Guest Editorial : Special issue on advanced computing for image- guided intervention

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Editorial

Guest Editorial: Special issue on advanced computing for image-guided intervention

In the past years, we have witnessed a growing number of applications of minimally invasive or non-invasive interventions in clinical practice, where imaging is playing an essential role for the success of both diagnosis and therapy. Particularly, advanced signal and image processing algorithms are receiving increasing attention, which aim to provide accurate and reliable information directly to physicians. We have seen the applications of these technologies during all stages of an intervention, including pre-operational planning, intra-operational guidance and post-operational verification.

For this special issue, we have received a significant number of submissions from both academia and industry, out of which we have carefully selected eleven articles with outstanding quality. These articles have covered the topics of anatomic structure identification and tracking, image registration, data visualization and newly emerging applications.

In [1–3], from this issue, image processing algorithms are applied to support minimally invasive therapeutic procedures based on MRI imaging. In [2], Laser induced Interstitial Thermal Therapy (LITT) has been applied to treat prostate cancer and a quantitative analysis of MRI image features is presented which is shown to correlate well with the therapeutic response. Toth et al. [1] have addressed the image registration problem between pre- and post-radiated MRI to facilitate the evaluation of the therapeutic response after External Beam Radiation Treatment (EBRT) for the prostate cancer. A different approach has been employed by [3] to model the deformation induced by LITT for neurological disorders.

We have also included three papers on ultrasound-guided image interventions. In [4], the author has surveyed the recent developments in the area of in-body ultrasound imaging for cardiovascular interventions. Various relevant image processing algorithms are reviewed including tissue characterization, segmentation, device tracking and registration. In [5], ultrasound-based tracking of mitral valve leaflets is addressed, which is of crucial importance to better understand various cardiac diseases and to assist the surgical intervention for mitral valve repair. In [6], an image guidance method is presented for percutaneous nephrolithotomy (PCNL) by augmenting interventional ultrasound using a 3D statistical kidney shape model, which has been shown to reduce complications with traditional methods.

We have included in this special issue two papers on tissue characterization from endoscopic images. Nawarathna et al. have proposed in [7] a texture-based approach for finding abnormal lesions from wireless capsule endoscopy and colonoscopy images. In [8], a new algorithm is proposed to detect early cancerous tissue in high-definition endoscopic images. Color and texture features are defined, followed by a learning-based approach to classify the tissue types. Another tissue characterization application is addressed in [9] for mass classification from mammographic images. The latent characteristics of masses are captured by the use of the so-called Latent Dirichlet Allocation algorithm, followed by feeding the features to a classifier to determine if the mass is benign or malignant.

With the increasing use of various imaging modalities in image-guided intervention and therapy, how to optimally present and visualize the data becomes also an important issue. In [10], the authors have addressed the use of autostereoscopic volumetric visualization of the patient's anatomy, which has the potential to be combined with augmented reality. The paper especially addresses the latency problem in the visualization chain, and a few improvements have been proposed.

A new adjacent application has been presented in [11], which applies fMRI techniques to video clustering and retrieval. Features derived from natural stimulus fMRI data and other audiovisual features are integrated to show an improved performance for the video clustering. From this we can also envision more adjacent applications where biomedical imaging technologies can be used to address the needs from consumer application domains.

In summary, we have seen from submissions to this special issue a growing interest in applying advanced signal and image processing technologies to image-guided interventions. The submissions have covered a wide range of clinical applications using various imaging modalities. Image feature extraction remains to be an important subject and it has to be specifically designed to suit the needs for specific applications. Learning-based approaches have also attracted a lot of attention, especially in applications requiring automatic tissue characterization and classification. We are also very happy to have received new emerging applications which are able to extend the traditional interventional imaging into greater application areas.

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