

CHAPTER 10

FINITE STATE MACHINE: PRINCIPLE AND PRACTICE

A finite state machine (FSM) is a sequential circuit with “random” next-state logic. Unlike the regular sequential circuit discussed in Chapters 8 and 9, the state transitions and event sequence of an FSM do not exhibit a simple pattern. Although the basic block diagram of an FSM is similar to that of a regular sequential circuit, its design procedure is different. The derivation of an FSM starts with a more abstract model, such as a state diagram or an algorithm state machine (ASM) chart. Both show the interactions and transitions between the internal states in graphical formats. In this chapter, we study the representation, timing and implementation issues of an FSM as well as derivation of the VHDL code. Our emphasis is on the application of an FSM as the control circuit for a large, complex system, and our discussion focuses on the issues related to this aspect. As in previous chapters, our discussion is limited to the synchronous FSM, in which the state register is controlled by a single global clock.

10.1 OVERVIEW OF FSMS

As its name indicates, a *finite state machine (FSM)* is a circuit with internal states. Unlike the regular sequential circuits discussed in Chapters 8 and 9, state transition of an FSM is more complicated and the sequence exhibits no simple, regular pattern, as in a counter or shift register. The next-state logic has to be constructed from scratch and is sometimes known as “random” logic.

Formally, an FSM is specified by five entities: symbolic states, input signals, output signals, next-state function and output function. A state specifies a unique internal condition

Finite State Machine Principle And Practice

Pong P. Chu



Finite State Machine Principle And Practice:

RTL Hardware Design Using VHDL Pong P. Chu, 2006-04-20 The skills and guidance needed to master RTL hardware design This book teaches readers how to systematically design efficient portable and scalable Register Transfer Level RTL digital circuits using the VHDL hardware description language and synthesis software Focusing on the module level design which is composed of functional units routing circuit and storage the book illustrates the relationship between the VHDL constructs and the underlying hardware components and shows how to develop codes that faithfully reflect the module level design and can be synthesized into efficient gate level implementation Several unique features distinguish the book Coding style that shows a clear relationship between VHDL constructs and hardware components Conceptual diagrams that illustrate the realization of VHDL codes Emphasis on the code reuse Practical examples that demonstrate and reinforce design concepts procedures and techniques Two chapters on realizing sequential algorithms in hardware Two chapters on scalable and parameterized designs and coding One chapter covering the synchronization and interface between multiple clock domains Although the focus of the book is RTL synthesis it also examines the synthesis task from the perspective of the overall development process Readers learn good design practices and guidelines to ensure that an RTL design can accommodate future simulation verification and testing needs and can be easily incorporated into a larger system or reused Discussion is independent of technology and can be applied to both ASIC and FPGA devices With a balanced presentation of fundamentals and practical examples this is an excellent textbook for upper level undergraduate or graduate courses in advanced digital logic Engineers who need to make effective use of today's synthesis software and FPGA devices should also refer to this book

Fundamentals of the Theory of Computation: Principles and Practice Raymond Greenlaw, H. James Hoover, 1998-07-14 This innovative textbook presents the key foundational concepts for a one semester undergraduate course in the theory of computation It offers the most accessible and motivational course material available for undergraduate computer theory classes Directed at undergraduates who may have difficulty understanding the relevance of the course to their future careers the text helps make them more comfortable with the techniques required for the deeper study of computer science The text motivates students by clarifying complex theory with many examples exercises and detailed proofs This book is shorter and more accessible than the books now being used in core computer theory courses Theory of computing is a standard required course in all computer science departments

PRIMA 2018: Principles and Practice of Multi-Agent Systems Tim Miller, Nir Oren, Yuko Sakurai, Itsuki Noda, Bastin Tony Roy Savarimuthu, Tran Cao Son, 2018-10-23 This book constitutes the refereed proceedings of the 21st International Conference on Principles and Practice of Multi Agent Systems PRIMA 2018 held in Tokyo Japan in October November 2018 The 27 full papers presented and 31 short papers were carefully reviewed and selected from 103 submissions PRIMA presents subjects in many application domains particularly in e commerce and also in planning logistics manufacturing robotics decision support

transportation entertainment emergency relief and disaster management and data mining and analytics *Artificial Intelligence: Principles and Practice* George F. Luger, 2024-12-02 This book provides a complete introduction to Artificial Intelligence covering foundational computational technologies mathematical principles philosophical considerations and engineering disciplines essential for understanding AI *Artificial Intelligence Principles and Practice* emphasizes the interdisciplinary nature of AI integrating insights from psychology mathematics neuroscience and more The book addresses limitations ethical issues and the future promise of AI emphasizing the importance of ethical considerations in integrating AI into modern society With a modular design it offers flexibility for instructors and students to focus on specific components of AI while also providing a holistic view of the field Taking a comprehensive but concise perspective on the major elements of the field from historical background to design practices ethical issues and more *Artificial Intelligence Principles and Practice* provides the foundations needed for undergraduate or graduate level courses The important design paradigms and approaches to AI are explained in a clear easy to understand manner so that readers will be able to master the algorithms processes and methods described The principal intellectual and ethical foundations for creating artificially intelligent artifacts are presented in Parts I and VIII Part I offers the philosophical mathematical and engineering basis for our current AI practice Part VIII presents ethical concerns for the development and use of AI Part VIII also discusses fundamental limiting factors in the development of AI technology as well as hints at AI's promising future We recommended that PART I be used to introduce the AI discipline and that Part VIII be discussed after the AI practice materials Parts II through VII present the three main paradigms of current AI practice the symbol based the neural network or connectionist and the probabilistic Generous use of examples throughout helps illustrate the concepts and separate end of chapter exercises are included Teaching resources include a solutions manual for the exercises PowerPoint presentation and implementations for the algorithms in the book *Computer Security Principles and Practice* Mr. Rohit Manglik, 2023-06-23 Covers principles of cybersecurity including encryption authentication and network security for protecting digital systems **Software**

Engineering: Principles and Practices, 2nd Edition Khurana Rohit, 2010 This revised edition of *Software Engineering Principles and Practices* has become more comprehensive with the inclusion of several topics The book now offers a complete understanding of software engineering as an engineering discipline Like its previous edition it provides an in depth coverage of fundamental principles methods and applications of software engineering In addition it covers some advanced approaches including Computer aided Software Engineering CASE Component based Software Engineering CBSE Clean room Software Engineering CSE and formal methods Taking into account the needs of both students and practitioners the book presents a pragmatic picture of the software engineering methods and tools A thorough study of the software industry shows that there exists a substantial difference between classroom study and the practical industrial application Therefore earnest efforts have been made in this book to bridge the gap between theory and practical applications The subject matter is well

supported by examples and case studies representing the situations that one actually faces during the software development process. The book meets the requirements of students enrolled in various courses both at the undergraduate and postgraduate levels such as BCA, BE, BTech, BIT, BIS, BSc, PGDCA, MCA, MIT, MIS, MSc, various DOEACC levels and so on. It will also be suitable for those software engineers who abide by scientific principles and wish to expand their knowledge. With the increasing demand of software, the software engineering discipline has become important in education and industry. This thoughtfully organized second edition of the book provides its readers a profound knowledge of software engineering concepts and principles in a simple, interesting and illustrative manner.

Compilers: Principles and Practice Parag H. Dave, Himanshu B. Dave, *Compilers Principles and Practice* explains the phases and implementation of compilers and interpreters using a large number of real life examples. It includes examples from modern software practices such as Linux, GNU Compiler Collection, GCC and Perl. This book has been class tested and tuned to the requirements of undergraduate computer engineering courses across universities in India.

Network Management: Principles and Practice Mani Subramanian, 2010. *Network Management Principles And Practice* is a reference book that comprehensively covers various theoretical and practical concepts of network management. It is divided into four units. The first unit gives an overview of network management. The

SOFSEM 2000: Theory and Practice of Informatics Vaclav Hlavac, Keith G. Jeffery, Jiri Wiedermann, 2003-07-31. The international conference on current trends in the theory and practice of informatics SOFSEM 2000 was held 25 November - 2 December 2000 in the conference facilities of the Devet Skal Nine Rocks Hotel, Milovy, Czech Moravian Highlands, the Czech Republic. It was already the 27th annual meeting in the series of SOFSEM conferences organized in either the Czech or the Slovak Republic. Since its establishment in 1974, SOFSEM has gone through a long development in parallel with the entire field of informatics. Currently, SOFSEM is a wide scope multidisciplinary conference with stress on the interplay between the theory and practice of informatics. The SOFSEM scientific program consists mainly of invited talks which determine the topics of the conference. Invited talks are complemented by short refereed talks contributed by SOFSEM participants. The topics of invited talks are chosen so as to cover the span from theory to practice and to bring interesting research areas to the attention of conference participants. For the year 2000, the following three streams were chosen for presentation by the SOFSEM Steering Committee: Trends in Algorithmics, Information Technologies in Practice, Computational Perception. The above streams were covered through 16 invited talks given by prominent researchers. There were 18 contributed talks also presented, chosen by the international Program Committee from among 36 submitted papers. The program also included a panel on lessons learned from the Y2K problem.

Microprogramming: Principles and Practices Samir S. Husson, 1970. *Network Security Principles and Practices* Saadat Malik, 2003. Expert solutions for securing network infrastructures and VPNs. Build security into the network by defining zones, implementing secure routing protocol designs and building safe LAN switching environments. Understand the inner workings of the Cisco PIX

Firewall and analyze in depth Cisco PIX Firewall and Cisco IOS Firewall features and concepts Understand what VPNs are and how they are implemented with protocols such as GRE L2TP and IPSec Gain a packet level understanding of the IPSec suite of protocols its associated encryption and hashing functions and authentication techniques Learn how network attacks can be categorized and how the Cisco IDS is designed and can be set up to protect against them Control network access by learning how AAA fits into the Cisco security model and by implementing RADIUS and TACACS protocols Provision service provider security using ACLs NBAR and CAR to identify and control attacks Identify and resolve common implementation failures by evaluating real world troubleshooting scenarios As organizations increase their dependence on networks for core business processes and increase access to remote sites and mobile workers via virtual private networks VPNs network security becomes more and more critical In today's networked era information is an organization's most valuable resource Lack of customer partner and employee access to e commerce and data servers can impact both revenue and productivity Even so most networks do not have the proper degree of security Network Security Principles and Practices provides an in depth understanding of the policies products and expertise that brings organization to this extremely complex topic and boosts your confidence in the performance and integrity of your network systems and services Written by a CCIE engineer who participated in the development of the CCIE Security exams Network Security Principles and Practices is the first book that provides a comprehensive review of topics important to achieving CCIE Security certification Network Security Principles and Practices is a comprehensive guide to network security threats and the policies and tools developed specifically to combat those threats Taking a practical applied approach to building security into networks the book shows you how to build secure network architectures from the ground up Security aspects of routing protocols Layer 2 threats and switch security features are all analyzed A comprehensive treatment of VPNs and IPSec is presented in extensive packet by packet detail The book takes a behind the scenes look at how the Cisco PIX Firewall actually works presenting many difficult to understand and new Cisco PIX Firewall and Cisco IOS Firewall concepts The book launches into a discussion of intrusion detection systems IDS by analyzing and breaking down modern day network attacks describing how an IDS deals with those threats in general and elaborating on the Cisco implementation of IDS The book also discusses AAA RADIUS and TACACS and their usage with some of the newer security implementations such as VPNs and proxy authentication A complete section devoted to service provider techniques for enhancing customer security and providing support in the event of an attack is also included Finally the book concludes with a section dedicated to discussing tried and tested troubleshooting tools and techniques that are not only invaluable to candidates working toward their CCIE Security lab exam but also to the security network administrator running the operations of a network on a daily basis

Logic Synthesis for FPGA-Based Finite State Machines Alexander Barkalov, Larysa Titarenko, Malgorzata Kolopienczyk, Kamil Mielcarek, Grzegorz Bazydło, 2015-10-15 This book discusses control units represented by the model of a finite state machine

FSM It contains various original methods and takes into account the peculiarities of field programmable gate arrays FPGA chips and a FSM model It shows that one of the peculiarities of FPGA chips is the existence of embedded memory blocks EMB The book is devoted to the solution of problems of logic synthesis and reduction of hardware amount in control units The book will be interesting and useful for researchers and PhD students in the area of Electrical Engineering and Computer Science as well as for designers of modern digital systems

Synthesis of Finite State Machines Timothy Kam, Tiziano Villa, Robert K. Brayton, Alberto Sangiovanni-Vincentelli, 1996-12-31 Synthesis of Finite State Machines Functional Optimization is one of two monographs devoted to the synthesis of Finite State Machines FSMs This volume addresses functional optimization whereas the second addresses logic optimization By functional optimization here we mean the body of techniques that compute all permissible sequential functions for a given topology of interconnected FSMs and select a best sequential function out of the permissible ones The result is a symbolic description of the FSM representing the chosen sequential function By logic optimization here we mean the steps that convert a symbolic description of an FSM into a hardware implementation with the goal to optimize objectives like area testability performance and so on Synthesis of Finite State Machines Functional Optimization is divided into three parts The first part presents some preliminary definitions theories and techniques related to the exploration of behaviors of FSMs The second part presents an implicit algorithm for exact state minimization of incompletely specified finite state machines ISFSMs and an exhaustive presentation of explicit and implicit algorithms for the binate covering problem The third part addresses the computation of permissible behaviors at a node of a network of FSMs and the related minimization problems of non deterministic finite state machines NDFSMs Key themes running through the book are the exploration of behaviors contained in a non deterministic FSM NDFS and the representation of combinatorial problems arising in FSM synthesis by means of Binary Decision Diagrams BDDs Synthesis of Finite State Machines Functional Optimization will be of interest to researchers and designers in logic synthesis CAD and design automation

Agile Principles, Patterns, and Practices in C# Micah Martin, Robert C. Martin, 2006-07-20 With the award winning book Agile Software Development Principles Patterns and Practices Robert C Martin helped bring Agile principles to tens of thousands of Java and C programmers Now NET programmers have a definitive guide to agile methods with this completely updated volume from Robert C Martin and Micah Martin Agile Principles Patterns and Practices in C This book presents a series of case studies illustrating the fundamentals of Agile development and Agile design and moves quickly from UML models to real C code The introductory chapters lay out the basics of the agile movement while the later chapters show proven techniques in action The book includes many source code examples that are also available for download from the authors Web site Readers will come away from this book understanding Agile principles and the fourteen practices of Extreme Programming Spiking splitting velocity and planning iterations and releases Test driven development test first design and acceptance testing Refactoring with unit testing Pair programming Agile design and design smells The

five types of UML diagrams and how to use them effectively Object oriented package design and design patterns How to put all of it together for a real world project Whether you are a C programmer or a Visual Basic or Java programmer learning C a software development manager or a business analyst Agile Principles Patterns and Practices in C is the first book you should read to understand agile software and how it applies to programming in the NET Framework [Logic Synthesis for VLSI-Based Combined Finite State Machines](#) Alexander Barkalov,Larysa Titarenko,Kamil Mielcarek,Małgorzata Mazurkiewicz,Elżbieta Kawecka,2022-11-24 The book is devoted to design and optimization of control units represented by combined finite state machines CFSMs The CFSMs combine features of both Mealy and Moore FSMs Having states of Moore FSM they produce output signals of both Mealy and Moore types To optimize the circuits of CFSMs we propose to use optimization methods targeting both Mealy and Moore FSMs The book contains some original synthesis and optimization methods targeting hardware reduction in VLSI based CFSM circuits These methods take into account the peculiarities of both a CFSM model and a VLSI chip in use The optimization is achieved due to combining classical optimization methods with new methods proposed in this book These new methods are a mixed encoding of collections of microoperations and a twofold state assignment in CFSMs All proposed methods target reducing the numbers of arguments in systems of Boolean functions representing CFSM circuits Also we propose to use classes of pseudoequivalent states of Moore FSMs to reduce the number of product terms in these systems The book includes a lot of examples which contributes to a better understanding of the features of the synthesis methods under consideration This is the first book entirely devoted to the problems associated with synthesis and optimization of VLSI based CFSMs We hope that the book will be interesting and useful for students and PhD students in the area of Computer Science as well as for designers of various digital systems We think that proposed CFSM models enlarge the class of models applied for implementation of control units with modern VLSI chips

Machine Learning for Human Motion Analysis: Theory and Practice Wang, Liang,Cheng, Li,Zhao, Guoying,2009-12-31 This book highlights the development of robust and effective vision based motion understanding systems addressing specific vision applications such as surveillance sport event analysis healthcare video conferencing and motion video indexing and retrieval Provided by publisher

Associative Digital Network Theory Nico F. Benschop,2009-04-15 Associative Digital Network Theory is intended for researchers at industrial laboratories teachers and students at technical universities in electrical engineering computer science and applied mathematics departments interested in new developments of modeling and designing digital networks DN state machines sequential and combinational logic in general as a combined math engineering discipline As background an undergraduate level of modern applied algebra Birkhoff Barteo Modern Applied Algebra 1970 and Hartmanis Stearns Algebraic Structure of Sequential Machines 1970 will suffice Essential concepts and their engineering interpretation are introduced in a practical fashion with examples The motivation in essence is the importance of the unifying associative algebra of function composition viz semigroup theory for the practical

characterisation of the three main functions in computers namely sequential logic state machines arithmetic and combinational Boolean logic Principles and Techniques of Compilers Mr. Rohit Manglik,2024-04-06 EduGorilla Publication is a trusted name in the education sector committed to empowering learners with high quality study materials and resources Specializing in competitive exams and academic support EduGorilla provides comprehensive and well structured content tailored to meet the needs of students across various streams and levels Algorithmic Learning Theory Arun K. Sharma,Setsuo Arikawa,1996-10-09 This book constitutes the refereed proceedings of the 7th International Workshop on Algorithmic Learning Theory ALT 96 held in Sydney Australia in October 1996 The 16 revised full papers presented were selected from 41 submissions also included are eight short papers as well as four full length invited contributions by Ross Quinlan Takeshi Shinohara Leslie Valiant and Paul Vitanyi and an introduction by the volume editors The book covers all areas related to algorithmic learning theory ranging from theoretical foundations of machine learning to applications in several areas *Breakthrough* Mark Stefik,Barbara Stefik,2004 The authors explore strategies for fostering powerful cultures of innovation and creating breakthroughs The text includes several profiles of MIT innovators

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