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Abstract-Title:

A METHODOLOGY FOR THE EVALUATION OF SOFTWARE FRAMEWORKS IN THE DOMAIN OF COMPUTER-ASSISTED SURGERY

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Abstract-Text:

Purpose

The development of applications for computer-assisted surgery (CAS) requires substantial efforts in software design, implementation and validation. There are several commercial and open source medical software frameworks which provide a modular and reusable context that can be extended to custom applications. The use of medical software frameworks can strongly help to reduce development costs and time as well as to improve the quality of software. The decision for a particular framework has a lasting impact on the success of the resulting CAS developments. Therefore, there is a need for a framework evaluation methodology that guides the selection procedure in an objective and repeatable way.

This work defines an evaluation process that determines a framework, out of an entire group of candidates, which fits best to defined criteria as necessary for the development of CAS applications.

Method

The evaluation process is required to minimize subjectivity and uncertainty about the candidate software frameworks which typically exhibit disparate features. An incorrect decision has multiple risks associated which might invalidate the entire advantages inherited from the framework approach. An initial filtering with a small set of easy to measure high-level criteria has to be applied to narrow the range of evaluated products. The candidate frameworks are then discovered within a market survey. The main evaluation phase consists of testing the software framework against multiple criteria. The establishment of appropriate criteria is a critical step since these measures determine whether the candidate frameworks are judged in the right way. The definition of evaluation criteria follows a three-step process:

1) Definition of requirements

The framework requirements are stated in terms of needs which the software product should fulfil. The requirements should not be limited to functional capabilities of the framework but also include a broad range of quality characteristics.

2) Requirement prioritization

The requirements were prioritized according to their importance for the CAS development.

The requirements fall in one of two general categories: Mandatory requirements, that are obligate and need to be fulfilled, and Flexible requirements, that provide room for negotiation.

3) Derivation of evaluation criteria

Each evaluation requirement is decomposed into one or multiple criteria that state the terms of capabilities to satisfy the requirement.

The acquisition of the actual test data is realized using multiple techniques. Literature Reviews are used to gather general information using the internet or product related publications. Hands-on Techniques help to figure out technical or integration problems. Test Beds are used to assess the process of development with the particular framework.

A gap matrix then lists the candidate frameworks across the top and the requirements down the side. The cells provide information on the level of fulfilment of the criteria. The main deficiencies (gaps) were weighted and summarized according to the priority of the particular criterion. By reasonable weighting, with respect to mandatory or negotiable requirements, an analysis of the fitness of all frameworks is used to generate a ranking of the entire candidate frameworks.

The evaluation process concludes with a reasoned decision for a framework based on the gathered ranking. For each rejected framework, the rationale for rejection can be derived from the gap analysis.

Results

A complete evaluation process for the methodic evaluation and selection of software frameworks was defined. A set of capability requirements which reflect the demands for the development of CAS applications were generated (Table 1) within the evaluation. The evaluation process can be easily applied during the initial phase of software projects that require the reasoned selection of a framework to facilitate the development of CAS applications. We used the proposed method to select a framework which is appropriate for the design of software components for S-PACS systems.

Conclusion

The defined evaluation process minimizes potential errors which arise from inadequate efforts in software testing and wrong decisions for software products in early stages of medical software projects. Since the result of the evaluation process strongly depends on the defined terms of needs, the framework identified by the proposed process might vary among different research groups.

Bild 1/JPG

Requirement (a)	Importance (b)	Criterion (c)	Measurement Method
The programming scheme of the framework shall be clear and facilitate the development of custom CAS applications.	Mandatory	Flexible programming	Hands-on programming experiments
The framework must enable flexible design of custom graphical user interfaces.	Mandatory	Custom GUI design	Hands-on programming experiments
The framework shall provide direct access to data and methods of the Insight Segmentation and Registration Toolkit (ITK) as well as the Visualization Toolkit (VTK).	Mandatory	ITK/VTK access	Hands-on analysis
It shall be possible to distribute developed applications commercially.	Mandatory	Commercial use	Review terms of use
The framework shall provide ready-to-use algorithms for medical image processing of volume data sets within a graphical user interface.	Flexible	Visualization Segmentation	Hands-on programming experiments
The price shall be reasonable.	Flexible	Price Single-License	Request for a quote, Review web site
Costs for routine maintenance and updates shall be reasonable.	Flexible	Additional costs per License	Request for a quote, Review web site
The framework vendor shall provide support for the product or at least there shall be an active internet community forum.	Flexible	Developer support	Review documentation and internet forums or mailing lists
The documentation shall be complete for all functions. Tutorials and examples are desirable.	Flexible	Documentation	Review documentation
The framework shall provide hard- and software interfaces to S-PACS QFD entities, e.g. Tracker, HMI, input/output devices.	Very Flexible	Hard/Software Interfaces	Hands-on analysis
It is advantageous if project partners use the same framework and software can be exchanged.	Very Flexible	Project partners	Gather information from project partners
License can be commercial or open source.	Very Flexible	License	Review terms of use
The source code of the framework shall be open.	Very Flexible	Source open	Review documentation and terms of use

Table 1: Capability requirements for the candidate software frameworks. The priority indicates the importance of each criterion. The measurement method displays how the necessary information is acquired.