INTERACTION TECHNIQUES FOR COMMON TASKS IN IMMERSIVE VIRTUAL ENVIRONMENTS

DESIGN, EVALUATION, AND APPLICATION

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SUMMARY

Human-Computer Interaction (HCI)* in three dimensions is not well understood, and there are few 3D applications in common use. Moreover, the complications of 3D interaction are magnified in immersive virtual environment (VE) applications: characteristics such as inaccurate tracking and lack of access to traditional input devices cause the design of user interfaces (UIs) and interaction techniques (ITs) for immersive VEs to be extremely difficult. Despite these difficulties, we maintain that there are complex applications for which immersive VEs are desirable, so special attention needs to be paid to the design and implementation of ITs for these applications.

A large percentage of interactions that take place in immersive VEs fall into a small number of general categories, which include travel (movement of the user's viewpoint from place to place), selection (indicating virtual objects within the environment), and manipulation (setting the position and/or orientation of virtual objects). Given techniques with good performance characteristics for these three interactions, a large number of complex and effective VE applications could be built. In this research we studied ITs for these three universal tasks in the context of a formal, systematic framework, including the design of novel ITs and empirical, comparative evaluations of techniques.

This thesis presents several important results of the use of this methodology. First, we have developed new ITs perform well in a variety of application scenarios. Second, we have designed general testbeds for IT evaluation that may be reused for future performance comparisons. Third, we have obtained a large set of empirical results regarding the performance of ITs. These results led to general principles and guidelines (section 7.1) that can be applied to VE systems to improve performance. Finally, we validated these results by applying them to a real-world VE application, and showing that its usability was measurably improved as a direct result. The results presented in this thesis should be useful and important to anyone developing a VE system with even a moderate amount of interaction complexity.

* For precise definitions of this and other key terms, see section 1.2.