Computer Assisted Medical Interventions in North America – A Brief Survey of Research and Collaboration Activities

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Abstract—A brief survey of the North American activities in the area of computer assisted medical interventions (CAMI) will be presented.

PROGRESS IN CAMI

Computer assistance has become quite common in many areas of medical interventions. In particular, the use of treatment planning and quality control has become standard in radiotherapy, in which a team of physicians and medical physicists participate in a well defined therapy process. Based on images and tissue models, the areas to be treated and the regions of high risk are defined. Plans for radiation delivery are developed based on these and on tissue models that are becoming more and more sophisticated. Quality control is implemented based on pre-procedure simulations or post-operative imaging.

Many areas of surgery already benefit from precise image-based guidance, including neurosurgery, orthopedic surgery and ENT, for which commercial systems are available and widely used. Image guidance has enabled a reduction in the invasiveness of procedures. For example, many uterine fibroid tumors are often treated today with high intensity ultrasound instead of surgery.

There have been many improvements to minimally invasive catheter and needle-based procedures that have been traditionally carried out under fluoro or ultrasound guidance but without sensing or computer assistance. Catheter imaging can now benefit by the fusion of multiple views to indicate the catheter 3D location. Catheter localization can also be used for cardiac mapping for arrhythmia-related procedures.

Needle visualization based on electromagnetic sensing has become common in both research work and clinical practice. This allows the intuitive localization of the needle relative to the ultrasound imaging plane and the target.

Fusion of imaging acquired prior to interventions with intra-procedural imaging is currently supported by several software products for guiding biopsies.

For example, magnetic resonance imaging and ultrasound can be fused to allow for the much higher accuracy of targeting cancer with multi-parametric MRI, to point to a suspicious area to be biopsied under ultrasound guidance.

Robot assisted surgery has become commonly used in many procedures. Apart from the many advantages that it provides for minimally invasive surgery, the da Vinci platform offers an integrated system allowing precise control over the tools and camera in the same coordinate system. In addition to dexterity improvements and better visualization, the system now can provide registered fluorescence imaging for anatomical landmarks.

NORTH-AMERICAN ACTIVITIES

We will provide a brief survey of North American research activities in the area of image guidance.

In the area of robot-assisted surgery, we will survey work aiming at integrating pre-operative imaging in procedures using surface matching, by tracking instruments or camera features, and work aiming to accomplish this with the use of intra-operative imaging such as ultrasound. Research dealing with several clinical procedures, such as partial nephrectomy and radical prostatectomy, will be described.

We will also survey approaches to image guided biopsies. These include, for example, needle guidance systems compatible with magnetic resonance imaging (MRI) or systems that fuse MRI with ultrasound.

NORTH-AMERICAN COLLABORATIONS

Finally, we will look at various collaborations that exist in North America and describe the use of some common platforms, such as iGStk, in order to facilitate collaboration and the development of common tools.

We will consider various other aspects of collaboration and their requirements, such as data sharing, duplication of research equipment, and collaborative efforts that address different aspects of the same clinical problem in an effort to speed up translation to clinical practice. Different views of various issues that arise will be solicited and described at the conference.