Title: Experiences with Virtual Reality Accessibility in an African Context
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The *Collaborative African Virtual Environment System* (CAVES) project was set up as a joint venture between the University of Cape Town, CSIR, Contemporary African Music & Arts Archive, Visual Information Systems and Video Labs to overcome the problems with creating Virtual Environment (VE) systems for and in the South African context. CAVES' goals are to construct a methodology for developing multicultural VEs, tools to support the authoring of such environments and a low-cost platform that will exploit anticipated advances in the technology.

South Africa is a developing, multi-cultural society, and therefore creating VEs for public consumption presents us with many challenges, foremost being the lack of Virtual Reality (VR) content. For VR to be available to the general public, we have to define a cheap hardware platform that will enable the low cost production of VEs. Therefore, most of our research is focused on "Desktop VR" and polarized stereoscopic projection. "Desktop VR " utilises popular 3D hardware to render projected perspectives of 3D environments in real-time on normal computer screens. It is not true stereo 3D, however the manipulation of the perspective is real-time and the experience is quite convincing.

We believe that in order to make the content of VR more appealing, non-technical people who are experts in their domains should be given simple tools and methods to create engaging and useful environments. In order to explore usability of VEs for public consumption we have researchers creating VE applications for two of South Africa's pressing social concerns: *HIV/AIDS counselling* and *preserving the almost extinct San culture*. The *educational* scenario attempts to understand authoring of VEs amongst non-technical people and it is this scenario that will be the focus of this paper. We will give a brief introduction to the HIV/AIDS counselling and preserving San culture scenarios before we discuss the educational scenario.

The HIV/AIDS counselling scenario involves exposing people living with HIV to a virtual therapy session and aims to provide informational and emotional support to these individuals. The sharing of stories in a therapy session is not common practice in South Africa because of the stigma attached to the disease. A virtual therapy session can potentially alleviate this problem, as patients can examine how people in the VE coped with the disease. This scenario is highly applicable because of the overwhelming number of HIV/AIDs sufferers in South Africa. We explore VR as a potential medium for counselling and educating in this context.

The Cultural Preservation scenario explores the story-telling of the San culture through VE's. This scenario aims at investigating whether an interactive story-telling environment is more effective in terms of comprehension, enjoyment and presence, than a non-interactive, narrative story-telling environment. Blending contemporary South African hip-hop culture with San story-telling is also being explored to see if contemporary elements can be used to explain historical culture. We analyse VR as an educational

story-telling environment compared with other media. We also hope through this activity to expose people to the benefits of VR as a communication medium.

CAVES is currently developing authoring tools to not only make VR solutions more cost-effective, but solutions that will also empower non-technical people to develop their own applications. In order to make successful authoring tools, we believe that research needs to focus on the design and creation of VEs. The VE design and creation processes are complex and highly specialized tasks, particularly where the resulting VE is required to be of a high standard. To understand these processes, CAVES developed a participatory design field study, where we were involved in helping students explore VEs as a communication medium. CAVES had by this time development a basic authoring tool for creating VEs.

The University of Cape Town offered an Interactive Multimedia course to undergraduate students. The aim of the course was to expose the students to all aspects of VE creation (including graphics, audio and interaction) by requiring them to design and develop a game in interactive 3D. The course was done with forty eight contact hours, consisting of teaching and practical lab demonstrations. The students are from a humanities background with an introduction to film narrative. Ten students enrolled in the course with one student having had little programming experience and the rest no programming experience at all. They were divided into three groups, each group developing part of the mini-game. Group members were allocated different roles. These roles held the students responsible for the following aspects of the design: audio, graphics, music and interaction. Through distributing the task over different roles we aimed to relieve the amount of technology students had to master. Students were also provided with demonstrations, examples and tutorials in an attempt to scaffold their learning. Three researchers each participated with a group and had the role of scriptor. The researchers observed the group, while participating in the design.

Because of the restriction of contact hours with the students, several aspects of the project were designed and implemented prior to the research. Firstly, the game treatment was developed before the course began. The game was an adventure game set in a fictional theme-park in Cape Town, entitled, Handover Street. Players were to experience and explore the connections between the underworld gangsters of Cape Town and the rich tourists who frequent the beautiful city. The students were restricted to this treatment and each group fleshed out a design document around that theme. CAVES also developed a set of assets relating to the theme, reducing the amount of time spent on 3D modelling and animation. These assets consisted of models with their associated animations and textures. Finally, the students designs were restricted by CAVEAT (CAVES Authoring Tool).

Students were required to develop a detailed design document before they commenced implementation of their designs. This involved research on the theme, collecting textures and sounds to be used in the environment and deciding on the underlying back-story of their part of the game. Our observations of this section of the design process revealed many interesting aspects of VE design.

We expected that it would be difficult for students to specify interactions for a non-linear game scenario. The students were provided with a workshop on interactions and methods of specifying them. We also anticipated that it would be difficult for the students to implement the interaction specification. Students were given an introduction to

scripting and exercises using another very simple VR scripting application called ALICE. This appeared to be a very challenging task for the students to grasp. Instead of expecting the students to script their own games, we only required them to hand in their planning for the interactions. The students provided us with floor plans, flow diagrams and pseudo code and we were the "scripting interface" that implemented their interactions in CAVEAT.

Despite our efforts to teach the students about interactions in terms of programming logic, they still only managed to produce very linear designs as if designing for film. They did not think through all the interaction possibilities and described the interactions in terms of a "winning walkthrough". The full scope of alternatives a player might follow was often omitted. A major research problem area now being explored is in documenting possible interactions in a clear and meaningful way.

From our observations of the design process and our discussion with the students regarding what they wanted implemented, we were able to provide feedback and do heuristic evaluation on our authoring tool, CAVEAT. This tool allows the user to import Maya models and sounds and manipulate their position and orientation in the environment. CAVEAT uses Python for the scripting programming language. An attempt had been made to provide a user-interface into the scripting. This allowed the user to define different events – timer events, user selection events and collision detection events. All objects had to be declared and instantiated by hand in Python by the scriptors. CAVES is currently implementing a natural language layer to interactions in VEs.

Figure 1 shows the interface of the CAVEAT toolkit, showing CAVEAT in design mode. The designer can select assets (sets, actors, props, audio e.t.c) from the library and drag them onto the design surface and place them in the desired places in the VE. The designer can fly or walk to navigate around the VE in design mode and can also have different viewpoints – camera view, top down view and selection view.

The students began to customise the provided models and assets to suit their part of the design, using MAYA for modelling and Poser for animation. This seemed a feasible and enjoyable experience for the students. However, they did find creating and modifying textures for UV mapping onto models difficult. Only one group managed to customise a UV texture map by placing Manga inspired designs for tattoos on the arms of the model and a beard was added to the face.

Customization of models and textures could be supported by providing better tools to customize models with greater variety. An extensive library of objects must also be developed with standard animations that can be easily customized as the need develops. Assets need to come from a wide range of genres. It was found that once the groups had customised their assets they did not have the skills to effectively manage them. For example, the person with the graphics role, made many models but was confused as to which model was the most recent one. Due to the time constraints, the scriptors had to start implementing the interactions while the assets were still being developed. To overcome this problem the scriptors used other models to script while they waited on the final assets. An asset management system needs to be developed to effectively handle assets. A temporary solution was for everyone to upload there finished models to a local ftp site and then an email sent to the scriptors to notify them of

updated material. Students sometimes forgot to send an email to notify the scriptors of the new changes and sometimes uploaded the files to the wrong location.

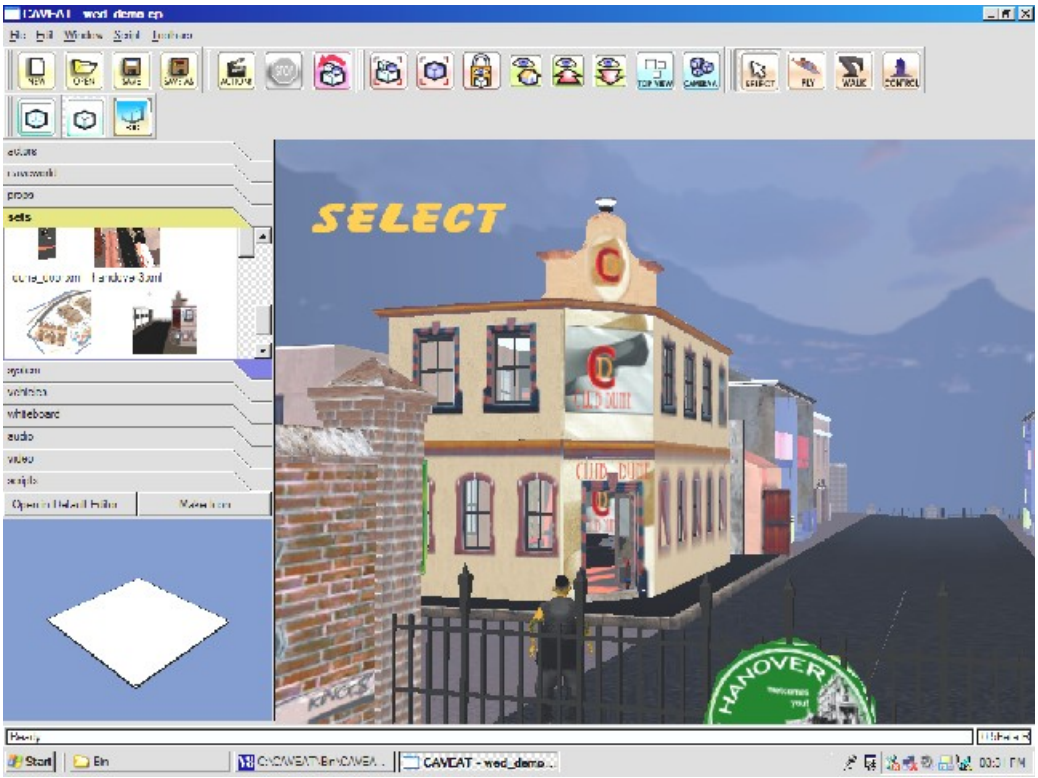

Figure 1 CAVEAT, an interactive VE authoring tool. The open VE is one of the students' designs, showing club dune and Cape Town's table mountain as the skylight.

Even though CAVEAT was a helpful tool to allow us to place models in the world, it still relies on other expensive software to support the entire VE creation process. Also, converting models and animations into the format that CAVEAT could use was a tedious process. There needs to be a standard way of importing these into CAVEAT. It would be better to have a suite of tools to eliminate the need for so many applications. As mentioned earlier, an interface that is understandable and intuitive for designers to use must be implemented. Using Python requires technical programming skills and knowledge. Thus an extensive script library needs to be created to support the scripting interface. This library is being developed by the CAVES programming team.

Through our participation in this scenario we hoped to better understand how novice users attempt interactive VR development and discover what they found problematic. We also aimed to find concrete solutions to their design problems and evaluate our authoring tool. We are currently improving our authoring tool by adding the functionality requirements illuminated through our experiences with the novice users. The course will be re-run later this year. We will evaluate the changes made to CAVEAT and our methodology. We are also working on plans to improve our documentation of VE requirements and improving our method for prototyping in the design phase to avoid the pitfalls in implementation. This year we hope we can do away with the scriptors and test our interface to scripting with novice users.

This exercise gave us insight into understanding the creation of VEs from a designer's perspective. The students also benefited from being involved in an inter-disciplinary development project and had gained insights into the potential of VR as a communication medium. We learned where improvements need to be made and where further research needs to be undertaken. Creating VEs for novice users presents us with many problems but despite the present difficulties in developing VE applications, we believe that with further research into VR design and creation, VR can be made publicly accessible.