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Computer-Based Edutainment for Children Aged 3 to 5 Years Old

Man-Ying Cheung, Koon-Ying Raymond Li, & Tim Zapart
Berwick School of Information Technology, Monash University, 100 Clyde Road, Berwick, Victoria, 3806, Australia
tim.zapart@infotech.monash.edu.au

ABSTRACT

Research indicates that children learn best while playing games. Edutainment is a term describing a computer environment where learning and playing takes place simultaneously. Game based edutainment applications, therefore, should benefit a child in his/her learning process. Young children of age 3 to 5 are often deprived of this wonderful learning opportunity as the design of traditional computer interfaces such as keyboard and mouse are not suitable for them. This research proposes the use of speech technology to address the interface issue. The prototype system developed in this project can be used by future researchers to investigate the suitability of using voice command interface for the targeted group of children. Furthermore, the prototype should provide an opportunity for researchers to conduct experiments to establish whether a young child of that age can actually understand virtual objects in 3D context and manage to use a first person game to experience problem solving by trial and error. The findings from experiments conducted using the prototype should provide valuable information to help educationists in the future to develop 3D edutainment applications suitable for 3 to 5 years old children.

PREAMBLE

Over the past decade, computers, in particular the personal computer, has changed the ways we work and learn, and how we are being entertained. In 1984, the term edutainment was coined by Trip Hawkins in his press release promoting an educational game called *Seven Cities of Gold*. The term is now commonly used to describe a new computer based learning style in which education and entertainment are combined. Researchers such as Ellision (1993), Okan (2003) and Bloom and Hanych (2002) are all convinced that having fun while learning is the most effective way of learning, in particular, for children. Edutainment increases their learning motivation and helps children maintain longer attention spans. The success of edutainment applications are often based on attractive visual presentation, visual learning content, interactive features and unlimited practice. Many children's edutainment applications are designed in a game based format (Elin, 2001). While using these applications, children learn while they play the game. The feeling that they are forced to learn under pressure is now diminished. With all these advantages, it is not surprising that there are so many computer based edutainment applications existing today that target children.

Given that the current generation of children spend most of their time indoors and become "passive" players/spectators of games, promoting computer usage is therefore a controversial topic, in particular, when dealing with young children of ages 3 to 5. Researchers such as Clements (1987), however, found that the problem is not the computer itself but "the quality of the software, the amount of time it is used and the way in which it is used". As long as the amount of time spent is moderate, there is no reason why computer game playing should be discouraged in particular when the games can facilitate learning.

Researchers such as Haugland (1992) are convinced that children of age 3 to 5 can definitely benefit from having computer experience through appropriate educational software in their class. Besides an increase in children's creativity and self-esteem, abilities such as non-verbal abilities, visio-motor abilities, memory capacity, manual agility, problem solving, abstraction and conceptual dexterity, can also be improved. Unfortunately, young children below the age of 5 may not have the capability to handle the computer interface properly (Mackenzie et. al. 1991). As such, children aged 3 to 5 years old (young toddlers) may be deprived of the fantastic opportunity of benefiting from edutainment.

In this article, the above assertions are discussed and a voice driven solution enabling young toddlers to benefit from edutainment is presented. A supporting prototype is developed to prove and test the functionality of the system. The prototype uses *Macromedia Director's* real-time 3D capabilities (with 3D content created using *Alias Maya*) and integrated with the Chant Speech Kit engine to provide voice recognition interface to the (functional) simulated environment. This research project however does not cover the evaluation of the proposed solution in a real setting, which is currently in progress.

GAME-BASED EDUTAINMENT

Traditionally, text is a fundamental means for knowledge transfer. Given that young toddlers have limited vocabulary and reading ability, text is not appropriate and therefore visual display, such as illustrations, are often used. With computers, learning can be further enhanced by using moving pictures, in the form of animation, complimented with audio elements. Interactivity is another important element within edutainment that enhances learning. Interactivity promotes exploration that can intensify children's curiosity and thus hold their span of attention for a longer period of time. Exploration can also help children to develop their problem solving skills; encourage them to learn by trial and error; and thus improve their knowledge development skills (McFarlance 1997). Instead of passively receiving information, children are now able to learn through active control of the application (Chapman & Chapman 2004). Computer games have all these important edutainment ingredients. Besides, games are full of fun and can often satisfy player's psychological and emotional needs.

Games come in two visualised formats; two-dimensional and three-dimensional. With the advancements in computer technology and animation techniques, most games are now delivered in a 3D format. According to Whitney (2003), children prefer 3D characters to 2D; therefore, the best game format can be assumed to be 3D. Furthermore, 2D can only show the length and breadth of an object but not the depth, and thus does not represent that object as perceived in the real world.

WHY SPEECH-DRIVEN?

The conventional computer interface often consists of a keyboard and a mouse. Research survey findings indicate that young children often found such an interface difficult to use.

Young children often found it difficult to hold the mouse steady over a small target object on the screen while required to simultaneous press the mouse button (Crook et al 1992). Children of age 5 to 7 found it difficult to hold the mouse button pressed and move the mouse simultaneously

(Mackenzie et. al. 1991). Children can also be frustrated by the orientation of the mouse pointer on the screen in relation to the movements of the mouse. Hourcade et.al. (2004) are convinced that there is a need to replace the current style pointing device for children 4 and 5 years of age.

Traditional keyboards are often too big for the small hands of a young child. Children under 5 years often lack typing skills. This may be due to the fact that they are just starting to learn the alphabet sequentially and are confused by the placements of keys on the computer keyboard. Kidtech has released a specially designed "peanut button proof" keyboard with 55 colour coded keys arranged in alphabetical order. (Hopkins, 1997)

Young children love to narrate what they are doing while drawing a picture or dragging an object around the screen (Bredekamp and Rosegrant, 1994). Buckleitner (1990) observed that young children love to speak into a computer microphone, in particular, when the objects on the screen react to their voices. Nicol et.al. (2002) observed that children are able to speak and interact better with computers than adults. Using Speech to drive the edutainment application is therefore a good candidate to provide the required interface solution especially for children of age of 3 to 5.

SPEECH TECHNOLOGY AND COMPUTER SOFTWARE

Speech technology deals with voice recognition and speech synthesis. Speech synthesis enables the simultaneous use of both visual and auditory sensory channels. This increases the learning process of the user as they interact with the software, as dual modality demands less cognitive resources. Voice recognition, which converts captured voice into commands, can be used to drive computer software in real time. A voice driven interface can simplify a complex task, in particular those that require a lot of hand-eye coordination on the display as well as keyboard.

Speech technology has improved greatly over the last few years. The speech synthesiser nowadays can output speech which closely resembles natural human speech. The accuracy of voice recognition has improved with the use of a feature called "profiler" that is now available with many voice recognition software (Ravesi, 1999). The "profiler" can help to address issues such as verbalising inconsistency by "at risk users" and background noise. An "at risk user" is one who has pronunciation accents, physical characteristics (e.g. missing teeth) and/or cultural factors which make it difficult for his/her voice commands to be recognized (Bradford 1995).

According to Chang et. al. (1997), three year old children are ready to learn to use a computer. Gaddy (2000) found that children of age 3 to 5 are often able to verbalise consistently and clearly. Papalia and Olds (1996) indicated that the vocabulary of a three year old child can be as high as 1000 words. Though, limited, the number of words should be more than adequate to drive edutainment applications for this age group.

THE PROTOTYPE

The aim of developing the prototype is to provide a tool for other researchers to conduct investigations into the suitability of using speech technology as an alternative interface for computer software created for young children, thereby making computer-based learning a suitable means of further developing the learning process of children of age 3 to 5. The prototype is a voice-driven edutainment learning system targeted at children of 3 to 5 years of age. It is designed to teach a child the directional concepts left, right, forward and back.

A 2D format game was originally chosen. This was abandoned due to the directional nature of the words that the game aims to teach. As seen from Figure 1, the concepts of up and down are not possible. Even with the presence of left and right movement, it would still confuse the child as in reality, the rabbit can not move up and down on a vertical plane.

With the recent advancements in 3D technology and game engines, the market is now flooded with 3D games with more realistic characters and environments. The success of 3D animated feature films such as "Toy Story", reinforced by recent blockbusters such as "Finding Nemo" and "The Incredibles", has now consolidated 3D's position in the film industry. Children now prefer 3D animation over traditional 2D cartoons.

2D has only two dimensions and as such a 2D object does not represent an object as seen in the real world (Discher 1999). Whitney (2003) believes that 3D animation can maintain young children's attention longer. A 3D environment should therefore be an ideal choice for edutainment. Literature surveys by the authors, however, fail to identify any research discussing the suitability of a 3D edutainment application for children of 3 to 5 years old. The prototype can therefore be doubled as a tool to investigate whether these children will have difficulties in understanding virtual objects within a 3D context.

Figure 1. 2D game environment

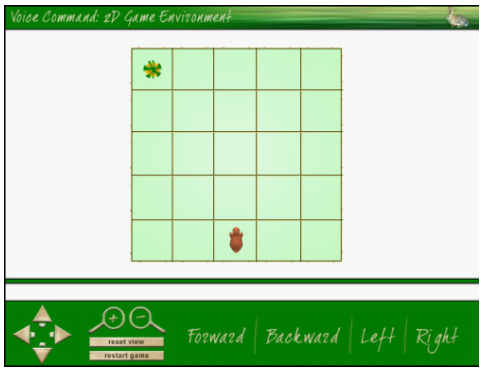


Figure 2a. 3D game (3rd person)

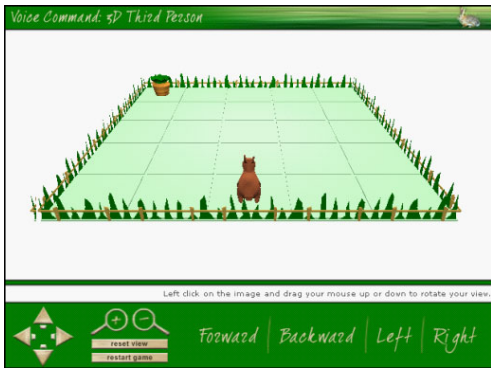


Figure 2b. Visual reward system

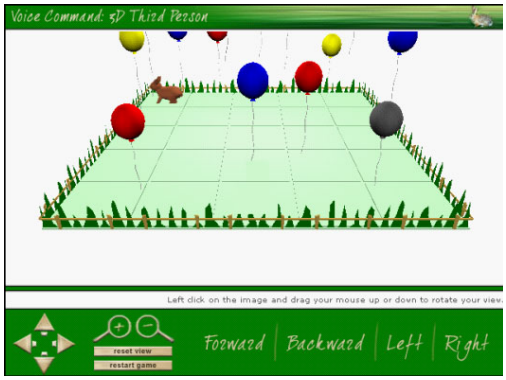


Figure 3a. 3D game (1st person). Target unseen

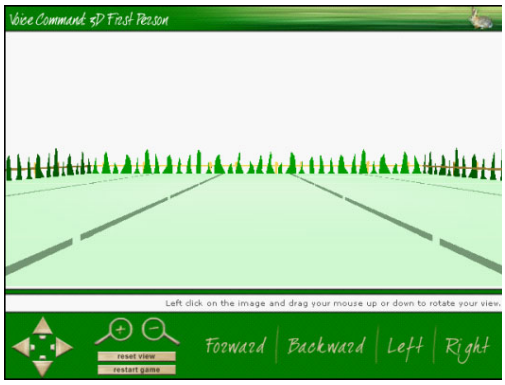
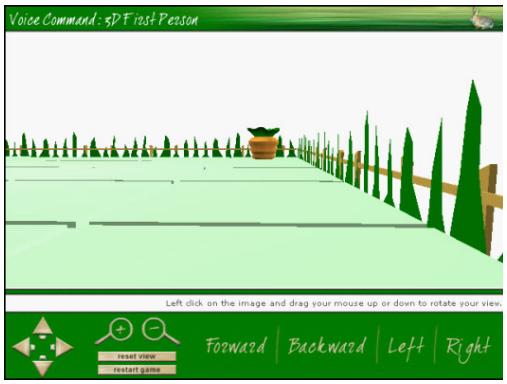


Figure 3b. 3D game (1st person). Target sighted



The prototype is designed to teach a child the concept left, right, forward and back utilizing a 3D game (see Figure 2a).

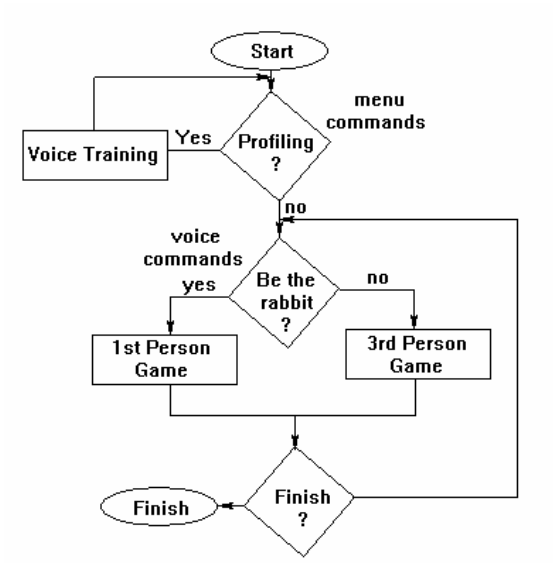
In the game, a rabbit (the avatar) moves from one location to another depending on the voice command given by the child. The initial position of the rabbit and its target position are randomly generated. As the target audience is very young, the game consists of a very simple task; to direct the rabbit towards its target (a carrot) by using the four primary voice commands. As suggested by Soule (2000), this game, therefore, has no rigid rule governing what path the rabbit should be taking. According to Elin (2001), games can satisfy player's psychological and emotional needs. When a player passes a stage of a game, he/she feels that they are achieving something. To further increase the level of satisfaction, games are often designed to reward players when they have completed a stage of a game. In the prototype, balloons will be falling down from the ceiling of the virtual 3D environment to reward the child's effort (see Figure 2b). Figure 4 depicts the overall system flowchart for the prototype.

The prototype was developed using Macromedia Director MX 2004 and Chant's SpeechKit software. It is equipped with a profiler that can be used under an adult's supervision to improve the accuracy of the voice recognition for any user/child.

As seen from Figure 2a, the rabbit is actually orientated with its back facing the child. In this way, the child does not have to transpose left to right and vice versa. It is a common sense concept; however, such a simple idea is often overlooked as evidenced in a lot of training programs. For example, in a lot of DVDs teaching people Ballroom Dancing, the instructors are dancing facing the learner!

To make it simple for a child to use the application, the rabbit always has its back facing the child after it has completed a movement (based on an instruction given by the child). For example, on the receipt of a "left" instruction, the rabbit will first turn to face the left, move to the next position and then turn right again to face away from the child, orientating itself to the *"forward"* position.

Figure 4. System FlowChart



Within a 3D game world, there are two common perspectives used for visualising an avatars movement throughout the environment: first person and third person perspectives. The prototype has an advanced option to allow the child to be the rabbit itself (first person). In this mode, the rabbit is not programmed to re-orientate itself to the *"forward"* end of the screen. The game in first person has added an additional difficulty in that the child (rabbit) may lose sight of its target after a movement (see Figure 3b. The child needs to experiment with different directions to re-gain the sight of the target (see Figure 3b). Mafarlance (1997) indicates that exploration can help children to develop their problem solving skills, encourage them to learn by trial and error; and improve their knowledge development skill. This game, though simple, should be able to provide such an opportunity to the child whilst further developing his/her sense of spatial orientation.

CONCLUSION

This research questions the suitability of traditional computer interfaces (such as the keyboard and mouse) for young children and queries the current research findings on what age a child should be allowed to use the computer. The authors proposed the use of voice technology to address the issue of inadequate typing skills, poor motor skills required to control the mouse, and small hands of children of such a young age group.

Furthermore, the use of a voice interface also means that the computer can be hidden and the computer display can be replaced by a TV. Such an "interactive TV" setup can be used in pre-school where there are strong feelings about the use of computers by pre-schoolers.

Edutainment applications combine entertainment and education in one package. Children can learn while they are playing. Children learn best in a pleasant learning environment and the best learning environment is one in which children are able to have fun. Game-based learning is therefore a feasible and preferred vehicle for educating young children.

There are a lot of objections from researchers in that children should not be encouraged to play computer games. These researchers are concerned based on the amount of time children are now spending playing computer games. These arguments seem to focus on the duration of time without taking into account the potential benefits: such as

whether the computer game is actually educating the child whilst they play.

Given that computer-based game-based edutainment applications provide such a great way to learn, the current interface issues should not disadvantage young children. The voice commands interface and voice narrative system as illustrated in the prototype should help young children of all ages to benefit from computer-based edutainment applications. In fact, the voice command system together with the use of TV to display the output would make the computer transparent to the children turning the TV itself into an interactive learning system. Voice driven systems can also be designed to respond to commands from multiple children making team play and collaborative learning a possible reality.

3D games are preferred over 2D ones. Besides third person, a 3D game can also be designed to provide a first person experience to the player. Due to the "directional" nature of the teaching content, a 3D game with both first and third person options are provided in the prototype.

The aims of the prototype are as follows:

- To allow further investigation into the suitability of voice command interface for young children aged 3 to 5.
- To enable experiments to be conducted to explore the understanding of virtual objects in 3D context by the children of the targeted age group.
- To assess the suitability of the 3D game format for edutainment applications targeting children aged 3 to 5.
- To identify difficulties associated with young children navigating within a 3D environment using both first and third person perspectives.

The prototype, at present, provides a rabbit as the avatar. A rabbit was chosen as both genders show affection towards the animal, however, more gender specific characters should be included in the game.

The authors hope that research findings from the experiments using the prototype could help in designing better game-based edutainment applications that can be used to assess the effectiveness of game-base edutainment in assisting learning for 3-5 year old children.

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