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BOOK REVIEW

CMOS Imagers: From Phototransduction to Image Processing

This book will interest both beginning analog designers and those interested in bio-inspired silicon circuits.

Orly Yadid-Pecht and Ralph Etienne-Cummings (Eds.)
Publisher: Kluwer Academic Publishers
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This is the first book written on complementary metal-oxide semiconductor (CMOS) imagers and their application to focal-plane image processing, and will be of interest to those already working on analog circuit design and/or building image processing systems for various applications. In particular, the book presents the technology crucial for building neuromorphic vision systems, and should therefore be of great interest to this community.

I myself am interested in building human-like intelligent systems based on state-of-the-art silicon VLSI technology. To this end, CMOS imagers form an integral part of the system including ROI (region-of-interest) detection, motion detection, feature extraction from images, and so forth. Several of my students have worked on projects related to this topic, but—until now—there were no good textbooks that provided an overview for newcomers to the technology. In this respect I found the book very useful: it contains sufficient information for beginners to start their projects, as well as a lot of ideas and hints to guide students to develop their own new ideas in focal-plane processing. I believe the book is very valuable not only for Ph.D. students, but also for researchers and engineers in industries interested in silicon technology. Not in the traditional Moore's-Law-driven digital technology, of course, but the more fascinating analog neuromorphic or bio-inspired VLSI systems.

Though CCD has been the mainstream technology for image acquisition, CMOS imagers are now invading the market. Their advantages include low-voltage, low-power operation, and compatibility with standard CMOS fabrication processes. Of particular importance is the nondestructive readout of pixel data in CMOS imagers, enabling various kinds of image processing operations to be performed in the focal plane.

The first four chapters provide readers with sufficient practical information to start designing their own CMOS imagers. The book starts with an introduction to silicon device physics in relation to the photon-to-electronic-charge conversion in Chapter 1, which is followed by the analysis of the modulation transfer function (MTF) of CMOS active pixel sensors (APSs) in Chapter 2. In Chapter 3, a semi-analytical model is developed for the estimation of APS photo response. This is based on experimental data incorporating the effect of substrate diffusion of photo-generated carriers as well as geometrical shape and size of the photodiode active area. Review of APS design is presented in Chapter 4 from the very basics to more advanced system-on-chip examples. Smart vision-system-on-a-chip and tracking sensors are presented as examples of CMOS imagers with integrated intelligence.

Next, more examples of advanced focal-plane-processing applications are presented. Chapter 5 discusses three systems for imaging and visual-information processing at the focal plane, using three different representations of the photon flux density: current-mode, voltage-mode, and mixed-mode. The chapter also outlines how spatiotemporal image processing can be implemented. Chapter 6 looks at a stochastic adaptive algorithm for on-line correction of spatial non-uniformity in random-access addressable imaging systems. An adaptive architecture is

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implemented in analog VLSI, and is integrated with the photo sensors on the focal plane. The idea presented is particularly attractive for compact implementation using floating-gate MOS circuits.

The book is written by well-recognized leading researchers in the area. I believe its publication is timely, that it will serve as a good reference for this area of technology, and that it will prove invaluable for both experienced and novice designers.

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Tadashi Shibata is currently developing intelligent VLSI systems based on psychological brain models using state-of-the-art silicon technology.