ISBN: 978-972-8924-59-1 © 2008 IADIS

NIKVISION: NATURAL INTERACTION FOR KIDS

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ABSTRACT

This paper shows the development of a video game console based on the use of natural interfaces. Its use does not require any training, nor using any piece of technological hardware, and the kid plays with it the same way he plays with any of his non technological toys. An important aim has been the development of technologies that do not require sophisticated technological elements and installation nor very restricted environment conditions. Regarding kid/computer interaction, not only natural but emotional interaction is sought. This is accomplished by means of a virtual 3D character that acts as a pedagogical guide. The character speaks, recognises the kid's voice, and shows emotions in a natural way. Based on the developed video console, a collection of educational video games is being designed to research new way and possibilities of natural computer-children interaction.

KEYWORDS

Natural interfaces, Tangible bits, image analysis, educational videogames, virtual agents

1. INTRODUCTION: SEARCHING NEW WAYS OF INTERACTION FOR KIDS

In the field of human-machine interaction, the Natural Interfaces issues are capturing more and more interest in the computer science community. These interfaces are experimenting with new interaction solutions that do not require any learning process from the user, nor the use of unnatural hardware gadgets. Moreover, tangible bits allows users to "grasp & manipulate" bits in the centre of users' attention by coupling the bits with everyday physical objects and architectural surfaces. They bridge the gaps between both virtual and physical environment, as well as the foreground and background of human activities.

Previous works on natural interfaces with children have given interesting results. The Entertainment Technology Center at Carnegie Mellon University is dedicated to research the application of natural interfaces to video games (Pausch and Marinelli, 2007). They are adapting old videogames (mainly Nintendo NES) to the natural interfaces paradigm. The University of Montreal is developing devices (bracelets, trampolines…) to be use in educational music applications in which children can interact with their entire body (Zilgelbaum, et al., 2006). Likewise, the University of Education in Denmark, along with the company Kompa, are launching to the market devices for playground equipment (Zuckerman et al. 2006), mainly electronic tapestry for the soil that operates as an input device that reports the position of the child in the game room. The Singapore University of Technology is using ARToolkit (Kato and Billinghurst, 2004) to develop educational applications and games using natural interfaces. Children play by placing white cards with black patterns on a desk. The computer visually recognizes these patterns and replaces them by 3D objects which are displayed to the user through virtual reality glasses.

These new interfaces can benefit children's learning from many ways (Xu, 2005, O'Malley and Fraser, 2004). Physical objects give rise to mental images which can then guide and constrain future problem solving in the absence of the physical materials: learners can abstract symbolic relations from a variety of concrete instances. Furthermore, tangible interfaces can make the learning activity fun, as they take the same elements than make traditional toys fun (Fontijn and Hoonhout 2007).

Regarding our proposal, and compared to previous works, we are not looking for a system to work on large multimedia installations, but a cheap and simple system aimed to be used at home. The aim is to bring natural interaction over home, focusing on younger kids (from 3 to six years old) and trying to be as open as possible (actualizations and new games could be downloaded via Internet). Looking for affective or emotional computer interaction, our work combines the use of tangible elements and virtual human characters acting as helpers or guides. Another aim of our work has been the development of technologies that do not require sophisticated technological elements and installation, nor very restricted environment conditions.

2. VIDEOKIDS: A VIDEO GAME CONSOLE FOR KIDS

As previously pointed out, the purpose of the work has been to develop an educational video game console for children, based on natural interfaces. The child will use usual pieces of toys that he is already familiar with: a cardboard, building blocks, cubes… The only input information will be the video captured by a conventional video camera, and the output, image and audio, will be shown on a television. A 3D virtual actor, who interacts with the child through speech, is displayed on another screen or through video projection. Details of the system follow.

2.1 Console Description

As children are our main target, we designed a system to be used on the floor or on a not so high table. The child sits in front of the television; there is also a white surface in front of him/her where he/she is going to put the tangible elements (colour cards, Duplo blocks...). The child will see on the TV screen the feedback of his/her actions (see Figure 1left).

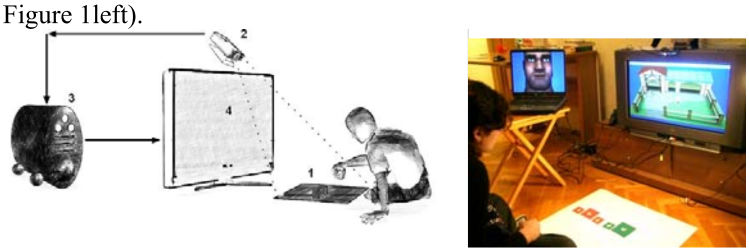

Figure 1. Console diagram (left) and the real implementation (right):
1: desktop and tangible bits. 2: Video camera. 3: PC computer. 4: screen and speakers

Different kinds of tangible bits can be used depending on the application developed for the system: usual elements in children games have simple shapes and vivid colours, so that they are patterns easily recognizable by the system software (explained in next section).

The system works on a PC computer with Windows XP with following input-output connections:

Outputs: television screen (video), and speakers (audio)

Inputs: Video camera and microphone.

The tangible bits the child puts over the carpet desktop are shown by means of 3D virtual representations on the TV monitor in front of the child. Depending on the game the child is playing with, they could be houses, people, animals… that move, sound, and interact with the others.

At the same time, on the nearby monitor, the pedagogical agent is shown, teaching, suggesting activities or correcting child's errors (see Figure 1right).

2.2 Console Technologies: Image Analysis and Recognition

When the system starts, the desktop is empty, and the camera performs the initial calibration to adapt system operation to current lighting conditions. It is automatic and requires no activity from the user. After calibration, the camera continuously monitors activity on the desktop, and the software analyses and maintains the status of the tangible bits. A C ++ library based on standard visual recognition algorithms, but adapted to the needs of our educational applications have been specially developed for the console. The process of visual recognition follows these stages:

1. RGB array retrieving from video camera, using Windows Media

2. Image thresholding that separates tangible elements from the desktop.

3. Retinal Vision (motion detection): the console only gives answers when the user motion has stopped, ie, when the child has finished distributing tangible elements on the desktop.

4. Segmentation: it identifies the tangible bits on the desktop

5. Setting tangible bits properties relative position on the desktop, orientation, size, color and pattern recognition (the tangible bit could have a “symbol” recognisable for the software).

With all this information, a 3D graphics motor displays on the screen a 3D scene containing the appropriated tangible bits representation, depending on the pedagogical game the child is playing with.

2.3 Natural Interaction through a Virtual Pedagogical Agent

To implement the virtual agent, who guides the child, Maxine has been used. It is a 3D engine for real-time management of virtual environments and autonomous agents. The engine allows multimodal and emotional character-user interaction. The virtual characters are provided with facial expressions, lip-synch, and emotional voice. More specifically, Maxine provides the following features: 3D Engine based on OpenSceneGraph (multiplatform); real-time management done via scripting, character design through 3D standard software; facial and complete body animation, allowing the character to express emotions; voice interaction through natural language (voice synthesis and voice recognition based on Loquendo and SAPI).

The system has been explained elsewhere (Cerezo et al. 2007). Maxine application communicates with the video game through TCP-IP. During the video game, Maxine characters can be use to help, encourage or correct the child, guiding the activities, proposing new ones, making questions,…

3. THE FARM VIDEOGAME

Using the system described above, we have implemented a video game based on a “building game” with farm animals. The idea of the game is to involve the child in association and spatial distribution activities.

The child has several colour cardboards with a farm animal drawn in the middle (chickens, sheep, pigs, horses, cows, dogs…) available. Also, the kid has smaller cards with younger version of the same animals (chicks, calves, piglets…).See Figure 2left.

Figure 2. Cards with farm animals (left), and virtual 3D representation on screen (right)

On the TV screen, the desktop is showed as a meadow with a stable on the side. When the child puts the card of an animal, the system recognizes it and displays a 3D animated avatar of the animal. Also, the 3D animals emit their characteristic sound and are animated. (See Figure 2right). In the nearby monitor or projection, the teaching agent asks the child for animals, indicating the type of animal and how many of them are required. The child has to select and play the right card on the desktop. If the child is wrong, the agent says it him and asks for correction. When the child is right, the agent congratulates him to and proceeds with new requests. Some requests have additional requirements, for example young animals are required to be and stay side by side with their "mother"(for example, a piglet at the right side of a pig).

This is the first application we have used to demonstrate the feasibility of the techniques developed and to study the recreational and educational benefits of the system we are working on. As first complete videogame activity, the design work has focused on covering the gap between the physical manipulation and the on screen representation (Fernaeus and Tholander. 2006). In fact, the child, most of time, puts over and distributes the tangible elements over the desktop and doesn’t need to see what is happening on screen. Only when he has finished, he stops moving the objects, and he visually checks the virtual representation on screen that matches his recent actions on the physical desktop and receives emotional feedback from the autonomous agent via voice and face expression.

It is clear that it is just a starting point and new uses and applications have to be studied.

4. CONCLUSIONS AND FUTURE WORK

We have developed a video game console based on natural interfaces, which can be used to easily implement educational games with different activities and learning possibilities. It has been oriented to children aged 3 to 6 years, developing different games with different pedagogical orientations. The idea is to let the child play deploying different real elements on a desktop, and to display the results of his/her actions on a television screen. The console has been developed so that it can be easily installed in the living room of any house. The tangible elements to be used by the child are not technological or new, but durable and resistant elements that he/she is already used to play with.

After completing the implementation and correcting the operation of the system, a simple demonstration game has been developed. Many other video games with new educational possibilities should join the games collection in a near future. In the short term, our purpose is to evaluate the existing system with its natural users, the kids. To accomplish this, a collaboration project with a school has been set, so that they provide us with a comprehensive set of children who will help us to refine, improve and expand the system.

ACKNOWLEDGEMENT

This work has been partly financed by the Aragon Government thanks to the WALQA agreement (ref. 2004/04/86) and the project CTPP02/2006, as well as by the Spanish General Research Direction through project TIN2007-63025

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