STRUCTURED REPORTING OF MEDICAL WORKFLOWS BASED ON 3-D IMAGE VOLUMES

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Introduction

Medical activities are specifically adapted to symptom complexes. To ensure the medical process quality, these activities may be logged in a list, which records the individual working steps (activities) without necessarily regulating the form or sequence of those steps [1]. Such lists either contain working steps which have to be performed inevitably in a sequence (sequential workflows) or can be processed, at least in parts, independently (concurrent workflows). The activities of all protagonists (actors) are interdependent and therefore have to be coordinated. For an individual actor, it can be helpful to get information about the status of a complex workflow adapted to his point of view and to inform others about his own activities by posting information.

As tomographic images - e.g. X-ray CT, MRI or PET - offer a three-dimensionally (3-D) resolved noninvasive view to anatomy and function, image based activities like diagnostics or therapy planning are customary in medical workflows. The exploration of tomographic images, e.g. for the initiation or processing of medical activities, may be difficult when anatomical structures are not visible in the current image orientation. Through the use of 3-D visualization, findings become more intuitive and in consequence diagnostic quality is enhanced. Thus, the documentation of such 3-D image visualizations must be an integral part of a visualization software.

The DICOM standard defines the communication and archiving of both images and reports. In general, it allows to mark and annotate certain image contents. But DICOM neither documents information of 3-D visualizations nor it is possible to describe the best view for diagnostics or therapy planning. Therefore, DICOM has only restricted capacities for archiving spatially resolved findings in volume datasets.

In the project, Java libraries were developed for the documentation of the visualization of DICOM image volumes and the documentation of workflow activities. Based on these libraries, a Graphical User Interface – VisualMediJa – for findings and therapy planning was realized. The software e.g. makes it possible to assign annotations to interactively definable voxels, which are then visible in 2-D and 3-D image presentations, to manipulate virtual surgical instruments, and to document workflow activities.

Materials and Methods

The development platform of VisualMediJa is a notebook with an Intel Pentium™ IV CPU 2.53 MHz, 1 GB RAM, a GeForce4 graphics card and runs on Windows XP™Professional. The following programs and libraries have been used:

- J2SE v 1.4.2
- Netbeans IDE v 3.5.1
- VTK Interim Release v. 4.4.

Due to the use of Java, the visualization program is platform independent, and the internal concept of the programming language allows the implementation of a websafe program with minor development effort and at low cost. The visualization was implemented using VTK, which is a complete visualization toolkit with a multiplicity of rendering functions and hundreds of image processing filters. In addition, it is widely spread in the community of medical image processing.

Colour-coded annotations can be assigned to image voxels to highlight anatomical landmarks or critical findings. Furthermore, virtual 3-D objects like surgical instruments or prostheses can also be incorporated into visualizations. The workflow of planned interventions can be reported in a structured notation, and thus information is explicitly accessible.

Results

The storage of single steps of a medical workflow in different file-formats and forms allows

- to demonstrate relevant diagnostic aspects during a shared treatment. This is valuable when a transferring (service requesting) colleague receives images and findings from a (service providing) radiologist and wants to become informed about diagnostic details. For this purpose, several image settings can be stored by the radiologist and reloaded by the transferring colleague. This way, a demonstration can even be performed asynchronously, i. e. without a direct

ISSN: 1727-1983 © 2005 IFMBE

communication between service requesting and service providing actors;

- to modify or to continue a workflow process at a defined step which is documented by defined image settings respectively. Parts of an interventional plan can be adopted, while others may be modified. Due to the incorporation of textual or visual annotations, the possibilities for documentation of findings become manifold.

Conclusion

A GUI for the uniform handling of image based medical workflows was implemented. It can be used to define but also to supervise e.g. intra-operative workflows.

References

[1] MOLINO, G. Form clinical guidelines to decision support. In Horn, W. et al., editor, *AIMDM'99*.

ISSN: 1727-1983 © 2005 IFMBE