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An Information Architecture for the
Development of Medical Image Processing Components

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Zusammenfassung:

The work presented here aims at an innovative support of the development of image processing applications for the medical domain. In contrast to existing approaches the outcome of this work is not yet another monolithic development environment which replaces all other tools. A modular architecture was designed with the goal to extend existing development tools by domain-specific aspects. Such a domain-specific character is needed to create imaging systems in shorter time and with more emphasis on the medical imaging than software engineering. The term information architecture was used in order to emphasize on the aspect of restructuring information in a way that the developer can be aided in his/her work. Such a goal can be accomplished if only one domain is targeted at a time, in this case image processing for clinical applications. This is due to the fact that the demands of the realm under consideration can be better focused on and will not suffer under the generality of all round solutions.

Following the trend in computer science, the basic assumption of the architecture presented here was the development of small, problem-oriented components for an existing application. Thus the medical end-user will have a main application installed at his/her site, extended by more and more aspects every time there is a need for them. Such a component-oriented development is opposed to the creation of monolithic systems trying to cover a priori the potential needs of their users by overloading them with functionality. The inherent disadvantage in this sort of approach is that the use of these systems takes place on a level closer to the functions provided and farther from the needs of the user. The resulting requirement for our work was, therefore, the support of the development of medical imaging components.

The first goal was the identification of a workflow and all major aspects within it during the development of medical systems. The result led to the identification of the modules of the architecture:

- The data exploration component supports the developer while trying to become acquainted with new medical image data; the component consists of two parts: one for customizing various statistical calculations so as to best reflect the kind of information needed about the image data and another part for the retrieval of imaging information. The latter part is called a radiological infobase and represents the first digital taxonomy-oriented system aimed at the developers of medical imaging systems. Information contained in it does not only come from the medical literature, but also from experiences of clinical partners in various projects of the division for

Medical and Biological Informatics at the Deutsches Krebsforschungszentrum.This information would otherwise have remained not properly documented or even not documented at all.

- The GUI-creation support component solves a basic problem in medical image development. It supports the generation of visual representations for medical imaging algorithms by creating graphical elements for the configuration of the algorithmic core of the imaging component, i.e. parameter value setting. The developer needs only to realize the imaging algorithm (or sequence of algorithms) that solves a specific problem. The component developed in the framework of this work creates a generic visual representation for imaging algorithms and adapts its look-and-feel to that of specified host applications. The algorithmic core, created by the developer, and the visual representation, generated by this module, are merged into one component and are ready to be integrated in any host application that supports this extension mechanism.

Developing solutions for medical imaging systems on the basis of components can only be successful if the developed components and the gained experience can be efficiently reused. Therefore a means for storing and retrieving development resources is needed. The systems used for the effective administration of development efforts (software or documentations) are referred to as repositories or meta-information facilities. In this work a model of such a facility was designed and implemented. It is the first meta-facility for medical imaging components based on object-oriented technology. The repository is the core of the architecture as it is the means for storing and retrieving meta-information needed to assemble components into larger pieces of software and integrate them into host applications.

All modules of the architecture are designed to operate independent of each other. The reason for that is the intension to support both development-in-the-large and development-in-the-small. When developing smaller systems and ad-hoc solutions some of the modules of the architecture might not be necessary and some stages of the workflow might be skipped. The repository is the connecting instance as all modules store information in it that can be used by their counterparts.

The feasibility of the conceptual part of the architecture was demonstrated by the development of modules designated to perform the tasks specified for each module. Their development has reached different maturity levels. The creation of visual representations for medical imaging algorithms is the aspect best exploited and implemented. The data exploration component is developed in a stable manner that can form the base for further enhancements and everyday use. The parameter value estimation component is basically conceptually tackled. The steps needed to convert the whole architecture from a prototypical development into an open system meeting high level standards were also suggested. Ways to further improve the conditions of work and the quality of the outcome in medical image processing were mentioned. Therefore other research directions both in basic medical image processing and computer science were taken into consideration.

The process of medical image software can be enhanced by structuring it and providing the developers with intelligent software added to their current tools. This will help them spend more time with the actual problem which again will result in higher quality of outcome.