Preface

Diagnostic imaging in biomedicine is based on several techniques and processes aiming at the enhancement of experts’ capability to evaluate imaging data. Diagnostic imaging combines image processing and decision support methods to improve and accelerate case-specific advice in clinical environments.

Decision support today focuses on diagnosis, prognosis, therapy and follow-up recommendations and is usually based on simple and easily acquired features met in biomedical data. The latest breakthroughs in imaging technologies in medicine lead to an explosion of the imaging data available. New techniques and methods addressing mainly acquisition and processing of information from medical and biological images appeared and the integration of biomedical image data into decision support systems is a challenging task. This mainly supports the decision on the patient’s health status and the quality of the extracted diagnosis and prognosis.

Despite the wide application of decision support systems in medicine, only a few such systems have been developed for biomedical imaging. One of the reasons is the difficulty in representing anatomical or functional units of the images in formal features. Dealing with this uncertain and imprecise information increases the complexity of decision support systems. Furthermore, each imaging modality and each type of pathology requires the development of dedicated low-level feature extractors. Although, standard computer-vision techniques may be used (template matching, region growing, etc.), specific methodologies and algorithmic approaches need to be developed. These difficulties, combined with the computational cost associated with biomedical imaging applications, have prevented, so far, the development of fully automated image guided decision support systems. By producing a formal and structured representation of the images, imaging decision support systems enable new applications such as the automated generation of anatomical and functional atlases or the content-driven image retrieval. The abundance of information derived from cross-sectional imaging modalities, such as computed tomography (CT), magnetic resonance imaging (MRI), single photon emission computerized tomography (SPECT), positron emission tomography (PET), or conventional planar imaging technologies such as digital X-ray, and ultrasound highlights the need for the design and the development of decision support systems based mainly on multiple imaging data. Such tools improve diagnostic accuracy and overall reproducibility by providing a second opinion and objective measurements of normal and abnormal patterns.

This handbook features the most current research findings in all aspects of biomedical imaging, diagnostic and decision support methodologies, from theoretical and algorithmic problems to successfully designed and developed biomedical image guided decision support systems. The handbook is intended for all those working in the field of medical image analysis and information technologies in biomedicine. It provides different approaches and levels of knowledge for experienced researchers, graduate students, computer engineers, and medical practitioners interested in emerging intelligent diagnostic tools and systems. The handbook serves as the basis for understanding the future of decision support technolo-
gies and services based on biomedical imaging, exemplifying the impact of knowledge extraction on clinical environments.

The objective of this Handbook is to present state of the art in the field and present advances which:

• Bridge the gap between medical and biological imaging with clinical decision support systems.
• Integrate biomedical images in the most efficient way in existing decision support systems.
• Present a unified framework for image analysis in medical and biological applications.
• Enhance the readers’ capability in designing decision support systems which employ biomedical images.

This book is divided into three sections. The first introduces the readers to some advanced image-based decision support applications. This part addresses the utilization of existing methodologies and techniques to several clinical areas with increased needs for computer-aided assistance. An overview of computational methods and tools applied in decision support systems is presented. Integration of imaging data as well as new approaches on cardiac, intracoronary and cardiac MRI data are analyzed extensively. In addition, clinical decision support systems for the interpretation of hepatic lesions, oncology samples and breast imaging are presented, along with a quantitative analysis of hysteroscopy imaging in gynecological cancer. The second section of the book presents novel methodologies in the field of biomedical imaging. 3D quantitative radionuclide dosimetry and combination of geometry and image data appear to have great interest in the area of radiation therapy. Diffusion tensor imaging, infrared imaging as well as DNA microarray analysis are new issues. Research studies based on the mechano-elastic properties of matter and elastographic applications are also presented. In the third section, methodological approaches of image processing and their medical applications are presented.

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