor at The Ohio State University who pioneered work in many areas of floriculture Joe is one of the most precise floricultural researchers I have known said Dr Gus De Hertogh Chairman of SAF s Research Committee That excellence is reflected in his latest book Greenhouses Advanced Technology for Protected Horticulture which was published in 1998 nine years after his official retirement

Geothermal,

Wind and Solar Energy Applications in Agriculture and Aquaculture Jochen Bundschuh, Guangnan Chen, D.

Chandrasekharam, Janusz Piechocki, 2017-08-02 The agri food chain consumes about one third of the world s energy

production with about 12% of it for crop production and nearly 80% for processing distribution retail preparation and cooking The agri food chain also accounts for 80 90% of total global freshwater use where 70% alone is for irrigation Additionally on a global scale freshwater production consumes nearly 15% of the entire energy production It can therefore be argued that making agriculture and the agri food supply chain independent from fossil fuel use has a huge potential to contribute to global food security and climate protection not only for the next decades but also for the coming century Provision of secure accessible and environmentally sustainable supplies of water energy and food must thus be a priority One of the major objectives of the world s scientists farmers decisions makers and industrialists is to overcome the present dependence on fossil fuels in the agro food sector This dependency increases the volatility of food prices and affects economic access to sustenance This book provides a critical review of recent developments in solar wind and geothermal energy applications in agriculture and the agro food sector such as processing distribution retail preparation and cooking

WP3 - Innovation in Agriculture and Forestry Sector for Energetic Sustainability Andrea Colantoni,Massimo Cecchini,Alvaro Marucci,Fabio Recanatesi,2021-04-15 The papers published in this Special Issue WP3 Innovation in Agriculture and Forestry Sector for Energetic Sustainability bring together some of the latest research results in the field of biomass valorization and the process of energy production and climate change and other areas relevant to energetic sustainability 1 20 Moreover several works address the very important topic of evaluating the safety aspects for energy plant use 21 24 Responses to our call generated the following statistics Submissions 21 Publications 15 Rejections 6 Article types research articles 13 reviews 2 Of the submitted papers 15 have been successfully published as articles Reviewing and selecting the papers for this Special Issue was very inspiring and rewarding We also thank the editorial staff and reviewers for their efforts and help during the process For better comprehension the contributions to this Special Issue are divided into sections as follows

Sustainable Agriculture Reviews Eric Lichtfouse,2017-01-17 This book deals with a rapidly growing field aiming at producing food and energy in a sustainable way for humans and their children It is a discipline that addresses current issues such as climate change increasing food and fuel prices poor nation starvation rich nation obesity water pollution soil erosion fertility loss pest control and biodiversity depletion Novel environmentally friendly solutions are proposed based on integrated knowledge from sciences as diverse as agronomy soil science molecular biology chemistry toxicology ecology economy and social sciences Indeed sustainable agriculture decipher mechanisms of processes that occur from the molecular level to the farming system to the global level at time scales ranging from seconds to centuries For that scientists use the system approach that involves studying components and interactions of a whole system to classical narrow science Instead of solving problems using the classical painkiller approach that treats only negative impacts sustainable agriculture treats problem sources Because most actual society issues are now intertwined global and fast developing sustainable agriculture will bring solutions to build a safer world this book series gathers review articles that analyze current

agricultural issues and knowledge then proposes alternative solutions It will therefore help all scientists decision makers professors farmers and politicians who wish to build a safe agriculture energy and food system for future generations

Complex Analysis and Dynamical Systems IV Mark L'vovich Agranovskiĭ,2011 The papers in this volume cover a wide variety of topics in the geometric theory of functions of one and several complex variables including univalent functions conformal and quasiconformal mappings and dynamics in infinite dimensional spaces In addition there are several articles dealing with various aspects of Lie groups control theory and optimization Taken together the articles provide the reader with a panorama of activity in complex analysis and quasiconformal mappings drawn by a number of leading figures in the field The companion volume Contemporary Mathematics Volume 554 is devoted to general relativity geometry and PDE

International Joint Conference SOCO'13-CISIS'13-ICEUTE'13 Álvaro Herrero,Bruno Baruque,Fanny Klett,Ajith Abraham,Václav Snášel,André C.P.L.F. de Carvalho,Pablo García Bringas,Ivan Zelinka,Héctor Quintián,Emilio Corchado,2013-08-13 This volume of Advances in Intelligent and Soft Computing contains accepted papers presented at SOCO 2013 CISIS 2013 and ICEUTE 2013 all conferences held in the beautiful and historic city of Salamanca Spain in September 2013 Soft computing represents a collection or set of computational techniques in machine learning computer science and some engineering disciplines which investigate simulate and analyze very complex issues and phenomena After a through peer review process the 8th SOCO 2013 International Program Committee selected 40 papers which are published in these conference proceedings and represents an acceptance rate of 41% In this relevant edition a special emphasis was put on the organization of special sessions Four special sessions were organized related to relevant topics as Systems Man and Cybernetics Data Mining for Industrial and Environmental Applications Soft Computing Methods in Bioinformatics and Soft Computing Methods Modelling and Simulation in Electrical Engineer The aim of the 6th CISIS 2013 conference is to offer a meeting opportunity for academic and industry related researchers belonging to the various vast communities of Computational Intelligence Information Security and Data Mining The need for intelligent flexible behaviour by large complex systems especially in mission critical domains is intended to be the catalyst and the aggregation stimulus for the overall event After a through peer review process the CISIS 2013 International Program Committee selected 23 papers which are published in these conference proceedings achieving an acceptance rate of 39% In the case of 4th ICEUTE 2013 the International Program Committee selected 11 papers which are published in these conference proceedings The selection of papers was extremely rigorous in order to maintain the high quality of the conference and we would like to thank the members of the Program Committees for their hard work in the reviewing process This is a crucial process to the creation of a high standard conference and the SOCO CISIS and ICEUTE conferences would not exist without their help

Greenhouse Ecosystems G. Stanhill,Herbert Z. Enoch,1999 Hardbound This book the first integrated treatment of the greenhouse ecosystem consists of sixteen chapters by an international list of expert authorities and is divided into four parts

The first section consists of four chapters describing greenhouses their history and geographical distribution their mechanical structures light transmitting cladding and environmental control mechanisms the way in which these modify the greenhouse s aerial microclimate and root environments The second section contains six chapters dealing with the biological contents of greenhouses the most widely grown edible fruit and salad crops ornamental flower and foliage crops the diseases and the pests attacking these crops and the growers cultivating them The third section has four chapters dealing with the flows of energy carbon water and nutrients within and across the boundaries of the greenhouse The two chapters of the fourth section descr

Biosystems Engineering: Biofactories for Food Production in the Century XXI Ramon Guevara-Gonzalez,Irineo Torres-Pacheco,2014-01-24 This book presents new food production systems for plants and animals involving agrochemicals that increase in a controlled manner the bioactives content under greenhouse conditions Moreover conception and design of new instrumentation for precision agriculture and aquaculture contributing in food production is also highlighted in this book

Advanced technologies for energy saving, plant quality control and mechanization development in plant factory Yuxin Tong,Myung-Min Oh,Wei Fang,2023-06-09 *Intelligent computing research with applications in biotechnology* Yu Xue,Ferrante Neri,Ali Wagdy Mohamed,2024-01-22 *Surface Modeling* Tian-Xiang Yue,2011-02-04 Although GIS provides powerful functionality for spatial analysis data overlay and storage these spatially oriented systems lack the ability to represent temporal dynamics which is a major impediment to its use in surface modeling However rapid development of computing technology in recent years has made real time spatial analysis and real time data visualization become realizable Based on newly developed methods Surface Modeling High Accuracy and High Speed Methods explores solutions to big error and slow efficiency problems two critical challenges that have long plagued those working in with geographical information system GIS and computer aided design CAD By developing high accuracy and high speed methods for surface modeling the book builds a bridge between the mathematical oriented theory of surface modeling and the user oriented application where the user is actually able to retrieve information on the method itself The author examines a novel method of high accuracy surface modeling HASM in terms of the fundamental theorem of surfaces He then analyzes the coefficient matrix and develops an adaptive method of HASM HASM AM a multi grade method of HASM HASM MG and an adjustment method of HASM HASM AD He uses numerical tests and real world studies to demonstrate that HASM AM HASM MG and HASM AD have highly accelerated computational speed especially for simulations with huge computational work Building on this the book discusses a HASM based method for dynamic simulation HASM FDS and then applies HASM methods to simulate terrains climate change ecosystem change land cover and soil properties It demonstrates HASM s potential for simulating population distribution human carrying capacity ecosystem services ecological diversity change detection and wind velocity The book concludes with a discussion of the problems that exist in surface modeling on a global level and evaluates possible solutions to these problems

Advances in Computational Intelligence Systems

George Panoutsos, Mahdi Mahfouf, Lyudmila S Mihaylova, 2024-05-18 The scope of this book is to present the papers included at the 21st UK Workshop on Computational Intelligence UKCI 2022 hosted by The University of Sheffield between 7 and 9 September 2022 Sheffield UK This marks the first fully in person UKCI conference following the pandemic a testament to the success and resilience of the UKCI community as well as to the importance of computational intelligence CI research The papers in this book are divided into five sections fuzzy logic systems machine learning hybrid methods and network systems deep learning and neural networks and optimization and search

Greenhouse Engineering Ilhami Yildiz, 2021-05-23 Sustainable energy development concept requires and maintains multiple linkages among energy production energy consumption human well being and environmental quality Greenhouse Engineering Integrated Energy Management puts forward the concept of integrated energy management and modeling pertinent to greenhouses that will eventually help reduce the load on power grids demand for fossil fuels and water and supply CO₂ for the greenhouse production This book helps enhance the competitive position of the global greenhouse industry by introducing economically environmentally and socially sustainable technologies and management strategies Exclusive title on integrated energy management approach for greenhouse designing Addresses energy for heating concept Includes case studies from real work greenhouse systems Incorporates a design energy management approach Contains updated material on greenhouse heating with examples and case studies Aimed at researchers professionals and students in the fields of energy systems mechanical agriculture and biosystems engineering

Design and Construction of Bioclimatic Wooden Greenhouses, Volume 4 Gian Luca Brunetti, 2023-01-25 This book is the fourth of four dealing with bioclimatic design and construction by focusing on the most basic and polyvalent of modern environmental systems the bioclimatic greenhouse the Swiss army chainsaw of architecture More specifically this fourth volume focuses on architectural integration environmental prediction and how to simulate and structurally size a bioclimatic wooden greenhouse In more general terms it helps us to consider how to design and build the structure of bioclimatic low energy architecture with low environmental impact This multi volume book covers both free standing greenhouses that can naturally heat and cool themselves and lean to greenhouses that support the natural heating and cooling of buildings this includes both agricultural greenhouses and greenhouses suited to host people As a result it is a trans disciplinary work deriving its areas of concern from a broad range of study areas spanning from environmental to constructional to structural drawing the clarity of the approach from the fact that the topics are presented by a single author with a single voice and a designer s mindset To achieve this the book adopts a composite set of explanatory strategies and communication registers including extensive support by 3D construction drawings and examples and presents not only state of the art solutions but also experimental ones

Next-Generation Greenhouses for Food Security Redmond R. Shamshiri, 2021-06-16 Modern greenhouse technology has revolutionized the food supply chain scenario over the past 40 years Closed field cultivation by means of agri cubes plant factories vertical farming structures and roof top solar

greenhouses has become the backbone of sustainable agriculture for producing all year round fresh fruits and vegetables This book is an attempt to explore several profound questions such as how digital technology and simulation models have saved energy in commercial greenhouses and why growers prefer LPWAN sensors and IoT monitoring devices over the traditional timer based controllers How artificial intelligence is capable of performing microclimate prediction and control and what considerations should be taken into account for implementing desiccant evaporative cooling systems With case study examples and field experiments each chapter highlights some of the most recent solutions and adaptation strategies toward improving the efficiency and sustainability of closed field crop production systems

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



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