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Reconstruction, Segmentation, and Analysis of Medical Images

First International Workshops, RAMBO 2016 and HVSMR 2016
Held in Conjunction with MICCAI 2016
Athens, Greece, October 17, 2016
Revised Selected Papers

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Preface

This book gathers the works presented at the Workshop on Reconstruction and Analysis of Moving Body Organs (RAMBO) and the Workshop on Whole-Heart and Great Vessel Segmentation from 3D Cardiovascular MRI in Congenital Heart Disease (HVSMR), which were held in conjunction with MICCAI on October 17, 2016.

RAMBO

Physiological motion is an important factor in several medical imaging applications. For instance, the speed of motion may inhibit the acquisition of high-resolution images needed for effective visualization and analysis, for example, in cardiac or respiratory imaging or in functional magnetic resonance imaging (fMRI) and perfusion applications. Additionally, in cardiac and fetal imaging, the variation in frame of reference may confound automated analysis pipelines. The underlying motion may also need to be characterized either to enhance images or for clinical assessment. Techniques are therefore needed for faster or more accurate reconstruction or for analysis of time-dependent images. Despite the related concerns, few meetings have addressed the issues caused by motion in medical imaging, without restriction on the clinical application area or methodology used. RAMBO 2016 was set up to provide a discussion forum for researchers for whom motion and its effects are critical in image analysis or visualization. By inviting contributions across all application areas, the workshop aimed to bring together ideas from different areas of specialization, without being confined to a particular methodology. In particular, the recent trend to move from model-based to learning-based methods of analysis has resulted in increased transferability between application domains. A further goal of this workshop was to enhance the links between image analysis (including computer vision and machine learning techniques) and image acquisition and reconstruction, which generally tends to be addressed in separate meetings. The presented contributions can be broadly categorized into segmentation, registration, and reconstruction, while application areas include cardiac, abdominal, fetal, and brain perfusion, showing the breadth of interest in the topic. Research from both academia and industry is presented. We hope that this workshop enables the cross-fertilization of ideas across application domains with the aim of tackling and taking advantage of the problems and opportunities arising from motion in medical imaging.

October 2016

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HVSMR

Congenital heart disease (CHD) affects approximately 1.2% of children and is the leading cause of birth defect-related deaths. About 6 to 19 per 1,000 cause moderate to severe problems requiring immediate surgical repair. Clinicians currently rely on two-dimensional imaging (2D) for monitoring and procedural planning. However, 2D images cannot depict the 3D spatial relationships of intracardiac anatomy, and reliance on them limits efficient decision-making.

Compared with conventional 2D imaging techniques, it has been recently shown that 3D virtual and physical heart models convey several benefits when visualizing intracardiac anatomy in 3D and in producing consensus around a surgical plan.

Three-dimensional images can be generated by segmenting the cardiac muscle and blood in 3D images acquired from echocardiography, X-ray, or magnetic resonance imaging (MRI). MRI has many advantages including better image quality compared with echocardiography, and unlike X-ray is not associated with ionizing radiation. However, segmentation of cardiac MR images is challenging owing to intensity inhomogeneities (due to the motion of the heart and blood), poor contrast, the presence of thin walls separating cardiac chambers, and the wide anatomical variability in congenital heart disease patients.

Manual segmentation has been the most robust technique for delineating the cardiac muscle and blood in cardiac MR datasets. This technique, however, is time intensive (4–8 h of work), prone to error, and subject to intra- and inter-observer variability. As of yet, there is no robust automatic segmentation algorithm developed for cardiac MR segmentation for congenital heart disease.

The HVSMR workshop gathered researchers from around the world to tackle this challenging problem, sharing a newly released open dataset of cardiac MR images from patients with various forms of congenital heart disease. The ultimate goal is to improve surgical planning for patients with complex congenital heart disease. We believe this workshop provided a snapshot of the current progress in the field of cardiac MR segmentation for this patient cohort.

October 2016

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Organization

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