[DC] User Study on Augmented Reality User Interfaces for 3D Media Production

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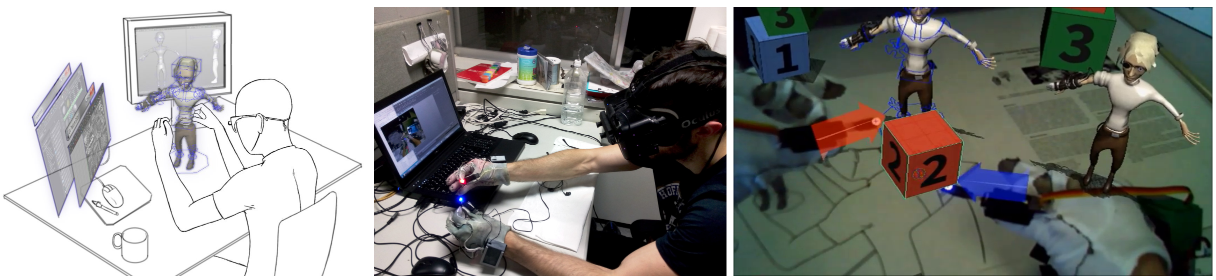

(a) (b) (c)

Figure 1: We perform a user study on Augmented Reality User Interface aimed at professional 3D design, in order to bridge the gap between the lab and real-life application. (a) Illustration of the prototype system. (b) An artist working with the system. (c) View through the HMD.

Abstract

One of the most intuitive concepts in regards of applications for Augmented Reality (AR) user interfaces (UIs) is the possibility to create virtual 3D media content, such as 3D models and animations for movies and games. Even though this idea has been repeatedly suggested over the last decades, and in spite of recent technological advancements, very little progress has been made towards an actual real-world application of AR in professional media production. To this day, no immersive 3D UI has been commonly used by professionals for 3D computer graphics (CG) content creation.

In our recent paper published at ISMAR2014 [15] we have analyzed the current state of 3D media content creation, including a survey on professional 3D media design work, a requirements analysis for prospective 3D UIs, and a UI concept to meet the identified challenges of real-world application of AR to the production pipeline.

Our current research continues on this by working on validating our approach in a user study with both amateur and professional 3D artists. We aim to show that several characteristics of UI design common in academic research are highly problematic for research focused on real-world applications. These are: placing the primary focus on intuitiveness, neglect of typical demerits of a novel technology, and relying on easy-to-acquire samples from the general population for both qualitative and quantitative data.

The results of this user study will produce new insights helpful for the future research, design, and development of 3D UIs for media creation.

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1 Introduction

Reseach on using AR as a UI for immersive creation and editing of virtual 3D models has a long history [4] and has been shown to have excellent potential for 3D tasks thanks to correct spatial alignment [22, 24]. Not only has the technology enabling AR applications dramatically improved over the decades, but also the demand for 3D Computer-generated imagery (CGI) content such as 3D-models and animations has exploded with the rise of popularity of computer animation movies and 3D video games. However, there is still little research on trying to bridge the gap between the research labs and the media production studios. To this day, most all 3D content is commonly created with traditional 2D UIs such as mouse and keyboard [15].

In our previous research efforts we analyzed the work-flow commonly employed in professional 3D production and identified six requirements for 3D design UIs. We furthermore proposed a number of UI concepts to meet these requirements. However, we did not perform an appropriate empirical evaluation of our concepts. Our current research now aims to support and extend our previous reseach efforts by preforming a formal user study with 3D artists.

2 Motivation

It has been a common problem of research efforts to bridge the gap between the lab experiment and the real-world productive application of technology. Fite-Georgel [8] surveyed a large number of systems on their applicability and successful adoption for industrial applications such as manufacturing and construction. Out of the reviewed projects only two succeeded, suggesting that most of the research on AR UIs seem to divert from the requirements of the industry. LaViola and Keefe [16] give an overview of past and recent 3D UIs for art and design purposes. While these projects seem more promising at first, they are mostly limited to experimental applications and not used by a wider audience in a commercial productive setting. Gandy and MacIntyre [9] interviewed users of their DART framework for authoring *for* AR (not to be confused with our focus on authoring content *using* AR) ten years after it was released to the public to see how people are using it. This produces a number of interesting insights and development guidelines that are valuable for developing new frameworks.

In our previous research we performed a survey with media production professionals to gather information on the current work situation in the media industry. Furthermore we reviewed educational material and stayed in close contact with several professional 3D artists during the development of our own prototype AR UI. Through this work we found that mouse and keyboard are still the dominant UI in this field, even though many problems with this set-up are well known and artists were generally open to new concepts to make their work easier [15].

This shows us that there is potential for a wider adoption of novel UIs, if we can figure out how to design them appropriately. After reviewing a larger body of prior research on this topic and related fields, we believe to have identified a number of commonly held conceptions that hinder the development of adequate solutions.

3 Background

Using AR as a UI for artistic 3D modeling, animation, etc. as we intend it has been proposed by several authors, however without concerning the professional application. 3Dm [3] was one of the first systems that explored the design space of immersive modeling in a VR setting. The THRED system [21] offers bi-manual modeling using 3D tracked "bats", each assigning distinct roles to each hand. Similarly, JDCAD+ [11] is a non-immersive modeling and animation system that uses a 6 degrees of freedom (DOF) tracked "bat" to create content *for* virtual environments, but is not in itself immersive. 3darmodeler [6] is a stand-alone AR based modeler directed toward amateurs, using a webcam and home-printed maker paddles. Similarly, Schlaug [20] developed an voxel-based AR sculpting program that allows simple but only very basic content creation. Kim et al. [13] developed immersive VR modeling system that is based on 5 hand gestures for basic Subdivision-Surface modeling. The outdoor AR system Tinmith [18] was also used for creating 3D models in a very limited way. Construct3D [12] is a modeling system which aims for mathematical education. ICOME [19] explored remote collaboration in immersive modeling environments. None of these systems concerns itself with professional application in media production and are thus not designed to be used within a studio environment.

Only a small number of publications investigated the possibilities and demands of professional application. ARpm[7] is an AR front-end to Autodesk® 3D Studio Max®, which functions by taking screenshots of the software and sending Windows system calls to control it which greatly limits performance and usability. Takala et al. [23] implemented a semi-immersive 3D UI for the Blender modeling software using a Playstation3 and a number of PlayStation Move controllers. Their aim was to create an inexpensive set-up. Most interestingly, they tested their prototype with 7 professional 3D artists. However, their evaluation only concerned the use of the prototype, whether it was "fun" or whether they experienced "fatigue" during their 25 minute use time. The results were mixed, but almost all artist agreed that 3D UIs will become commonplace for 3D design within this decade. Barakonyi published a system that targets character animation exclusively by using a physical puppet [1]. The concept of tracking a physical rig — originally developed by Knep et al. [14] — was improved by applying AR technology. Such an approach is logically limited to a very narrow application: only animation of virtual content which can be represented by a physical puppet (no fluids, hair or muscle rigs) and no possibility to play back recorded animation, forcing the animator to work "straight-ahead". Such an application is uncommon in professional animation because of the requirement to adjust or fine-tune animations based on feedback from superiors or customers. None of these publications performs an in-depth analysis of professional 3D work and none tries to establish a set of requirements or specific empiric UI design guidelines.

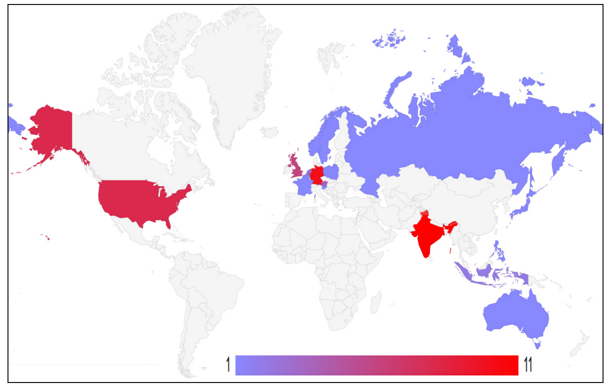

Figure 2: Map indicating the countries of participants of our previously conducted survey. A total of 54 media professionals from 17 countries participated.

In our own previous research [15] we performed a survey with 54 participants from 17 countries (Figure 2), all 3D media production professionals, on common 3D design work. We also reviewed training material and stayed in close contact with media professionals who tested our own prototype 3D UI and gave feedback. Based on this information we identified a number of requirements which are difficult to achieve for AR UIs and thus usually neglected by UI designers.

4 Research Methodologies and Objectives

With this research we aim to advance the practical application of AR 3D UIs for media production by providing more information on the viewpoint of the artists. We therefore plan to execute a user study with both amateurs and professionals in 3D design. We hereby distinguish their level of expertise by the technical complexity of the task, not by artistic mastery, since the latter is difficult to measure and often subjective. We assume that amateurs commonly limit the technical complexity of their work, since they have less time (working in leisure time instead of full-time), work in smaller teams with less expensive tools (limited funding), and have shorter review cycles (no production hierarchy or customers that need to be satisfied).

We stress the concept that amateurs are not „beginners" and do not count people aspiring to be professionals but with limited experience as „amateurs". Beginners who aim to become professional artists embrace the technical complexity of the task and will try to produce high-quality results. Amateurs on the other hand will not necessarily work towards achieving a professional level of proficiency, and rather seek to produce a desired result with limited means and in a limited amount of time. An amateur may work on hobby projects for many years without acquiring new technical expertise or having to stay up-to-date with latest technology.

In order to distinguish between the two groups we ask each participant to state their work experience over the last ten years, whether they were employed, worked as freelancers, worked in teams of hobbyists or just by themselves, including the average number of hours per time frame that they have spent working. From this we can estimate their level of proficiency and assign them to either group. If a participant has insufficient experience even as an amateur or is a borderline case, we exclude the data from comparative analysis.

Having established this distinction between professionals and amateurs, we invite our participants to a formative user study, where they test our prototype of a 3D AR UI for modeling and animation. We decided not to design our experiment as a summative user study, because the novelty of the UI will make comparisons difficult and unreliable. The artists will be very comfortable with their own choice of 3D software with which they had years of experience, and comparing different versions of the prototype against each other at such an early stage might not yield very interesting results. Instead, we collect use data and feedback from the participants, encouraging exploration and criticism of the presented system. This is done via three means: recording of the usage session, a post-use questionnaire and a post-use interview. Recording the participants use of the prototype can give quantitative information (for example: if users commonly got confused or slowed down at a specific step) as well as qualitative information through comments made by the user. In the questionnaire we then ask the participants specifically to identify usability issues and rate them by severity, as well as to give an overall preformance evaluation of the UI. Finally, a closing interview gives the participant room express thoughts that were not adequately captured by the the questionnaire.

In addition to collecting data on the use of the prototype, we ask each participant for a recording of their normal work-flow, with their own preferred software and when working on their common project. Quantitative data derived from this recording (such as time spent on a particular sub-task) can be correlated to the use of the 3D UI prototype to better understand the effect of immersive 3D UIs on professional design work.

Previous studies have shown that cultural background can have a significant effect on common user study methods [5, 17]. Therefore, we aim to ensure that all participants in our user study are Japanese or of related eastern origin, and have Japanese staff help with the execution and evaluation of the results.

5 Hypotheses

The research conducted is based on the hypothesis that the current scientific approach to designing and evaluating UIs has major shortcomings that make it impracticable for real life. These are: evaluation using the general population (or rather the people most easily available), the focus on intuitiveness, and the neglect of weaknesses typical for a new UI method.

Evaluation using the general population. It is commonly assumed that people will react and perform similarly in a novel UI, and thus small sample sizes and a simplified procedure for selecting subjects is acceptable. Hence most research is performed with a small number of subjects who are often themselves graduate students or university staff. While this approach is sufficient for analyzing very general concepts in human factors, it quickly becomes invalid when a task demands specialized skill and a productive work-flow. We hypothesize that the feedback given by amateurs and professionals will therefore differ, pointing in two separate directions of development: a more simple tool for the general public and a highly specialized UI for highly productive professional work. For example, our prototype features several bi-manual interaction techniques which can reduce the time required to perform certain tasks, but due to their asymmetric nature are not easy to master, such as controlling the animation time frame with one hand while continuing the modeling work with the other. We expect professionals to be more welcoming of these features which will make them more productive, even though some investment is required to master them.

Focus on intuitiveness. Most prototypes created in the scientific community focus on creating a UI that can immediately be used without requiring a long learning phase. While there is obvious merit in this approach, it often results in severely limiting the features made available to the user. Professional or semi-professional work however is inherently complex and thus can no longer be performed with the novel UI, making it unattractive for commercial adoption. For the researcher, who has to introduce his work to people unfamiliar with the background in a limited amount of time (such as a conference demonstration) a very different use-case arises than for the industry professional trying to use the tool productively. For example: Gao et al. [10] suggests using voice commands to make the UI simple and intuitive to use. This approach is valid in a laboratory setting, but in a studio environment where several artists work in close proximity every day over an extended period of time, using voice commands becomes impractical. We argue that UIs for professional application may and sometimes must be complex and unintuitive in order to live up to the complicated task and the requirements of the work-flow. When comparing traditional 3D software products, there is no trend apparent that more simple tools supersede heavy and complex-to-use software suites. Similar reconsideration may be required when inventing novel forms of user interaction. We therefore hypothesize that not only will professional 3D artist not place „intuitiveness" high on their list of requirements, we should even see a drop in importance when compared to the amateur group who might prefer an easier UI over a more powerful workspace.

Neglect of weaknesses typical for a novel UI method. Similarly to hiding complexity, UI research often prefers to focus on topics where new technologies can outperform traditional concepts. In 3D UI research a great body of research has been published investigating many ways of performing rapid 3D operations. In a real-world application however, one cannot ignore the cases where user interactions are required that are notoriously ill-suited for 3D UIs, such as precision input, alphanumerical input, or 2D operations. In the example of 3D media content creation, it may at times be required to edit single vertices on a millimeter scale, or edit the associated 2D texture coordinates (UV coordinates). These tasks are easier performed with a mouse on the table than with a hand in free air. Another example is when alphanumeric input is required for example in specifying precise coordinates or object names. Only little research was performed on these topics since it is less impressive to tackle the limitations of a technology than to unleash it's strengths. However, having to constantly switch between 2D and 3D UI can make professional application of the technology less appealing. We hypothesize that professional artists who have a deeper understanding of the scope and complexity of media creation will point to these shortcomings and demand proper solutions, while amateurs may not miss these features as much.

6 Results to date

We have not yet started the formal user study, but for preparation and testing have invited several amateur artists to use our prototype system. These test-runs revealed a number of surprising insights that may justify further investigation. These are: difference in the use of depth between tasks, a lack of sense for „click" and „double-click" timings when using pinch gloves, and the accidental or careless pressing of buttons on the glove.

Difference in the use of depth between tasks. Previous research already identified that selection and manipulation of 3D objects in immersive environments is best handled by employing two separate mechanisms, commonly referred to as „Hand-centered object manipulation extending ray-casting" (HOMER)[2]. In our trial runs however we found that hand-centered interaction only seems more natural for translation and rotation. When the users used two hands to scale an object, they often naturally employed ray-casting based gestures, pulling their hands apart on a plane in front of the object, and expecting the object to grow in all three dimensions. Clearly more research is required to identify the most efficient UI metaphors for a more diverse number of spatial tasks than just „selection" and „moving".

No sense for „click" and „double-click" on pinch gloves. For our prototype we created wireless pinch gloves 3 by sewing eight conductive areas on each of a pair of from simple cotton gloves.

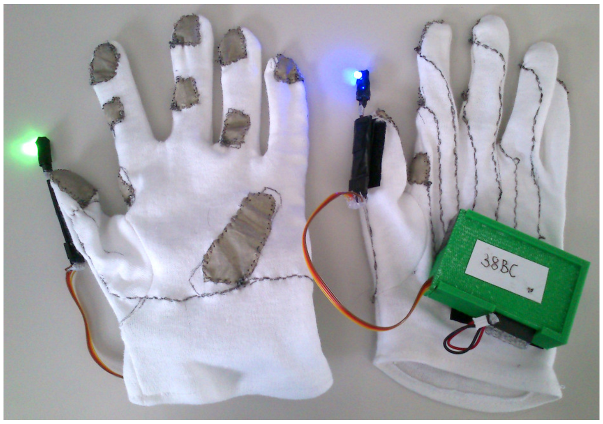

Figure 3: Wireless pinch gloves for our prototype, featuring eight distinct touch areas.

The UI concept did expect users to use these buttons similar to a mouse, by „clicking" and „double-clicking" at icons or 3D objects. We have found however that even long-time computer users behave like PC novices usually do when using a mouse for the first time. They lack an understanding of the concept, press the button for too long while simultaneously moving the hand (thus performing a „dragging" operation instead) and do not have the dexterity to perform consistent „double-click" timings. Furthermore, „double-click" speed seemed to differ between different fingers and regions of the hand. While these may be temporary issues of getting used to pinch gloves, we decided adjust our UI concept to use more „dragging" interactions and less „clicking".

Accidental or careless pressing of buttons on the glove. Early pilot user tests often had to be aborted, because the users would get themselves into a UI state out which they could not return by themselves. For example, some would use the „navigation" function of the UI to displace the 3D scene in an area where they could not see the models anymore, and then complain that the content had „disappeared". This happened because they repeatedly used functions that they had not yet been instructed how to use yet, similar to clicking random buttons in a 2D UI. One possible explanation might be that by some psychological effect buttons that are placed on the the body of the user are seen as part of oneself, making it okay to trigger them even when one does not know their function. Either way, for introducing new users to complex UIs using gloves or other wearables, it is important to disable functionality that has not yet been explained.

7 Expected contribution and plan for completion

We are currently finalizing the details and recruiting participants for the user study. Since it can be difficult to recruit a larger number of professional artists for this, we expect data collection to continue until end of September. We anticipate to find not only evidence regarding our hypotheses, but also unexpected insights into professional 3D design work and 3D UIs, both of which we believe to be of interest to the scientific community. Analysis and compilation of the data is planned to take until December, when we finish a journal publication summing up our findings.

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