Challenges for Interaction in Software Visualization Systems

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Abstract. In the past nearly 30 years the information visualization field has produced many robust solutions and approaches and is still an ongoing research area. However still many open problems exist and new research challenges appear. In this paper we discuss the possibilities for interaction with software visualizations in virtual and augmented reality that strive to make the software more tangible.

Keywords: software visualization, interaction, virtual and augmented reality

1 Software visualization

Visualization is a process that transforms various data to graphical representation. Software visualization aims to make the software more tangible by providing graphical representations, which can be studied and discussed by software developers. Usually software visualization is done via generic information visualization techniques e.g. tree and graph visualizations, scatterplots, parallel coordinates etc.

Although many software visualization system have been developed in the past, very few of them manage to become part of daily routine of software developers. This is often related to the fact, that most software visualization systems are research projects and researchers do not have enough capacity to develop a final product. Another key factor are the missing evaluations in praxis. Software visualization is currently often done using standard desktop applications that contain 2D visualizations and utilize common WIMP interaction techniques. 3D software visualizations are appealing, but also bring their own challenges like the problematic navigation in virtual space and manipulation with the visualization.

The upcoming challenges for visualization are related to technical advances. The increasing availability of massive parallelization and emerging high performance computing architectures allow to process Big data in terra-byte ranges. Processing data that does not fit into memory is now commonplace. Rendering such amount of data is not trivial even with the support of GPGPU technologies like CUDA or OpenCL. Visualizations on mobile devices or distributed via Internet technologies are becoming more and more popular, which has significant impact on data management and application architectures.
2 Challenges for interaction

Recent approaches in software visualization aim to utilize fully immersive Virtual Reality (VR) or Augmented Reality (AR) systems. The interest in these technologies is due to financially more available head-mounted-displays, massive monitor walls or CAVE systems. In near future we might see more of these approaches to be used by software developers. Both directions however need post-WIMP interfaces and interaction techniques, which should be in researcher’s focus. In our previous works we have developed prototypes for 3D software visualizations of software structure [1], program behavior [2] and also software evolution, which use force-directed 3D graph layout algorithms. In our recent work we also experimented with the transition of our software visualization prototypes to AR. We used face tracking and allowed manipulation via hand gestures, which where handled by devices like MS Kinect or the Leap Motion sensor. From these experiments we observed that designing and developing 3D software visualizations is a challenging problem and often needs creative solutions. Designing easily comprehensible 3D representations (3D glyphs) and defining suitable visual data mappings is not trivial, especially when scalability of the visualization is important. We observed that using 3D software visualizations requires skilled users as navigating the virtual space, in which the visualization is done, is not easy via mouse and keyboard (a specialized 3D mouse device could be a solution). However navigating the virtual visualization space is not the only interaction technique – exploration, selection, filtering, changing the visual mapping etc. are often more important for comprehension. The other mentioned interaction techniques are also not trivial in a 3D visualization. In our experiments with interactions via hand gestures to manipulate 3D visualizations of software structure we observed, that although currently available hand-tracking devices may be used for input, it is still an open problem how to design and process gestures. The precision of input devices greatly influences the design of gestures and the user is also a major factor, because he/she needs to learn how to use gestures. Providing simple but effective hand and gesture interaction techniques for visualization is therefore a major research challenge for the visualization to be usable and useful. Future work should be oriented towards the experimentation with AR and VR software visualizations, which are based on graph visualizations, especially in conjunction with recent input devices and head-mounted-displays.

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References