IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 5, Ver. V (Sep. – Oct. 2015), PP 30-34
www.iosrjournals.org

Framework For Improving Access To VR Environments For Citizens With Debilities

J.Frank Reuben Jebaraj [1], Dr. E. Kirubakaran [2]
[1]*(School of Computer Science and Engineering / Bharathidasan University, Tiruchirappalli , India)*
[2]*(SSTP Systems/ Bharat Heavy Electricals Limited,, Tiruchirappalli , India)*

Abstract: *Technological innovation in graphics and other human motion tracking hardware has promoted approaching "virtual reality" closer to "reality" and thus usage of virtual reality has been unlimited to various realms. The world is becoming ever more interconnected and reliant on information obtainable on the Internet. The use of Virtual Reality Modeling Language (VRML) worlds as a mechanism for information access is a breakthrough. Access to that information for all people is vital. The challenge is to develop methodologies and guidelines for making VRML accessible. VRML opens up new prospects but also raises new hurdles. In this paper, we propose some strategies, develop some techniques, and provide some tools to help create more accessible VRML worlds. Also in this paper we will describe a set of techniques for improving access to VRML environments for people with debilities ranging from simple documented additions to the VRML file to scripts which aid in the creation of more accessible worlds. We also propose an initial set of strategies authors can use to improve VRML accessibility. This paper presents a framework for improving access to interactive, multisensory, three-dimensional environments called virtual worlds for citizens with debilities.*
Keywords: *VRML worlds, methodologies, virtual reality, access utilities, framework, authoring strategies.*

I. Introduction

In the media age humanity is facing a process where life expectancy is slowly but constantly increasing. Consequently, the group of senior citizens is growing to become one of the most sizable in the entire population which implies that the occurrence of physical and intellectual impairments is increasing in proportion [3]. Seniors citizens usually suffer from vision deficiencies, hearing limitations, motor impairments and slight deterioration of their cognitive skills. Against this backdrop, (providing citizens with debilities by exploring a convenient application of VR technologies in the process of designing and developing accessible solutions that could improve their level of independence) in order to enhance their quality of life has become the need of the hour.

Within this intricate and persistently progressing background, it is very exciting to technologically meet all users' needs and requirements regarding accessibility and usability along the development process. Accessibility becomes a must for the use of products for all users in general and senior persons and persons with sensory, physical or cognitive debilities in particular. Usability denotes the ease with which these products or services can be used to achieve specified goals with efficiency, expertise and satisfaction in a specified context of use [14]. In this sense, Virtual Reality (VR) is expanding to become a very useful tool for the empowerment of a large number of citizens.

The potential usefulness of VR for these persons was already abridged almost two decades ago [9]; [10] stating that VR offers them the possibility to perform tasks and experience situations that they might not otherwise because of any physical or cognitive limitation, since it can transform the sensory information that they cannot perceive into other modalities and can present a world where citizens with debilities may learn in a simplified way, applying afterwards the skills acquired to more complex real environments. Moreover VR technologies can be adapted to a wide range of individual senses and capabilities of the user. E.g. blind users can receive more aural information; visual information can be reinforced for persons with hearing debility, etc. Also, individual abilities of the users can be assessed so that the adaptation is optimal for them. Lastly VR allows citizens with distinct needs to interact with other users with the same disorders.

At present, costs of emerging VR technologies are being constantly reduced while becoming adaptable to a wider range of environments and individual requests. Therefore they may offer significant opportunities to support user interaction in technological environments, while helping to reduce the existing usability gaps. As a consequence, VR has become the central research concern for a new generation of technologies that may be used to help citizens with debilities.

This paper describes a set of techniques for improving access to Virtual Reality Modeling Language (VRML) environments for people with debilities. These range from simple documented additions to the VRML file to scripts which aid in the creation of more accessible worlds. We also propose an initial set of strategies authors can use to improve VRML accessibility.

II. Literature survey

Almost certainly the main advantage of VR is the possibility to create realistic environments. The experience of feeling immersed in a virtual scenario helps the user to overlook that s/he is actually in an artificial testing environment, allowing the assessment of the user experience under usual environments. Another important benefit is the capability for controlling the type, number, speed and order of stimulus that are to be presented to the user of the virtual scenario, which enables the specialists to improve their interventions by personalizing the environments, adapting them to the distinct conditions of each user. In the same way, trial and error methods can be easily applied into virtual environments where VR may then be used to analyze the user's behavior in potential dangerous situations without any risk. Finally, by selecting different sets of stimulus to be presented to the user, the level of complexity of test exercises can be gradually increased, so the specialist is able to personalize the treatment or training scenario. VR technologies can be a great help for citizens with dysfunction or complete loss of specific interaction functions such as motion or speech. Techniques are progressing, and today certain applications and devices, which were used at first only to interact with VR, are now useful in the real world as assistive technologies (e.g. VR gadgets for transforming sign language into speech).Citizens with physical debilities can also use VR to perform the same complex tasks as physically challenged citizens. VR may provide an adaptable mechanism for taking advantage of a convenient physical ability of one person to operate an input device for a computer program and, therefore, go around his limitation. E.g. there are systems based on data gloves that allow users to record custom-tailored gestures and map these gestures into actions. In this way, citizens with vocal impairments could even enhance their communication skills by mapping specific hand gestures to speech phrases.

Another area of use is creating simulations for citizens with sensory impairments like blind or deaf citizens. In these applications the focus is helping them to learn the use of new tools like a walking stick or sign language. VR systems are also used for testing the usefulness and accessibility of products and environments before they are actually built. Virtual buildings can be designed in advance and displayed through a head mounted display (HMD) to a wheelchair user who will move around and check for potential obstructions or non-accessible places [17].Educational inclusion for children with sensorial debilities is also an important research goal for VR developers. The overall objective of virtual learning environments is to allow students to interact physically and intellectually with a new generation of instructional materials, and the focus of a significant number of researchers is to offer the same opportunities to users with debilities to access and take advantage of all these resources. For example, there are virtual environments for visually impaired or blind, which focus on the creation of mental structures of navigable objects using only spatial audible information and no visual information; there are also virtual environments for the education and training of children with spatial problems caused by movement limitations; hearing impaired children can also benefit from virtual environments by helping them to improve in structural inductive processes and flexible-thinking ability [11].One type of application is the improvement of training results for citizens with cognitive impairments. Here, VR environments provide a safe and completely controlled surrounding that removes many stresses caused by natural human interactions and thus allows a gradual development of social abilities that are impossible to attain through real-life interactions.

VR appears to provide varied and motivating opportunities for the rehabilitation of seniors citizens with chronic diseases, like stroke patients. In stroke rehabilitation, animal studies have suggested that, through the use of intensive therapy (which implies the repetition of individual movements hundreds of times per day), a significant amount of the motor control lost by the stroke can be recovered. Human therapy approaches supplement this approach with keeping patients informed about their progress. Since sessions with therapists usually only cover a small set of motions and significant recovery requires more effort, patients are required to stick to an extensive home exercise routine. However, only a fraction of the patients actually perform these exercises as recommended. Here, VR games are considered for improving rehabilitation involvement by increasing patient motivation and quantifying recovery progress, with a focus on supporting the re-development of proprioception [16]. In the case of brain damage, VR approaches not only include direct rehabilitation work but also give the opportunity for tele-rehabilitation [5]. A further use of VR in healthcare is the involvement of so-called virtual humans in senior citizens' assistance scenarios. In this background, simulated doctors or healthcare workers are being used to let a system communicate with patients. Similarly, VR representations of patients are being used by healthcare personnel for bed-side soft-skills training [1]. Thus we have extensively surveyed the VR technologies and its potential which can be an immense help for citizens with debilities. The challenge is to develop methodologies and guidelines for making VRML accessible. VRML, now a draft international standard and what some have called the second Web, opens up new prospects but also raise new hurdles. In this paper, we propose some guidelines, develop some techniques, and propose some tools to help create more accessible VRML worlds.

III. Organization Of Access Modus Operandi

Debilities are a subject of measure to the extent we are affected to a few impairments like visual, auditory, motor control, speech, cognitive and so on. However a myriad of media types like aural, graphics and video can certainly improve access to information based on the exact disability. Here we have examined the use of virtual environments for information access. Nevertheless what is a blind person to do if the information is important and only accessible via these worlds? Graphical User Interfaces, the GUIs of the mid 1980s and 90s, have shifted the user's interaction with computers from a primarily text-oriented experience to a point-and-click experience. This shift, along with improved ease of use, has also erected new barriers between people with disabilities and the computer. There have been a variety of devices and software techniques that have been developed to improve access. The concept of auditory icons has been pursued for over a decade. Devices which are used to make PCs more accessible range from speech synthesizers and screen readers to magnification software and Braille output devices. There is some concern over access to VRML for people with disabilities. However, it is quite uncommon. Many of the concepts such as aural introductions, and the use of embedded documented metaphors are addressed. We propose the following VRML mechanisms as a starting point for improving access. These mechanisms fall into three main realms: documented metaphors, aural stimuli and verbal metaphors, and console input facilitation. All of these mechanisms use the inherent capabilities of the VRML specification to make the VRML world more accessible.

3.1 Documented metaphors

Documented information about a VRML world can be added for improving access. Strategically this needs to be implemented with the use of two different nodes. They should be the World and Anchor nodes. Firstly the World node should contain the label for the overall world and provide information about individual objects. Mostly a VRML browser will use the title field of World node it encounters to put a label on a section of the browser window. Then the World nodes should be placed inside of Groups to document individual objects with supplemental text. The JavaScript functions needs to be defined here in order to use the additional World nodes to change the label displayed by the browser. A note worthy thing is that the setDescription JavaScript method is supported by amenable browsers. Also the VRML pre or post-processors can perform additional actions along with the text, for instance speech synthesis. Secondly the Anchor node should hold the additional text in its description field. From a practical view point this will be a predominantly useful way of adding value to a world since VRML browsers display the text from the description field when the cursor is rolled over the object. Now we are aware that the VRML provides a common method, by means of the World node, for documenting and supplementing object information. It would be fascinating that if browser builders would allow access and use the World nodes associated with objects, so that the world builders would be more optimistic to include more explanatory documented information in their worlds. Of course there are a few approaches existing. For instance an approach to using World nodes would be to use some Java code by the use of the External Authoring Interface (EAI) so as to read the contents of the World node and display the text or send it to a speech synthesizer.

3.2 Aural Stimuli and Verbal Metaphors

A novel way to improve access to a VRML world subsequently to documented metaphor would be through the aural stimuli and verbal metaphors. Aural provides an array of rich possibilities. Here we would examine the three types of aural. They are: surrounding music, verbal metaphors, and speech synthesis. Synthetically we can cause the surrounding music to effect the change as the user changes his/her position from one place to another while moving, yielding an intuitive location clue. As the viewer draws close to an object the verbal metaphors of objects can be devised to play. By gaining the accessibility and usability of a speech synthesizer embedded text can be read and text from Anchor node metaphors or World nodes can be made verbal. The core potential of the description field in the Aural node is yet to be realized. Aural nodes hold the address to real audio files as well as a description field which should be used as a documentation of the sound. In order to imbibe more realism than just to cause a sound we have adopted the triggering procedure. Some of the events like the beginning of a talk, audio effects, or one other external program can be started based on the different styles of triggers. We can realize to the core the potential of triggering procedure supported by VRML. The three triggering procedures supported by VRML are: 1. Proximity (where the implementation should be, based on viewer position). 2. Viewpoint (when the implementation should be, based on the selection of the viewpoint). 3. Touch (should implement, only when the viewer clicks). Here the triggers characterize the events when an audio is to play. For instance a Proximity Sensor is used to cause an event when the user is contained by the area defined by the sensor. An audio describing an object plays when the viewer moves close to that object. The role of Triggers is not limited only to playing audio clip. It can cause a speech synthesizer to read text, print Braille, and by means of programmed external utilities carry out almost any type of code. Also triggers can commence the execution of random code and direct devices to carry out preferred events. We are yet to explore fully the advantage of the audio in VRML which is also a spatialized feature. On the other hand audio can be coupled directly with object and triggered while considered suitable. Ultimately this should pave a way for users to be able to locate objects by sound alone.

3.3 Console Input aid

In the Console mappings, the facility to carry out application functions just by using a console, rather than a mouse, is a significant enabling technology. Here we would draw up some support from the VRML browsers in this field. Regular console equivalent is to map the Page Up and Page Down keys to let users tread to the next or prior viewpoint. Consequently the viewpoints ought to be defined as part of the world which would be unusual incident. More over a few manifestations can happen here as well in the different modes of operation like examiner mode and walk mode. Additionally to viewpoint selection, the arrow keys can be used to rotate the object (when in examiner mode) and to travel (when in walk mode). Conversely this would hold good for Cosmo Player. We are aware of the fact that every VRML browser works a little different. Steady console mappings and their subsequent behavioral effects in the VRML world can provide significant accessibility ability for a VRML browser. To conclude we suggest that by creating large control areas through virtual worlds we can improve the access to VR environments for citizens with debilities. Now if such a world be used by citizens with debilities like no hand control (especially for the aged) the world they live would become a nicer place. This aid in the creation of more accessible worlds will not be just limited to people with debilities but also for people when they are busy (riding, driving, working in a field). Along this line of research we foresee that soon by harnessing alternate devices like voice controlled cursor and other technologies like, driving a car would be made hands free and voice operated cursor control can select links and examine objects as well.

IV. Authoring Strategies

While exploring more than a few ways to compose VRML worlds accessible by the citizens with debilities (visually and physically impaired) we realized what VR environments could really offer. The virtual environment provides object metaphors that are significant to users while interactivity is enabled. Also we are aware of the fact that the addition of embedded documentation and audio and assistive devices such as a speech recognition system all add up to a more accessible virtual worlds. This research work has enabled us to propose a set of strategies which authors can use. These are precisely identified and bulleted. In this paper we propose an initial set of strategies authors can use to improve VRML accessibility. The authors building their VRML worlds which should be more accessible ought to necessarily adhere to the strategies so as to maximize the result. The strategies are as follows:

- Add World node metaphors for both the entire world and individual objects.
- Use the description field of Anchor nodes.
- Create Viewpoints since they are handy via the console Page Up and Page Down keys.
- Associate Audio nodes with verbal metaphors of objects of significance.
- Name significant objects to allow for automated audio.
- Create large control areas for alternate input devices to gain more access.
- Activate a graphical menu to personalize different communication features like audio, video.
- Offer both audio and video feedback when they interact with the elements in the scene.
- Permit to modify the point of view and make zoom in the scene to find the most pleased perspective.
- Execute with at least two modalities.
- Integrate the different interaction devices and modalities in order to attain the most functional solution.

Also we have proposed to develop utilities to assist in the creation of virtual worlds which would certainly improve VRML accessibility and would pave a way to improve their level of independence thereby enhancing their quality of life. Also we have proposed how to create accessible worlds through the addition of aural content. A more thorough discussion of browser issues is in the Serflek and Treviranus paper cited previously, and points out issues such as console equivalences, and alternative input devices. Nevertheless, VR has been proven to offer significant advantages for persons with all kinds of debilities when it can present virtual worlds where users can be trained or learn in a controlled environment, and then apply the skills acquired to a real context. VR technologies can be adapted to a wide range of individual requirements and, at the same time, user’s abilities and experience can be assessed in order to reach an optimal adaptation. Particularly the multimodal approach is inherent to VR and the low-effort interaction techniques followed can make VR-based interfaces especially valuable for users with debilities or special needs. The combination of these facts may enhance the variety of accessible solutions for addressing the specific impairments and preferences of each person, especially in terms of interaction limitations. This involves not only physical, but also cognitive debilities. In addition, users can participate in a controlled environment, since VR technologies assure safe and secure interaction and finally, the citizens with debilities will be provided with new services to improve their quality of life, and improve autonomy of different target users.

V. Conclusion

In this paper we have developed methodologies and guidelines for making VRML accessible. Here we have proposed some guidelines, suggested some techniques, and proposed some tools to help create more accessible VRML worlds especially by realizing the following VRML mechanisms in the realms of documented metaphors, aural stimuli and verbal metaphors, and console input facilitation for improving access. All of these mechanisms use the inherent capabilities of the VRML specification to make the VRML world more accessible. We have also proposed an initial set of strategies authors can use to improve VRML accessibility. We have presented a framework for improving access to interactive, multisensory, three-dimensional environments called virtual worlds for citizens with debilities. It is clear that there are challenges and a variety of research issues to address. Starting with the strategies outlined in this paper there is much that can be done today towards making VRML worlds more accessible. Here we have explored the most promising technologies and applications in the field of VR applied to citizens with debilities. However there exists enough room for future scope. They are as follows: 1.To present the outcomes of assessing user experience through innovative approaches, bringing together VR and other technologies such as environment control systems. 2. Develop several utilities **(**VRML ACCESS UTILITIES) to assist in the creation of more accessible VRML worlds that could improve debilities of citizens' level of independence and thus enhance their quality of life and prove to be a very useful tool for the empowerment of a large number of citizens. Hope this provides new vistas for research scholars to come to grips with VR technologies in order to improve accessibility for citizens with debilities.

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