Handbook of Signal Processing Systems

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Editors

Handbook of Signal Processing Systems

Second Edition

Foreword by S.Y. Kung

Springer

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Foreword

It gives me immense pleasure to introduce this timely handbook to the research/development communities in the field of signal processing systems (SPS). This is the first of its kind and represents the state-of-the-art coverage of research in this field. The driving force behind information technologies (IT) hinges critically upon the major advances in both *component integration* and *system integration*. The major breakthrough for the former is undoubtedly the invention of IC in the 1950s by Jack S. Kilby, the Nobel Prize Laureate in physics in 2000. In an integrated circuit, all components were made of the same semiconductor material. Beginning with the pocket calculator in 1964, there have been many increasingly complex applications followed. In fact, processing gates and memory storage on a chip have since then grown at an exponential rate, following Moore's Law. (Moore himself admitted that Moore's Law had turned out to be more accurate, longer lasting, and deeper in impact than he ever imagined.) With greater device integration, various signal processing systems have been realized for many killer IT applications. Further breakthroughs in computer sciences and Internet technologies have also catalyzed large-scale *system integration*. All these have led to today's IT revolution which has profound impacts on our lifestyle and overall prospect of humanity. (It is hard to imagine life today without mobiles or Internets!)

The success of SPS requires a well-concerted integrated approach from multiple disciplines, such as device, design, and application. It is important to recognize that *system integration* means much more than simply squeezing components onto a chip and, more specifically, there is a symbiotic relationship between applications and technologies. Emerging applications, e.g., 3D TV, will prompt modern system requirements on performance and power consumption, thus inspiring new intellectual challenges. The SPS architecture must consider overall system performance, flexibility, and scalability, power/thermal management, hardware–software partition, and algorithm developments. With greater integration, system designs become more complex and there exists a huge gap between what can be theoretically designed and what can be practically implemented. It is critical to consider, for instance, how to deploy in concert an ever increasing number of transistors with acceptable power consumption and how to make hardware effective for applications and yet friendly

to the users (easy to program). In short, major advances in SPS must arise from close collaboration between application, hardware/architecture, algorithm, CAD, and system design.

The handbook has offered a comprehensive and up-to-date treatment of the driving forces behind SPS, current architectures, and new design trends. It has also helped seed the SPS field with innovations in applications; architectures; programming and simulation tools; and design methods. More specifically, it has provided a solid foundation for several imminent technical areas, for instance, scalable, reusable, and reliable system architectures, energy-efficient high-performance architectures, IP deployment and integration, on-chip interconnects, memory hierarchies, and future cloud computing. Advances in these areas will have greater impact on future SPS technologies.

It is only fitting for Springer to produce this timely handbook. Springer has long played a major role in academic publication on SPS, many of them have been in close cooperation with IEEE's signal processing, circuits and systems, and computer societies. For nearly 20 years, I have been the editor-in-chief of Springer's journal of signal processing systems, considered by many as a major forum for the SPS researchers. Nevertheless, the idea has been around for years that a single-volume reference book would very effectively complement the journal in serving this technical community. Then, during the 2008 IEEE Workshop on Signal Processing Systems, Washington D.C., Jennifer Evans from Springer and the editorial team led by Prof. Shuvra Bhattacharyya met to brainstorm implementation of such idea. The result is this handsome volume, containing contributions from renowned pioneers and active researchers.

I congratulate the authors and editors for putting together such an outstanding handbook. The fact that the second edition is released so soon after the first version is a clear attestation of its great demand from all the professional communities working in the broad area of signal processing systems (SPS). It is truly a timely contribution to the field of SPS for many decades to come.

Princeton, NJ S.Y. Kung

Preface to the First Edition

This handbook provides a reference on key topics in the design, analysis, implementation, and optimization of hardware and software for signal processing systems. Plans for the handbook originated through valuable discussions with SY Kung (Princeton University) and Jennifer Evans (Springer). Through these discussions, we became aware of the need for an integrated reference focusing on the efficient implementation of signal processing applications. We were then fortunate to be able to enlist the participation of a diverse group of leading experts to contribute chapters in a broad range of complementary topics.

We hope that this handbook will serve as a useful reference to engineering practitioners, graduate students, and researchers working in the broad area of signal processing systems. It is also envisioned that selected chapters from the book can be used as core readings for seminar- or project-oriented graduate courses in signal processing systems. Given the wide range of topics covered in the book, instructors would have significant flexibility to orient such a course towards particular themes or levels of abstraction that they would like to emphasize.

The handbook is organized in four parts. Part I motivates representative applications that drive and apply state-of-the-art methods for design and implementation of signal processing systems; Part II discusses architectures for implementing these applications; Part focuses on compilers and simulation tools; and Part IV describes models of computation and their associated design tools and methodologies.

We are very grateful to all of the authors for their valuable contributions and for the time and effort they have devoted to preparing the chapters. We would also like to thank Jennifer Evans and SY Kung for their encouragement of this project, which was instrumental in getting the project off the ground, and Jennifer Maurer for her support and patience throughout the entire development process of the handbook.

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Preface to the Second Edition

In this edition of the Handbook of Signal Processing Systems, many of the chapters from the first edition have been updated and several new chapters have been added. The new contributions include chapters on inertial sensors, real-time stream mining, stereoscopic and multiview 3D displays, wireless transceivers, radio astronomy, stereo vision, particle filtering architectures, and multidimensional dataflow graphs.

We hope that this updated edition of the handbook will continue to serve as a useful reference to engineering practitioners, graduate students, and researchers working in the broad area of signal processing systems. Selected chapters from the book can be used as core readings for seminar- or project-oriented graduate courses in signal processing systems. Given the wide range of topics covered in the book, instructors have significant flexibility to orient such a course towards particular themes or levels of abstraction that they would like to emphasize.

This new edition of the handbook is organized in three parts, where, due to their close relationship, the third and fourth parts from the first edition have been integrated into a single part (Part). Part I of the second edition motivates representative applications that drive and apply state-of-the-art methods for design and implementation of signal processing systems; Part II discusses architectures for implementing these applications; and Part focuses on compilers, as well as models of computation and their associated design tools and methodologies. In each part, chapters are ordered alphabetically based on the last name of the first author.

We are very grateful to all of the authors for their valuable contributions and for the time and effort they have devoted to preparing the chapters. We would also like to thank Courtney Clark for her support and patience throughout the entire development process of the handbook.

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