Industrial Image Processing
As a student of ETH Zurich, I encountered image processing for the first time in the mid-1980s. Then, the subject was primarily discussed from a scientific and theoretical point of view (algorithms) and had no practical use in automation technology. Expensive special hardware with weak, non-standardized processors in combination with error-prone assembler programming resulted in poor reliability for industrial processes and thus prevented its spread.

While writing my doctoral thesis in the early 1990s as one of the first Ph.D. candidates at the Paul Scherrer Institute in Zurich (now the Centre Suisse d’Electronique et de Microtechnique, abbreviated CSEM), I focused on this subject with research concerning the then novel CMOS image sensors. Since then, image processing has become the central focus of my professional career.

In the wake of the rapid development of PC technology, the triumphant progress of industrial image processing began in the mid-1990s and continues to this date. Modern industrial production processes are inconceivable without image processing systems. Many automation solutions are even made possible only by using image processing. Industrial image processing has turned from an abstract science into a still ambitious, yet also extremely useful key technology of modern automation technology.

The authors deserve credit for providing the first edition of this book back in 1999, a reference book on the subject of industrial image processing for the first time offering both beginners and advanced readers an ideal introduction and reference. This is not an abstract work of academia but explains in an understandable way the methodical processes and mathematical foundations of important image processing functions. It also deals with all vital aspects needed to implement industrial image processing systems for quality control in industrial manufacturing processes. From illumination to optics, cameras and image capturing hardware, the fundamental software algorithms and automation interfaces, the relationships of all relevant parts are presented.

What makes this book unique is the practical relevance. Using the professional image processing software NeuroCheck developed by authors Demant and Streicher-Abel, the reader is able to follow the many examples in the book taken from practice using an intuitive, modern graphical interface, and parameterize
them anew interactively. From the viewpoint of my former academic work at the institute this is a revolutionary approach.

Therefore, for many interested in image processing the book has rightly become a standard reference within a short time after its publication. And it is still an authority even if the image processing user of today usually does not need to develop algorithms since standard software is available on the market enabling him to implement even complex applications. The understanding of the interaction of all components described in the book is still vital and valid.

Since the publication of the first edition in 1999, many things have changed in the area of image processing hardware, e.g. imaging sensors. The availability of modern digital cameras with ever faster CCD and CMOS sensors, and of modern digital interfaces such as USB, IEEE 1394 (“FireWire”) and Gigabit Ethernet have contributed to image processing becoming even faster and more productive. Modern multi-core CPU technology allows for more comfortable and more reliable image processing software—while simultaneously cost is decreasing.

The authors allow for this development in this heavily revised second edition, and not least thanks to the new NeuroCheck software version 6.0 (available since 2009), they demonstrate what state-of-the-art image processing systems can look like. This standard reference in its latest edition should have its place on every bookshelf.

Frauenfeld, Switzerland, January 2013

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Since the publication of the first edition of our book in 1999, machine vision has enjoyed continuous strong growth as in the decade before. After machine vision had crossed the 1 billion Deutsche Mark revenue line in Germany in 2000, the same euro milestone was then reached in 2005. The average growth rate was approximately 6.4% between 2000 and 2010 [VDMA (German Engineering Association)]. One has to look carefully to find industries with comparable growth dynamics.

However, this glossy image has experienced its first setbacks. In 2009 in the wake of the global economic crisis, companies in this industry suffered significant losses (−21%) for the first time.

In addition to this, machine vision had by now reached the phase of a “consolidated industry” in the life cycle of an economic sector. The spirit of optimism from the 1990s has mostly evaporated, technological quantum leaps have become rare, and by now the continuous reduction of system cost is at a premium. Start-ups can only establish themselves on the market with the help of huge grants and only rarely do they leave the “small business” sector. On the other hand, the number of co-operations is increasing and many market players are growing solely by purposefully acquiring smaller businesses.

Where in the 1990s a complex algorithm was able to convince on the spot, today software reliability during continuous production and trouble-free integration into networked production structures are vital.

Since all industry partners feel the increasing time pressure, intelligent easy-to-use functionality becomes more and more important. Wherever possible, system providers have to use high performing hardware and software standards since the development of proprietary systems is no longer acceptable to the market, neither technologically nor financially.

However, the subject retains its fascination and there is a number of reasons why, globally, machine vision will continue to grow successfully over the following years.

Ensuring quality is the top priority among manufacturers. Machines that are able to “see” gauge high-precision parts, guide robot arms into the correct position, and identify components during production flow from incoming to outgoing goods.
Let us summarize: today, industrial production without machine vision is unthinkable! Therefore, visual inspection systems can be found in businesses of all sizes and industrial sectors.

Especially German industry with its strong “Mittelstand” (medium-sized businesses) again and again holds numerous very different and demanding tasks for machine vision. Hence, German machine vision businesses are globally leading in many areas, especially when it comes to versatility, flexibility and integration into various production environments. Excellent competence with regard to solving the image processing task is the fundamental requirement to be seriously taken into consideration as a provider. With this background, a practical introduction into image processing is now more needed than ever before.

This book is based on years of practical experience on the part of the authors in development and integration of automated visual inspection systems into manufacturing industry. We have tried to use a different approach than most books about (digital) image processing. Instead of introducing isolated methods in a mathematically systematic sequence, we present applications taken with few exceptions from industrial practice. These image processing problems then motivate the presentation of the applied algorithms, which focuses less on theoretical considerations than on the practical applicability of algorithms and how to make them work together in a consistently designed system. The mathematical foundations will not be neglected, of course, but they will also not be the main focus of attention.

We hope that this approach will give students and practitioners alike an impression of the capabilities of digital image processing for the purposes of industrial quality control. We also hope that it will create an understanding for the prerequisites and methodology of its application.

We would like to thank Baumer Optronic, Radeberg, Germany, for the many years of successful cooperation and constructive support in writing the chapter on digital cameras.

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