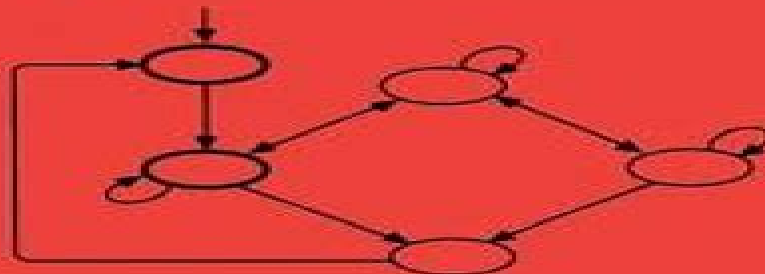


# Lecture Notes in Control and Information Sciences 212

Arturo Sanchez

## Formal Specification and Synthesis of Procedural Controllers for Process Systems



Springer

# Formal Specification And Synthesis Of Procedural Controllers For Proceb Systems

**A.S. Poznyak, K. Najim**



## **Formal Specification And Synthesis Of Procedural Controllers For Process Systems:**

Formal Specification and Synthesis of Procedural Controllers for Process Systems Arturo Sanchez, 1996-03-20 The operation of process plants involves a large number of event driven activities such as the start up and shut down of the plant the execution of emergency procedures and equipment interlocking These activities are normally carried out by procedural control systems such as PLCs or DCSs Despite the extent to which these control systems are used in practice limited theoretical frameworks exist to support their analysis and design This is particularly relevant in flexible production environments which are characterised by frequent changes in the product recipes production modes and equipment configuration The book outlines a formal framework for the synthesis of control systems employed in the automation of event driven process operations The approach used builds on other theories initially proposed in computing and control disciplines

**Formal Specification and Synthesis of Procedural Controllers for Process Systems** Arturo Sanchez, 2014-03-12 The operation of process plants involves a large number of event driven activities such as the start up and shut down of the plant the execution of emergency procedures and equipment interlocking These activities are normally carried out by procedural control systems such as PLCs or DCSs Despite the extent to which these control systems are used in practice limited theoretical frameworks exist to support their analysis and design This is particularly relevant in flexible production environments which are characterised by frequent changes in the product recipes production modes and equipment configuration The book outlines a formal framework for the synthesis of control systems employed in the automation of event driven process operations The approach used builds on other theories initially proposed in computing and control disciplines

ZUM '98: The Z Formal Specification Notation Jonathan P. Bowen, Andreas Fett, Michael G. Hinchey, 1998-09-16 1 In a number of recent presentations most notably at FME 96 one of the foremost scientists in the field of formal methods C A R Hoare has highlighted the fact that formal methods are not the only technique for producing reliable software This seems to have caused some controversy not least amongst formal methods practitioners How can one of the founding fathers of formal methods seemingly denounce the field of research after over a quarter of a century of support This is a question that has been posed recently by some formal methods skeptics However Prof Hoare has not abandoned formal methods He is reiterating 2 albeit more radically his 1987 view that more than one tool and notation will be required in the practical industrial development of large scale complex computer systems and not all of these tools and notations will be or even need be formal in nature Formal methods are not a solution but rather one of a selection of techniques that have proven to be useful in the development of reliable complex systems and to result in hardware and software systems that can be produced on time and within a budget while satisfying the stated requirements After almost three decades the time has come to view formal methods in the context of overall industrial scale system development and their relationship to other techniques and methods We should no longer consider the issue of whether we are pro formal or anti formal but rather the degree of formality if any that

we need to support in system development This is a goal of ZUM 98 the 11th International Conference of Z Users held for the first time within continental Europe in the city of Berlin Germany

*Algebraic Methodology and Software Technology*  
Armando M. Haeberer, 2003-05-20 AMAST's goal is to advance awareness of algebraic and logical methodology as part of the fundamental basis of software technology Ten years and seven conferences after the start of the AMAST movement I believe we are attaining this The movement has propagated throughout the world assembling many enthusiastic specialists who have participated not only in the conferences which are now annual but also in the innumerable other activities that AMAST promotes and supports We are now facing the Seventh International Conference on Algebraic Methodology and Software Technology AMAST 98 The previous meetings were held in Iowa City USA 1989 and 1991 in Enschede The Netherlands 1993 in Montreal Canada 1995 in Munich Germany 1996 and in Sydney Australia 1997 This time it is Brazil's turn in a very special part of this colorful country Amazonia Thus if we have done more it is by standing on the shoulders of giants The effort started by Teodor Rus Arthur Fleck and William A Kirk at AMAST 89 was consolidated in AMAST 91 by Teodor Rus Maurice Nivat Charles Ratray and Giuseppe Scollo Then came modular construction of the building wonderfully carried out by Giuseppe Scollo Vangalur Alagar Martin Wirsing and Michael Johnson as Program Chairs of the AMAST conferences held between 1993 and 1997

*Industrial-Strength Formal Methods in Practice* Michael G. Hinchey, Jonathan P. Bowen, 2012-12-06 Industrial Strength Formal Methods in Practice provides hands on experience and guidance for anyone who needs to apply formal methods successfully in an industrial context Each chapter is written by an expert in software engineering or formal methods and contains background information introductions to the techniques being used actual fragments of formalised components details of results and an analysis of the overall approach It provides specific details on how to produce high quality software that comes in on time and within budget Aimed mainly at practitioners in software engineering and formal methods this book will also be of interest to the following groups academic researchers working in formal methods who are interested in evidence of their success and in how they can be applied on an industrial scale and students on advanced software engineering courses who need real life specifications and examples on which to base their work

*Supervisory Control of Discrete-Event Systems* W. Murray Wonham, Kai Cai, 2018-08-17 This book shows how supervisory control theory SCT supports the formulation of various control problems of standard types like the synthesis of controlled dynamic invariants by state feedback and the resolution of such problems in terms of naturally definable control theoretic concepts and properties like reachability controllability and observability It exploits a simple abstract model of controlled discrete event systems DES that has proved to be tractable appealing to control specialists and expressive of a range of control theoretic ideas It allows readers to choose between automaton based and dually language based forms of SCT depending on whether their preference is for an internal structural or external behavioral description of the problem The monograph begins with two chapters on algebraic and linguistic preliminaries and the fundamental concepts and results

of SCT are introduced To handle complexity caused by system scale architectural approaches the horizontal modularity of decentralized and distributed supervision and the vertical modularity of hierarchical supervision are introduced Supervisory control under partial observation and state based supervisory control are also addressed in the latter a vector DES model that exploits internal regularity of algebraic structure is proposed Finally SCT is generalized to deal with timed DES by incorporating temporal features in addition to logical ones Researchers and graduate students working with the control of discrete event systems or who are interested in the development of supervisory control methods will find this book an invaluable aid in their studies The text will also be of assistance to researchers in manufacturing logistics communications and transportation areas which provide plentiful examples of the class of systems being discussed

**An Introduction to Hybrid Dynamical Systems** Arjan J. van der Schaft, Hans Schumacher, 2007-10-03 This book is about dynamical systems that are hybrid in the sense that they contain both continuous and discrete state variables Recently there has been increased research interest in the study of the interaction between discrete and continuous dynamics The present volume provides a first attempt in book form to bring together concepts and methods dealing with hybrid systems from various areas and to look at these from a unified perspective The authors have chosen a mode of exposition that is largely based on illustrative examples rather than on the abstract theorem proof format because the systematic study of hybrid systems is still in its infancy The examples are taken from many different application areas ranging from power converters to communication protocols and from chaos to mathematical finance Subjects covered include the following definition of hybrid systems description formats existence and uniqueness of solutions special subclasses variable structure systems complementarity systems reachability and verification stability and stabilizability control design methods The book will be of interest to scientists from a wide range of disciplines including computer science control theory dynamical system theory systems modeling and simulation and operations research

Stability and Stabilization of Nonlinear Systems Dirk Aeyels, Françoise Lamnabhi-Lagarigue, Arjan van der Schaft, 2008-01-26 These papers were presented at the first EC TMR Nonlinear Control Network Workshop on Stability and Stabilization of Nonlinear Systems that took place in March 1999 Ghent Belgium The TMR programme offers a unique opportunity for the academic community to expand their knowledge share their experience and identify and discuss strategic issues in aspects of nonlinear control engineering The aim is to create a resource centre of available expertise and research interests This outstanding reference volume presents current and emerging research directions including Stability analysis of nonlinear dynamical systems and converse Lyapunov theorems Stabilization and regulation of nonlinear dynamical control systems Control of physical systems using physics based Lyapunov functions and passivity as well as bifurcation analysis and optimal control This collection of peer reviewed papers provides a comprehensive overview of this field of research for graduate students and researchers in engineering and applied mathematics

Ontologically Controlled Autonomous Systems: Principles, Operations, and Architecture George A.

Fodor,2013-11-27 Kevin M Passino When confronted with a control problem for complicated physical process a control engineer usually follows a predetermined design procedure This procedure often begins with the engineer seeking to understand the process and the primary control objectives A simple example of a control problem is an automobile cruise control that provides the automobile with the capability of regulating its own speed at a driver specified set point e g 55 mph One solution to the automotive cruise control problem involves adding an electronic controller that can sense the speed of the vehicle via the speedometer and actuate the throttle position so as to regulate the vehicle speed at the driver specified value Such speed regulation must be accurate even if there are road grade changes head winds or variations in the number of passengers in the automobile After gaining an intuitive understanding of the plant s dynamics and establishing the design objectives the control engineer typically solves the cruise control problem by using an established design procedure In particular this control engineering design methodology involves 1 Modeling understanding the plant 2 Construction of a controller to meet specifications such as stability rise time overshoot and steady state error 3 Analysis to make sure that the system will meet the performance objectives e g we might use mathematical simulation based or experimental analysis and 4 Iterating on the design until it is possible to commission the control system

**Object-Oriented Technology and Computing Systems Re-Engineering** H. S. M. Zedan,A Cau,1999-10-01 This book delivers the latest developments in object technology and their impact in computing systems re engineering Object oriented programming is here shown to provide support for constructing large scale systems that are cheaply built and with reusable components adaptable to changing requirements and use efficient and cost effective techniques Internationally recognised authorities from Finland France Germany Italy Poland Spain the UK and the USA here record their research and development work on the industrial techniques and structured object oriented methodologies in forward and reverse engineering of computing systems This book takes stock of progress of that work showing its promise and feasibility and how its structured technology can overcome the limitations of forward engineering methods used in industry Forward methods are focused in the domain of reverse engineering to implement a high level of specification for existing software The book contains the selected quintessential content of the first UK Colloquium on Object Technology and Systems Re Engineering held at Oxford University in 1998 The conference was sponsored by British Telecom Laboratories EMSI limited and the OOSP Specialised Group of The British Computer Society Delivers the latest developments in object technology and their impact in computing systems re engineering Provides support for constructing large scale systems that are cheaply built and with reusable components adaptable to changing requirements and use efficient and cost effective techniques Contains the content of the first UK Colloquium on Object Technology and Systems Re Engineering held at Oxford University in 1998 *Finite-Spectrum Assignment for Time-Delay Systems* Qing-Guo Wang,Tong H. Lee,Kok K. Tan,2007-10-03 The presence of considerable time delays in many industrial processes is well recognized and achievable performances of conventional unity feedback control

systems are degraded if a process has a relatively large time delay compared to its time constants. In this case, dead time compensation is necessary in order to enhance the performances. The most popular scheme for such compensation is the Smith Predictor, but it is unsuitable for unstable or lightly damped processes because the compensated closed loop system always contains the process poles themselves. An alternative scheme for delay elimination from the closed loop is the finite spectrum assignment (FSA) strategy, and it can arbitrarily assign the closed loop spectrum. One may note that the Smith Predictor Control can be found in delay systems control books and many process control books, but the FSA control is rarely included in these books. It is therefore timely and desirable to fill this gap by writing a book which gives a comprehensive treatment of the FSA approach. This is useful and worthwhile since the FSA provides not only an alternative way but also certain advantages over the Smith Predictor. The book presents the state of the art of the finite spectrum assignment for time delay systems in frequency domain. It mainly contains those works carried out recently by the authors in this field. Most of them have been published and others are awaiting publication. They are assembled together and reorganized in such a way that the presentation is logical, smooth, and systematic.

Fundamental Approaches to Software Engineering Tom Maibaum, 2000-03-15. ETAPS 2000 was the third instance of the European Joint Conferences on Theory and Practice of Software. ETAPS is an annual federated conference that was established in 1998 by combining a number of existing and new conferences. This year it comprised five conferences: FOSSACS, FASE, ESOP, CC, TACAS, and satellite workshops: CBS, CMCS, CoFI, GRATRA, INT. Seven invited lectures, a panel discussion, and ten tutorials. The events that comprise ETAPS address various aspects of the system development process, including specification, design, implementation, analysis, and improvement. The languages, methodologies, and tools which support these activities are all well within its scope. The event blends of theory and practice, represented with an inclination towards theory with a practical motivation on one hand and soundly based practice on the other. Many of the issues involved in software design apply to systems in general, including hardware systems, and the emphasis on software is not intended to be exclusive.

*Workshop on High Performance Computing and Gigabit Local Area Networks* G. Cooperman, G. Michler, H. Vinck, 2006-04-11. The combination of fast, low latency networks and high performance distributed tools for mathematical software has resulted in widespread, affordable scientific computing facilities. Practitioners working in the fields of computer communication networks, distributed computing, computational algebra, and numerical analysis have been brought together to contribute to this volume and explore the emerging distributed and parallel technology in a scientific environment. This collection includes surveys and original research on both software infrastructure for parallel applications and hardware and architecture infrastructure. Among the topics covered are switch-based high speed networks, ATM over local and wide area networks, network performance, application support, finite element methods, eigenvalue problems, invariant subspace decomposition, QR factorization, and Todd Coxeter coset enumeration.

**$H_\infty$  Control and Its Applications** Ben M. Chen, 2013-11-09.  $H_\infty$  control theory is a subject that deals with the

minimisation of the  $H$  norm of the transfer matrix from an exogenous disturbance to a pertinent controlled output of a given plant **H Control and Its Applications** examines both the theoretical and practical aspects of  $H$  control from the angle of the structural properties of linear systems Constructive algorithms for finding solutions to general singular  $H$  control problems are presented as well as solutions to general  $H$  almost disturbance decoupling problems and the applications of the theory to real life problems with actual implementations is also presented The book deals with all such issues for general continuous and discrete time systems The book can be used in graduate courses in departments of aeronautics and astronautics applied mathematics chemical engineering electrical engineering and mechanical engineering It is also invaluable for practising engineers in industry

*Low Gain Feedback* Zongli Lin, 1999 This book gives a unified and unique presentation of low gain and high gain design methodologies In particular the development of low gain feedback design methodology is discussed The development of both low and high gain feedback enhances the industrial relevance of modern control theory by providing solutions to a wide range of problems that are of paramount practical importance This detailed monograph provides the reader with a comprehensive insight into these problems research results are examined and solutions to the problems are considered Compared to that of high gain feedback the power and significance of low gain feedback is not as widely recognized The purpose of this monograph is to present some recent developments in low gain feedback and its applications Several low gain techniques are examined including the control of linear systems with saturating actuators semi global stabilization of minimum phase input output linearizable systems and  $H_2$  suboptimal control

**Eurosymposium Computer Aided Process Engineering**, 2005-05-17 Eurosymposium Computer Aided Process Engineering **Computer Safety, Reliability and Security** Wolfgang Ehrenberger, 2003-06-29 Computers and their interactions are becoming the characteristic features of our time Many people believe that the industrial age is going over into the information age In the same way as life of the beginning of this century was dominated by machines factories streets and railways the starting century will be characterised by computers and their networks This change naturally affects also the institutions and the installations our lives depend upon power plants including nuclear ones chemical plants mechanically working factories cars railways and medical equipment they all depend on computers and their connections In some cases it is not human life that may be endangered by computer failure but large investments e g if a whole plant interrupts its production for a long time In addition to loss of life and property one must not neglect public opinion which is very critical in many countries against major technical defects The related computer technology its hardware software and production process differ between standard applications and safety related ones In the safety case it is normally not only the manufacturers and the customers that are involved but a third party usually an assessor who is taking care of the public interest on behalf of a state authority Usually safety engineers are in a better position than their colleagues from the conventional side as they may spend more time and money on a particular task and use better equipment

**New Directions in Nonlinear Observer Design** Hendrik



Nijmeijer, Thor I. Fossen, 1999-05-21 The past decade has witnessed an increasing interest in observers for nonlinear systems This subject is relevant in different contexts such as synchronization of complex dynamical systems fault detection and isolation and output feedback control This book contains the contributions that are to be presented at the workshop New Directions in Nonlinear Observer Design to be held from June 24-26 1999 in Geiranger Fjord Norway The workshop has been organised by Olav Egeland Thor I Fossen and Henk Nijmeijer it will include participants from Africa Asia Europe and USA and it will focus on recent developments in the above mentioned areas The contributions form a good review of present achievements and challenges in nonlinear observer design The workshop is supported by the Strategic University Program on Marine Cybernetics at the Norwegian University of Science and Technology and ABB      **Learning Automata and Stochastic Optimization** A.S. Poznyak, K. Najim, 1997-03-12 In the last decade there has been a steadily growing need for and interest in computational methods for solving stochastic optimization problems with or without constraints Optimization techniques have been gaining greater acceptance in many industrial applications and learning systems have made a significant impact on engineering problems in many areas including modelling control optimization pattern recognition signal processing and diagnosis Learning automata have an advantage over other methods in being applicable across a wide range of functions Featuring new and efficient learning techniques for stochastic optimization and with examples illustrating the practical application of these techniques this volume will be of benefit to practicing control engineers and to graduate students taking courses in optimization control theory or statistics      **AICHE Symposium Series** American Institute of Chemical Engineers, 1971

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