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Quality-centric modular software development in medical imaging research

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Modern medicine is increasingly supported by computer programs to achieve a more efficient treatment of the patient. With the growing number of different imaging modalities the resulting processing of their delivered data imposes special requirements on software in the medical imaging field. Computer-based methods cover the range from simple post-processing of images to real-time assistance in interventional scenarios. With closer contact to the patient, the safety and quality expectations and obligations also for research software grow.

Performing clinicians demand a high efficiency in medical workflows. Computer systems in the clinical environment and thus the software have to deal with many different data sources and are expected to support more and more complex workflows. The researcher in this area has to combine multiple methods and technologies and manage this complexity to produce valuable results that enhance the diagnostic and therapeutic process.

In this work, novel technical concepts and methods for the development of quality-centric modular software applications for research projects in the field of medical imaging were developed. A detailed analysis of the requirements of medical imaging researchers was presented, taking into account clinical, legal and organizational aspects. These motivated the development of different concepts for building medical imaging related software. In this context the following contributions were made:

Modularization: Novel concepts and methods for modularization allow to handle the growing complexity of applications in medical research. Different methods can be more easily combined and a flexible application platform supports complex use cases. The development of new methods is fostered by means of rapidprototyping and various options how to leverage the existing platform. The standardization improves the exchange between different researchers and institutions.

Software development process: Software processes and supporting tools that are compliant with the regulatory requirements for medical software and at the same time are applicable in a research environment were established. At the same time these processes support the collaboration within a large research group.

Clinical integration: Re-usable and standards-based components for the integration with clinical information systems were made available. Through the contribution to the Common Toolkit they are also integrated in other software platforms.

These contributions enable the translation of basic, technical research results into clinical settings for further evaluation and medical research. A large number of examples both from the research group at the German Cancer Research Center as well as other institutions and even companies show the applicability of the approaches. Since the results of this work are available as open-source, they can directly be used by the scientific community.

To conclude, the new concepts and methods presented in this work open a lot of opportunities for clinic-oriented and translational research and foster the transfer of results from the researchers' lab to the patient on a previously unmatched level.