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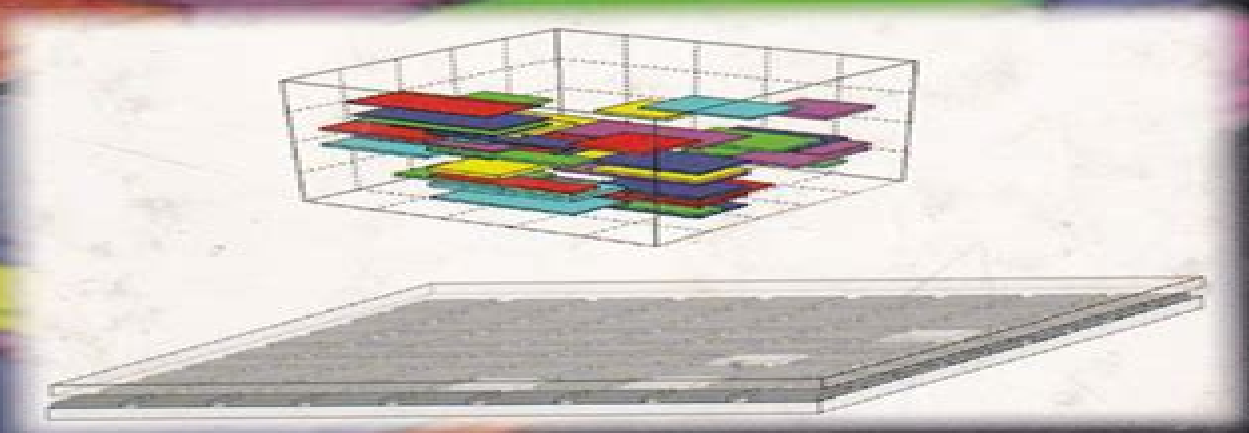
SYNTHESIS, TESTING, AND RECONFIGURATION TECHNIQUES

Krishnendu Chakrabarty

Fei Su

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Digital Microfluidic Biochips Digital Microfluidic Biochips:

   Design and Testing of Digital Microfluidic Biochips Yang Zhao,Krishnendu Chakrabarty,2012-07-25 This book provides a comprehensive methodology for automated design test and diagnosis and use of robust low cost and manufacturable digital microfluidic systems It focuses on the development of a comprehensive CAD optimization framework for digital microfluidic biochips that unifies different design problems With the increase in system complexity and integration levels biochip designers can utilize the design methods described in this book to evaluate different design alternatives and carry out design space exploration to obtain the best design point   *Digital Microfluidic Biochips* Krishnendu Chakrabarty,Tao Xu,2010-05-03 Microfluidics based biochips combine electronics with biochemistry providing access to new application areas in a wide variety of fields Continued technological innovations are essential to assuring the future role of these chips in functional diversification in biotech pharmaceuticals and other industries Revolutionary guidance on design opti   **Digital Microfluidic Biochips** Krishnendu Chakrabarty,Fei Su,2018-10-03 Digital Microfluidic Biochips focuses on the automated design and production of microfluidic based biochips for large scale bioassays and safety critical applications Bridging areas of electronic design automation with microfluidic biochip research the authors present a system level design automation framework that addresses key issues in the design analysis and testing of digital microfluidic biochips The book describes a new generation of microfluidic biochips with more complex designs that offer dynamic reconfigurability system scalability system integration and defect tolerance Part I describes a unified design methodology that targets design optimization under resource constraints Part II investigates cost effective testing techniques for digital microfluidic biochips that include test resource optimization and fault detection while running normal bioassays Part III focuses on different reconfiguration based defect tolerance techniques designed to increase the yield and dependability of digital microfluidic biochips Expanding upon results from ongoing research on CAD for biochips at Duke University this book presents new design methodologies that address some of the limitations in current full custom design techniques Digital Microfluidic Biochips is an essential resource for achieving the integration of microfluidic components in the next generation of system on chip and system in package designs   *Micro-Electrode-Dot-Array Digital Microfluidic Biochips* Zipeng Li,Krishnendu Chakrabarty,Tsung-Yi Ho,Chen-Yi Lee,2018-12-14 This book provides an insightful guide to the design testing and optimization of micro electrode dot array MEDA digital microfluidic biochips The authors focus on the characteristics specific for MEDA biochips e g real time sensing and advanced microfluidic operations like lamination mixing and droplet shape morphing Readers will be enabled to enhance the automated design and use of MEDA and to develop a set of solutions to facilitate the full exploitation of design complexities that are possible with standard CMOS fabrication techniques The book provides the first set of design automation and test techniques for MEDA biochips The methods described in this book have been validated using fabricated MEDA biochips in the laboratory Readers will benefit from an in depth look at the MEDA

platform and how to combine microfluidics with software e g applying biomolecular protocols to software controlled and cyberphysical microfluidic biochips **Exact Design of Digital Microfluidic Biochips** Oliver Keszocze,Robert Wille,Rolf Drechsler,2018-06-11 This book presents exact that is minimal solutions to individual steps in the design process for Digital Microfluidic Biochips DMFBs as well as a one pass approach that combines all these steps in a single process All of the approaches discussed are based on a formal model that can easily be extended to cope with further design problems In addition to the exact methods heuristic approaches are provided and the complexity classes of various design problems are determined Presents exact methods to tackle a variety of design problems for Digital Microfluidic Biochips DMFBs Describes an holistic one pass approach solving different design steps all at once Based on a formal model of DMFBs that is easily adaptable to deal with further design tasks *Design and Testing of Digital Microfluidic Biochips* Krishnendu Chakrabarty,Springer,2012-08-31 This book provides a comprehensive methodology for automated design test and diagnosis and use of robust low cost and manufacturable digital microfluidic systems It focuses on the development of a comprehensive CAD optimization framework for digital microfluidic biochips that unifies different design problems With the increase in system complexity and integration levels biochip designers can utilize the design methods described in this book to evaluate different design alternatives and carry out design space exploration to obtain the best design point **Digital Microfluidic Biochips** Krishnendu Chakrabarty,2007 **Digital Microfluidic Biochips** Krishnendu Chakrabarty,Tao Xu,2010 Microfluidics based biochips combine electronics with biochemistry providing access to new application areas in a wide variety of fields Continued technological innovations are essential to assuring the future role of these chips in functional diversification in biotech pharmaceuticals and other industries Microfluidic Biochips Design Automation and Optimization comprehensively covers the appropriate design tools and in system automation methods that will help users adapt to new technology and progress in chip design and manufacturing Based on results from several Duke University research projects on design automation for biochips this book uses real life bioassays as examples to lay out an outomated design flow for creating microfluidic biochips It also develops solutions to the unique problems associated with the process In addition to covering automated design the authors provide a detailed methodology for the testing use and optimization of robust cost efficient manufacturable digital microfluidic systems used in protein crystallization and other areas The authors present specialized pin constrained design techniques for making biochips with a focus on cost and disposability They also discuss chip testing to ensure dependability which is key to optimizing safety critical applications such as point of care medical diagnostics on chip DNA analysis automated drug discovery air quality monitoring and food safety testing This book is an optimal reference for academic and industrial researchers in the areas of digital microfluidic biochips and electronic design automation BOOK JACKET Fault-Tolerant Digital Microfluidic Biochips Paul Pop,Mirela Alistar,Elena Stuart,Jan Madsen,2015-09-07 This book describes for researchers in the fields of compiler technology design and test and electronic

design automation the new area of digital microfluidic biochips DMBs and thus offers a new application area for their methods The authors present a routing based model of operation execution along with several associated compilation approaches which progressively relax the assumption that operations execute inside fixed rectangular modules Since operations can experience transient faults during the execution of a bioassay the authors show how to use both offline design time and online runtime recovery strategies The book also presents methods for the synthesis of fault tolerant application specific DMB architectures Presents the current models used for the research on compilation and synthesis techniques of DMBs in a tutorial fashion Includes a set of benchmarks which are presented in great detail and includes the source code of most of the techniques presented including solutions to the basic compilation and synthesis problems Discusses several new research problems in detail using numerous examples **Design Tools and Optimization Methods for Digital Microfluidic Biochips** Tao Xu,2007 Hardware/Software Co-Design and Optimization for Cyberphysical Integration in Digital Microfluidic Biochips Yan Luo,Krishnendu Chakrabarty,Tsung-Yi Ho,2014-08-06 This book describes a comprehensive framework for hardware software co design optimization and use of robust low cost and cyberphysical digital microfluidic systems Readers with a background in electronic design automation will find this book to be a valuable reference for leveraging conventional VLSI CAD techniques for emerging technologies e g biochips or bioMEMS Readers from the circuit system design community will benefit from methods presented to extend design and testing techniques from microelectronics to mixed technology microsystems For readers from the microfluidics domain this book presents a new design and development strategy for cyberphysical microfluidics based biochips suitable for large scale bioassay applications Takes a transformative cyberphysical approach towards achieving closed loop and sensor feedback driven biochip operation under program control Presents a physically aware system reconfiguration technique that uses sensor data at intermediate checkpoints to dynamically reconfigure biochips Enables readers to simplify the structure of biochips while facilitating the general purpose use of digital microfluidic biochips for a wider range of applications **Synthesis, Testing, and Reconfiguration Techniques for Digital Microfluidic Biochips** Fei Su (Ph. D.),2006 **Design Automation for Digital Microfluidic Biochips** Tsung-Yi Ho,2016-02-15 This book demonstrates the use of computer aided design CAD tools to automate and optimize the design and synthesis of digital microfluidicbiochips DMFBs in fluidic and chip hardware domains It describes several associative combinatorial and geometric optimization problems considers new constraints in low cost large scale biochip design and includes real life bioassays as evaluation examples e g DNA sample preparation multiplexed in vitro human physiological fluids diagnostics PCR and protein crystallization The CAD techniques presented address real manufacturing issues and can be applied directly to industrial product development **Placement and Routing for Cross-referencing Digital Microfluidic Biochips** Zigang Xiao,2011 Secure and Trustworthy Cyberphysical Microfluidic Biochips Jack Tang,Mohamed Ibrahim,Krishnendu Chakrabarty,Ramesh Karri,2019-05-28 This

book describes novel hardware security and microfluidic biochip design methodologies to protect against tampering attacks in cyberphysical microfluidic biochips CPMBs It also provides a general overview of this nascent area of research which will prove to be a vital resource for practitioners in the field This book shows how hardware based countermeasures and design innovations can be a simple and effective last line of defense demonstrating that it is no longer justifiable to ignore security and trust in the design phase of biochips   Routing for Digital Microfluidic Biochips:From Fluidic-Level Toward Chip-Level □□□,2011   *Routing and Performance Optimization of Digital Microfluidic Biochip* Sarit Chakraborty,2024-01-22 Digital Microfluidic Biochips or DMFBs have emerged as a great alternative to various in vitro diagnostic tests in recent past These chips are expected to be closely coupled up with cyberphysical systems and with other healthcare related systems in the near future Hence design optimization of such micro or nano scale DMFB requires interdisciplinary study of computer science electronics along with biochemistry and medical technology Research in this new discipline of nano biotechnology needs the integration of diverse fields such as microelectronics biochemistry in vitro diagnostics computer aided design and optimization fabrication technology in association with healthcare engineering methodologies Potential applications of DMFBs include several real life applications such as point of care clinical diagnostics enzymatic analysis e g glucose and lactate assays high throughput DNA Deoxyribonucleic acid sequencing immunoassay proteomics study of protein structure and environmental toxicity monitoring water and air pollutant detection or food processing and so on and so forth These LoC systems provide a viable and low cost platform for rapid automated and accurate clinical diagnosis of various diseases including malaria neglected tropical diseases NTD prevalent in the developing countries Typically a microfluidic based chip implements one or more complex bioassays bio protocols by manipulating nanolitre or picoliter volume of fluids on a single chip of a few square centimeters in size   **Optimization Tools for the Design of Reconfigurable Digital Microfluidic Biochips** Tao Xu,2008   **A General Purpose Field-programmable Digital Microfluidic Biochip with Scannable Electrofluidic Control** Rissen Alfonso Joseph,2014 Applications of digital microfluidic biochips DMFBs are ever increasing Most of today s researchis focused on designing a cost effective DMFB that does not compromise the flexibility offered by individuallyaddressable electrodes Flexible DMFB architectures that use individual addressing have highI O pin demands which drive the cost Pin constrained designs though reduce the I O pin count makethe DMFBs assay specific rather than general purpose requiring the fabrication of specialized DMFBsfor each assay This negated the cost savings brought about by reduction in pin count Our proposedDMFB architecture utilizes pin constrained design techniques on top of scan chain based electrode controlto realize a highly flexible and customizable general purpose field programmable array with veryfew I O pins Experimental results show a pin reduction of 65x with respect to the direct addressablearrays and 5 7x in comparison to the field programmable pin constrained DMFBs An analysis of theassay execution time show that assays run up to 40 % faster on our architecture in comparison to thestate of the art pin constrained design of comparable size   **Design**

Automation Methods and Tools for Microfluidics-Based Biochips Jun Zeng,2006-11-08 Design Automation Methods and Tools for Microfluidics Based Biochips deals with all aspects of design automation for microfluidics based biochips Experts have contributed chapters on many aspects of biochip design automation Topics covered include device modeling adaptation of bioassays for on chip implementations numerical methods and simulation tools architectural synthesis scheduling and binding of assay operations physical design and module placement fault modeling and testing and reconfiguration methods

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