A Study of HAPTIC based APPS for mobile contact list call with visual impairments

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ABSTRACT

Technology as it finds its wide range of application in every field not an exception even the Mobile technology. One of the technologies which aid the blind person to call in android mobile is Virtual Reality. Even though virtual reality is employed to carry out operations the blind person attention is one of the most important parameter. If they commit any mistakes to use apps it leads to a wrong call. So, one may think of a technology that reduces the burdens of a blind person by using apps. Now our dream came to reality by means of a technology called "HAPTIC TECHNOLOGY". Haptic is the "science of applying tactile sensation to human interaction with computers". In our paper we have discussed the basic concepts behind haptic along with the haptic devices and how these devices are interacted to produce sense of touch and force feedback mechanisms. Also the implementation of this mechanism by means of haptic rendering and contact detection were discussed. We mainly focus on 'Application of Haptic Technology in Surgical Simulation and Medical Training'. Further we explained the storage and retrieval of haptic data while working with haptic devices. Also the necessity of haptic data compression is illustrated.
KEY WORDS: Software Design Document (SDD), Software Requirements Specification (SRS) ,Haptics Software Developers Kit (HSDK)

1. INTRODUCTION

Haptics is related to the cutaneous sense of touch in humans. Haptic interfaces provide force and touch feedback from virtual models on the computer to human users. This article describes an innovative project using haptic interfaces to assist the teaching of high school physics. The literature regarding the use of haptic in K-12 education seems to be non-existent. Haptics expert J. Kenneth Salisbury is quoted in a recent Discover magazine article (Lemley, 2000): "I've often wondered if you could teach physics more effectively if your students could feel molecular attraction or planetary motion." Existing papers relating haptics and education are in the medical training field: the Interventional Cardiology Training Simulator (Shaffer, 1999) links technical simulation with specific medical education content, and a virtual reality-based simulator prototype for the diagnosis of prostate cancer has been developed using the Phantom haptic interface (Burdea, 1999). The Immersion Corporation (www.immersion.com) has developed haptic interfaces for injection training and sinus surgery simulation; these interfaces are relatively expensive and are special-purpose. The GROPE Project (Brooks, 1990) has developed over 30 years a 6D haptic/VR simulation of molecular docking. The SPIDAR haptic interface has been adapted to serve as "the next generation education system" (Cai, 1997), although the authors do not elaborate on the type of education intended.

A group at the University of Ioannina in Greece is involved with virtual learning environments including a Power Glove with tactile feedback to "build a theoretical model for virtual learning environments, expanding constructivism and combining it with experiential learning." (Mikropoulos and Nikolou). A research group at the Ohio Supercomputing Center has applied haptics in virtual environments to improve tractor safety by training young rural drivers (Stredney, 1998). Haptics has been applied to make virtual environments accessible to blind persons (Jansson, 1999). Also, the effectiveness of virtual reality (without haptics) has been demonstrated in the learning process (North, 1996). Two new articles published in physics journals show that K-12 educational goals (including science education) set by President Bush have still not been met (Goodwin, 2000) and suggest a physics education reform agenda that must focus on politics and systemic change in addition to classroom innovation (Tobias, 2000). The current project has the potential for both classroom innovation and nationwide systemic change. Since humans rely on multiple input modes to synthesize sensory information from the real world, haptics can greatly augment Internet-based education tools: "feeling is believing". This project attempts bring science education to life by allowing students to "feel" concepts presented in class. In this way, learning and retention will be enhanced. Through experiencing haptics, it is hoped that more students will be excited by and excel in science and mathematics and thus increase our technical base for the future. The Learning Technologies Project at NASA Langley Research Center is concerned with innovative approaches at supporting K-12 education in this nation. The objective of the current project was to develop haptics-augmented computer simulations to enhance teaching high school physics. The goal was maximum accessibility for all U.S. schools, which dictated the use of the Internet to distribute the program and tutorials, and a reasonably-priced, commercially-available haptic interface. The project resulted in free software, available from: http://www.ent.ohiou.edu/~bobw/html/NASAHap/main.htm.

The program includes seven different haptics-augmented activities to reinforce concepts presented throughout a standard high school physics course. In addition to distributing the executable code (including help

files), the project website contains HTML tutorials for each activity to further strengthen concepts taught in class. Part of the effort is for the high school students to use the technology themselves to increase computer literacy. This includes evaluating the project on-line via the website. A pilot study was conducted in three physics classes from two local Ohio high schools to evaluate project results and identify improvements and future work areas. This pilot study was not intended as a statistically-significant result, but as useful feedback from students for project improvement. This article first presents the requisite technology behind this project, followed by a description of the HTML tutorials and haptics-augmented software activities. The pilot study results are presented (including evaluation by the three high school classes and the Robotics/Haptics class at Ohio University). Lastly, future work plans are discussed based on pilot study result

Educational intervention: A total of 20 haptics-based computer applications (apps) have been developed based on the Next Generation Science Standards or the Common Core Mathematics Standards. We use the term "app" in this context as an abbreviation for application and to represent a program that is used for one purpose. The apps are self-contained lessons to be used by a student to learn one or a few concepts about one topic. Each of the apps begins with an introduction followed by eight to ten haptics-based scenes presenting the necessary content. At the conclusion of each app an eight question quiz is presented to check understanding. The apps all contain human voice audio, force feedback haptic interaction and high contrast graphics. The apps are created to work with the Novint Falcon Haptic Controller. This low-cost controller (around $250) provides three degrees-of-freedom movement and can produce a myriad of desired 3-D effects for the apps. A student holds the grip at the end of three movable arms attached to the body of the controller. The student can move the grip in three directions, up-down, left-right, and forward-backward getting a sense of a full 3D space. As the grip moves, the computer keeps track of a 3D cursor. When the 3D cursor interacts with a virtual object in the scene, the computer registers contact and signals motors in the device to provide the appropriate force feedback that makes the virtual object seem like it is on the table in front of him. The student locates an object in the haptic 3D scene, like a sphere, and traces the object getting the sense of size, shape, position and texture. The force feedback sent from the device makes it feel like there is something real at the end of the grip. The device can also send vibration feedback to alert the user that something of interest is in a certain location and also be used to move the user's hand to a location of interest with a gentle elastic type pull as the user holds the grip. The device is robust enough for use in a middle school classroom and can be used with most PC computers currently in a K-12 classroom. This device has been on the market since 2007 and has been proven in the gaming industry to be a well-developed and problem free device. This project is the first to provide a market ready set of K12 applications for the Falcon geared toward students with visual disabilities.

Design and Development of the Apps: The design and development of the apps was based on a framework in order to maintain consistency of the learning experiences. The framework includes the requirements definition, software design documentation, pre-packaged haptic effects, and software programming. A full description of the framework can be found in. A summary of the framework is presented here. The Software Requirements Specification (SRS) describes the functionality that must be consistently applied for all applications. The only variation in functionality occurs between the different application models: sequential, springboard, and random problem. A sequential app runs from beginning to end with no variation to the order of the scenes. A springboard app contains one central scene from which all other scenes are accessed. A random problem app introduces a type of problem (generally a new mathematical formula) to the student then allows random scenes to be generated for practice. The student can continue to access random scenes from a defined set until the concept is understood. The design of each app begins with a topic that has haptic capabilities and matches the Common Core Mathematics Standards or Next Generation Science Standards. The lesson designer first creates a Lesson Guide identifying the standards met, and then creates a Software Design Document (SDD) to lay out each scene and its appropriate effects. Once the lesson designer and the developer agree on the SDD, the developer begins programming the app. Development consists of: integrating the Haptics Software Developers Kit (HSDK) with the game engine (Game Studio); obtaining the appropriate 3D models; applying the required effects; and inserting the necessary audio. The HSDK was created specifically for this project by Novint Technologies and includes simple function calls as a way to access the haptic effects. Novint provided the libraries that included the effects to create standard 3D shapes (cube, cylinder, and sphere), irregular 3D shapes (created from .stl files), surface textures (bumpy, smooth), vibration, elasticity, magnetism, surface compliance, weight, moving objects, and shape tracing. The 3D models require both visual model (typically an .mdl file) and the haptic rendering (.stl format). Finally, the audio is human-voice and recorded by an approved narrator. The development is followed by a thorough review process. Each app undergoes several rounds of internal review in parallel with the development phase. Once the developer and internal reviewers agree the product is ready, the app is sent out for expert review. The expert reviewers are adults who are blind or work with students who have visual impairments. After the developer has incorporated the comments from the expert reviewers (along with internal reviews), the app is sent out for student review. All twenty of the apps were tested for usability, and six have been tested for the promise of student learning in the classroom.

Previous Testing with the Apps: Before the apps were tested with students in classroom settings, each one went through three rounds of usability testing, internal testing, testing by adult experts and testing by student experts with visual impairments in a controlled setting. During the adult expert review, all apps were reviewed for content and usability by several content experts (science teachers, math teachers, technology specialists, VI teachers, individuals who are blind). During the expert student testing in controlled setting, the researchers observed the students using the apps to see if any issues arose that needed to be addressed and then asked the students opinions of the apps. After these three rounds of usability testing all issues where addressed and the apps were released in a final version. Three apps were tested with students who were attending Space Camp for Interested Visually Impaired (SCI-VIS). In this informal setting, twenty students were in the same room and took turns using the apps. The students were given a pre-test, used the apps and were given a post-test to determine any learning gains. All students were considered visually impaired and their vision levels ranged from mild to total blindness: 11 mild/ moderate, 4 severe/profound and 4 near total or total blindness. There were 12 males and 8 females who ranged in age from 10 to 17 years old. Not all students were able to use all apps; fourteen students used Exploring the Atom, nine students used Gravity on the Planets, and fourteen students used Surface Area of a Cube. In this informal setting, student showed significant learning gains on all three apps . In each case, it seems reasonable to attribute this increase from pre-test to post-test scores to use of the apps, since the apps were used as a stand-alone lesson in an informal setting with no teacher intervention.

2. METHODS

This paper focuses on the classroom testing to show feasibility of teachers being able to implement the apps in their classroom and to determine if the apps could produce student learning. This section describes how the haptics-based computer applications were tested by teachers in their classrooms at various locations.

Participants: A total of five teachers participated in the testing over two academic semesters. Two were teaching at residential schools for the blind, two worked as teachers of the visually impaired in a typical school setting and one was a typical classroom teacher. The participants for this research were 32 students with various levels of vision. Table 1 shows the vision level classification for the students. Since the apps can be used with all students, we included three students with no vision problems in the study. One student did not report his/her vision level. Eight of the students participated in both sets of testing for all six apps, but most of the students only did three of the apps. The students ranged in age from 11 to 17 years and were in grades 4 through 12, with most students in grades 6, 7, 8, and 9 (the target age group). Only five students fell outside of this range.

Classroom Set-up: Each teacher was shipped a Novint Falcon Haptic Controller and sent an email containing links to download the apps that would be tested. No special computer was provided; instead the teachers were asked to install the apps on a classroom computer used for students. The teachers were instructed to set up the device and then practice, Vision Level Reported Number of Students No Vision Loss 3 Mild Visual Impairment (20/30 to 20/60) 5 Moderate Visual Impairment (20/70 to 20/160) 5 Severe Visual Impairment (20/200 to 20/400) 9 Profound Visual Impairment (20/500 to 20/1000) 2 Near Total Visual Impairment (More Than 20/1000) 2 Total Blindness 5 Did not Report using the apps before using them with their students. They were not given any special instruction in using the device or the apps. No problems were encountered with this part of the process. Each teacher had several students who participated in the testing. Most of the sites only had one haptic device, so the students had to use the software one at a time. The teachers completed the app testing with students over several months at their convenience. The teacher from one of the schools for the blind asked the researchers for assistance with the logistics of the testing so it could all be done in a short period of time. At this site three haptic devices were used and the researchers helped with the testing, but the same protocol was followed.

Apps Tested: The six specific apps that were tested in the classroom were exploring the Atom, Gravity on the Planets, Surface Area of a Cube, Exploring the Plant Cell, Blood Cells and Circulatory System. These apps covered a range of topics in math and science.

Study Design: When designing the apps, the team worked with several teachers of the visually impaired. The teachers explained to the team there were many methods employed to teach math and science concepts to students with visual impairments and that not all teachers used the same methods. The apps tested were in a wide range of topics, so there was no "standard" method or even set of methods that could be used for comparison to the apps. The intended use of the apps is to supplement and not a replace other methods of teaching students with visual impairments. Thus, the intention of the study was show that the apps could produce learning and not to show that the apps worked better than other methods. Therefore, a quasi-experiment pre-/post-test design without a control group was chosen as the design. This allowed the team to use all of students as the treatment group.

Procedures: The teachers first collected all the completed forms for the Institutional Review Board (IRB). These included a student assent form, a parent consent form and a teacher consent form, so that each party gave agreement to participate in the study. The teachers then allowed the students to work with the Three Dimensional Shapes App that has nine simple scenes (three basic shapes each with three different textures) to familiarize themselves with the

haptic controller and haptics-based software. The learning curve for using the software and the device was minimal; most students can master the use of the device within a few minutes. In observation of students using the device it typically took a student three haptic scenes before they were completely oriented to using the Novint Falcon with the haptics-based software. The pre- and post-tests for each app were developed by the lesson designer and reviewed by content experts. The same content questions were used, but the pre-test collected demographic data while the post-test gathered impressions of the app. The content questions were short answer, different from the quiz questions in the app. The pre-test allowed for the determination of student baseline scores. Since the students were of various ages, a few teachers noted that some of the older students may have already studied the material. However, the pre-test was able to assess what was previously known. To assure content validity the test content was reviewed by a science teacher, and a table of specifications was developed to map the test questions to the app's learning objectives. Students were also instructed to give an "I don't know" response to discourage guessing. On the day of testing apps with students, the teachers read over the copy of Student Assent Form again to remind the student of the assent to participate.

Implications of new technology: The growth of computer technology has significantly increased the potential to give students with low vision greater access to information. In recent years, several authors (Kapperman, 2002; Kelley, 2001; Vincent, 2003) have addressed the growing interest in assistive technology for individuals with visual impairments. Abner and Lahm (2002) detailed the past decade's new opportunities for access, including optical scanners, modern closed-circuit television systems, optical magnifiers, and various technologies for using computers. Although these advances promise greater visual access, many people who are visually impaired are unaware of the information or resources that are necessary to benefit from them, particularly because of the lag between technological innovation and application. The causes of this lag include universities' emphasis on providing instruction in traditional training versus teaching assistive technology applications and the delay in the dissemination of information on the effectiveness of programs in bridging the gap between technology and employment barriers for students with visual impairments (Butler, 2002; Church, 1992).

What is evident is that technology exists to increase visual access for students with low vision, when the visual sense is capable of and more efficient in gaining Policy to Practice: Teachers' and Administrators' Views on Curricular Access by Students with Low Vision - Education - October 2004 access to the general education curriculum. What is also evident is that students who are blind and those with low vision are equally capable of gaining access to information through braille and advances in technology and nonvisual ways of gaining access to computers. It is further axiomatic that administrators and teachers should promote whichever sensory mode or combination of sensory access modes best suits a student's learning capabilities. We believe that for students with low vision, an either/or philosophy regarding the use of vision constitutes an unnecessary philosophical pull, with students failing to obtain the benefits of the most-appropriate or least-restrictive medium or combination of media. If students are capable of gaining access to information visually, and if optical, non-optical, and computer technologies increase their access to the general education curriculum and enhance their learning, then it is the responsibility of professionals to facilitate this access. Professionals are equally responsible for facilitating non visual access for students who are blind or have insufficient vision to benefit from visual access modes.

In 1991, the Committee to Develop Guidelines for Literacy, composed of experts in the field of education of students who are visually impaired, presented recommendations on selecting appropriate learning media for students. As the report noted:

It is apparent to the majority of those concerned with the education of visually handicapped children that a major. Policy to Practice: Teachers' and Administrators' Views on Curricular Access by Students with Low Vision - Education - October 2004 (perhaps the major) reason for the fact that so many of these children are illiterate is that they do not have access to the learning medium that is most appropriate for their educational needs. (Committee, 1991)

The committee also stressed that combinations, such as braille and print, may be the most appropriate learning media. One partner in the AFB Solutions Forum, the National Center for Accessible Media, focuses its research and development on a multimedia approach to accessibility via CD-ROMs, digital television, the Web, and other advanced technologies. The center represents a trend toward the use of a variety of media in gaining access to information, which requires an ever-changing attitude to match the rapidly evolving technology, which promises greater and more timely access to information. Regardless of one's philosophy on the appropriateness of access, most professionals in the field concur that it is important to increase access to information in a timely manner for students with visual impairments.

3. DISCUSSION

The implications of this research and the resulting products for teaching and learning are far reaching. This project not only continues the research on using haptics for education, but has also helped to provide an important step in moving haptic technology into the K12 classroom and for utilizing haptic technology as an assistive device,

by offering products for sale. Currently, eTouch Sciences, LLC has twenty haptics-based apps for sale on their website (www.etouchsciences.com). The apps align with the Next Generation Science standards and the Common Core Math standards so they provide teachers with a good supplement to their usual practices. These are the first haptics-based educational software products for sale to K-12 educators and parents of student who are visually impaired. The apps were tested and have been used by many people, sighted, visually impaired and blind. While having some vision is helpful because of the presence of visual cues, the developers have found that it is not necessary to effectively navigate, learn from, or enjoy the apps. Some of the students who were very low vision or blind seemed to like the apps the most. The apps held their attention and seemed to have enough auditory and haptics-based stimulation to help the students navigate through the scenes. One user who was blind said she developed a particular method for investigating the scenes. She said she always started with the controller grip in the fully extended position and then pushed in to the scene from the front so she was sure that she would be able to locate the items in the scene. The developers took special care to ensure that the audio informed the user of what they would find in the scene and what they were looking for. For example, in the Circulatory System app in the scene with a model of the heart the user will hear, "In the center of the scene you will feel a model of a human heart… As you explore the heart model, you will find four vibrating hotspots that will give information about the parts of the heart." The care taken to ensure the apps would be accessible to users with little or no sight has had a great impact on the usability and utility of the applications for the target audience.

4. CONCLUSION

Innovative technology and software can integrate rich information through the sense of touch. This is to add the information being provided through auditory and visual means. This algorithm helps disabilities to use android mobile for call Different design patterns are applied for each contacts in the contact list. This puts demands on the haptic algorithm. This can be a new tool for blind persons to add to their tool box Already existing techniques of mobile calls done by search contact list in phone memory. Blind person not able to call with this facility. Contacts are presented in the phone memory. This new innovative technology and software can integrate rich information through the sense of touch to add to the information being provided through auditory and visual means. Blind person to call in android mobile with help of apps Calling done by drawing patterns i.e., gesture Future use of haptic technology covers a wide array of human technology and interaction .Phone contacts also added with help of gesture. Gesture is used for adding mobile numbers in phone contact list. The basic idea of this algorithm is to add phone contact lists from apps with gesture. As in the previous case, the contact list from phone memory.

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