Preface: Detection, Modeling, and Compensation of Organ Motion and Deformation—Part II

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In the second part of this special issue, we present critical reviews of the research on clinical applications in which organ motion and deformation play a central role. Even though neurosurgical navigation has reached a high level of technological optimization, and several research groups have contributed to biophysical models of the human brain, the inherent problem of tissue deformation (brain shift) during neurosurgical interventions is currently best compensated by advanced intraoperative imaging. Daniela Kuhnt at al. arrives at these conclusions based on their evaluation of the literature on the field. In radiotherapy, motion compensation, as reviewed by Matthias Guckenberger et al., is of the utmost importance for an accurate dose delivery and minimization of adverse side effects, and has been investigated for many years. Conversely, in liver surgery, image-guided procedures and navigation technology are still under development, and the first commercial solutions were presented only recently, as discussed by Matthias Peterhans et al. The special issue is rounded off by Stefan Braunewell et al. on the application of high-intensity focused ultrasound in moving organs, which represents a rather recent field of research, and by Tobias Böhler et al., who review the specific field of deformable image registration and deformation modeling in the female breast, which is crucial for many diagnostic and interventional procedures.

Although impressive research results and technological achievements have been presented, there is still a lack of integrated systems that are affordable, reliable, and easy to use. Establishing clinical solutions for the motion and deformation problem will allow for the translation of the technologically feasible precision of today's medical image acquisition to an extended range of highly precise therapeutic options in virtually all parts of the human body.

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