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Efficient comparison of platform alternatives in interactive virtual reality applications

Pablo Figueroa, Walter F. Bischof, Pierre Boulanger*, H. James Hoover

Department of Computing Science, University of Alberta, 221 Athabasca Hall, Edmonton, Alberta, Canada T6G 2E8

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Abstract

Virtual reality applications consist of an integrated combination of elements, such as hardware devices, interaction techniques, and content, in different modalities and qualities. Designers of virtual reality applications select combinations of such elements that allow users to accomplish their tasks, and it is feasible that more than one combination of such values will satisfy the user's needs. Unfortunately, current development environments, methodologies, and techniques in the field of virtual reality often preclude the exploration of the design alternatives, due to coverage or cost limitations. A limited number of options are covered by any given software development environment, and the development cost of new prototypes in such development platforms is too high to be considered as an evaluation tool. In this paper, we present a methodology for partial (i.e. hardware and interaction techniques alternatives) exploration of the design space of a virtual reality application, based on the creation of reusable components and a standard evaluation of alternatives. Since the cost of developing several versions of an application can be reduced by reusing elements from others, this method allows designers to evaluate the performance and user preferences of several implementations. As a proof of concept, we developed four versions of a simple matching application in different virtual reality platforms. Results of this study show how users react to each prototype

*Corresponding author. Tel.: +1 780 492 7418; fax: +1 780 492 1071.
E-mail addresses: pfiguero@acm.org (P. Figueroa), wfb@cs.ualberta.ca (W.F. Bischof), pierreb@cs.ualberta.ca (P. Boulanger), hoover@cs.ualberta.ca (H. James Hoover).

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and how the different solutions can be compared, no matter how different in technology they are.

Keywords: Virtual reality; Iterative development; User studies in virtual reality; Interaction techniques markup language; InTml

1. Introduction

Virtual reality is a broad field that defines a novel way to interact with information, different from the traditional graphical user interfaces based on the 20 year-old Windows, Icons, Menus, and Pointers (WIMP) paradigm. Virtual reality technology allow us to see geographical, molecular, or industrial design information in the same way that we use to understand real objects in the real world. This technology can also enhance our capabilities in the real world, so that our interaction in the virtual world is more efficient than the real world. Several industrial applications exist today, in areas such as car design, military, or oil exploration, and we expect many more to appear in the future.

Virtual reality applications are not limited to the traditional keyboard and mouse, and their interfaces can offer richer control and content to users. Currently, there are several input and output devices that may be used in virtual reality applications, and several interaction techniques that exploit device affordances and particular information characteristics. Each combination of devices and interaction techniques offers different features and limitations. Such variety creates problems for application designers in both the selection of hardware for a first prototype, and the hardware and software changes required to improve a successful application. Usually, the decision about which devices should be used in an application is taken in favor of the newer technology, the one that is most compatible with current applications, or the one that is easily available, without considering other options that might be favorable for the particular application and user needs. Further, it is often difficult to port an existing virtual reality application to a newer hardware platform. Common software practices create abstractions that do not fully exploit the device capabilities, so portability is achieved at the cost of minimal functionality in all environments.

The development of virtual reality applications should take into account alternatives in key design areas, regardless of technical limitations of the available software platform. Alternatives in devices, interaction techniques, content modality, and content quality should be taken into account, in order to better fulfill user requirements. At the same time, it should be possible to produce rapid prototypes, so designers can observe how users react to each alternative, and compare results and usability of different approaches.

One way to compare hardware platforms is to do an analytical analysis of device properties. However, little information is available on the functionality and efficiency of modern virtual reality devices, as compared to standard devices. This