Enabling the Children with Cerebral Palsy to Interact

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Abstract

This paper presents analysis of case studies based on several human-computer interaction projects that are applying the use of new multimedia interfaces for the children with CP. A variety of applications have been developed under the project providing recreation in a computerized environment and contributing to education of children between the ages of 4 to 7 living with Cerebral Palsyn (CP) who are studying at the TSCF (Turkish Spastic Children Foundation - www.tscv.org.tr) institution.

Keywords

Human Computer Interaction, Cerebral Palsy, Interaction Design, Disability

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Introduction

In an era of inevitable numerous opportunities added to our lives by technology, various individuals of the society are benefitting from these opportunities in different ways. Although some previous research (Harper-Ed, Hall TE, Meyer A, Rose DH) investigates on possibilities of use of computer for the disabled, building new multimedia interfaces for the disabled is still a field of research that can be considered relatively untouched. Several research has been embodied for children with various learning disabilities, however this research aims to address children with physical disabilities to interact with regular haptic control devices. Since 2007, students of the VA555 Physical Interaction course[1] have been producing applied arts and design projects through technology- human relationships. The theme of the course in the fall semester of 2010 was founded upon to develop technological projects that may help children with special needs. Examples that can be regarded compatible with the aforementioned technological projects are as follows.

- Interactive multimedia games that make treatment in the sense of rehabilitation fun for children with discomfort

- Specific products for personal needs and skills to facilitate the children's everyday life

- Various software and hardware interfaces that will allow access to the opportunities of the information age

Project Process

By contacting Therapy with Arts Specialist Nilgün Türkcan from the Metin Sabanci Turkish Spastic Children's Foundation (TSCV) and after obtaining positive opinion of TSCV Board Member - Foundation Representative Sertan Özan, the study was started at the end of March 2010.

> Metin Sabanci Center, which has been established with the aim to help children gain various abilities by educating and training them at an

[1] For more information: http://www.selcukartut.com/teaching/va555

early age, provides better care for children and teenagers with special requirements as well as makes them an active.[2]

In the first stage of the study mutual information presentations were made in order to enable Sabanci University team and Metin Sabancı team to move on a common platform. On 25 March 2011, the Sabancı University team talked about various examples already being implemented on Assistant Technologies and ideas they were developing.[3] After the presentations made Metin Sabanci TSCV was toured as a team, information were obtained from the trainers on various topics. At a joint meeting held with the participation of TSCV Board Member - Representative of the Foundation Sertan Özan and TSCV Service and Research Director Dr . Bülent Madi, a decision was taken to inform the TSCV Academic Board about the ongoing work. In addition, the necessity of the studies to be conducted with emphasis on the following criteria was accepted:

- The work and communication in harmony of the Trainers and the Physical Interaction Course team

- Measurable criteria of the studies to be done

- The equilibrium of virtual systems with children's perception of reality

- Determining the success criteria targeted for kids

On April 4, 2011 Banu Sözen of the TSCV (PSYCHOLOGICAL COUNSELING AND GUIDANCE), Ayça Atam (PSYCHOLOGY) made presentations telling ailments of the children with special needs.[4] At the meeting held after the presentation with the participation of teachers, a decision was agreed upon necessity of working with children living with CP.

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[2] http://www.tscv.org.tr/metin_sabanci_merkezleri.php (Retrieved 04/12/2013)
[3] To access sample videos: http://www.selcukartut.com/teaching/?p=297
http://www.selcukartut.com/teaching/?p=317
[4] To access sample videos: http://www.selcukartut.com/teaching/?p=306
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May 23, 2011 prototypes of the project prepared were shared with a small group of students at the TSCV. The pros and cons of the project have been observed. These problems and aspects that need improvement were identified.

On 15 June 2011 a well-attended presentation meeting was held where students and their families were present. Sabancı University team has applied the final state of the projects with the students; gave information to families and educators. For detailed information on the projects submitted can be found under the Projects title.

Projects

Project 1 : Computer Control with Camera Tracking– Farhood Negin[5]

Idea Development

Individuals with special needs in our society cannot enter into interaction with computer environment efficiently due to physical disabilities they have. In this project we have applied an imaging system that you can control your computer by using just body movements.

The system can identify a person with any internet camera (web cam) and the user can able the computer to follow any point of the body by selecting it as a reference point. After the aforementioned calibration the system becomes ready for use.

A variety of applications were tried to test the system at prototype stage. The result of the program that allows users to draw pictures using random colors was assessed as a successful application when interest of the children was considered.

[5] For video presentation of the project: http://www.selcukartut.com/teaching/?p=405

Figure 1 : Test phase with the Drawing Software

Technical structure of the Project

When developing the project various open-source software and technologies have been used. Web cam application was used for camera tracking, for eye and gaze tracking open source tracking application of the University of Copenhagen was used.[6] Processing[7] open source system was used for drawing pictures.

Testing Procedure and Results

When we tested our system with children living with CP necessity appeared to improve some points. While following the slow body movement system users could lose track due to contractions that can occur by sudden movements in children. Spending enough time with the system and experiencing the system of the children is

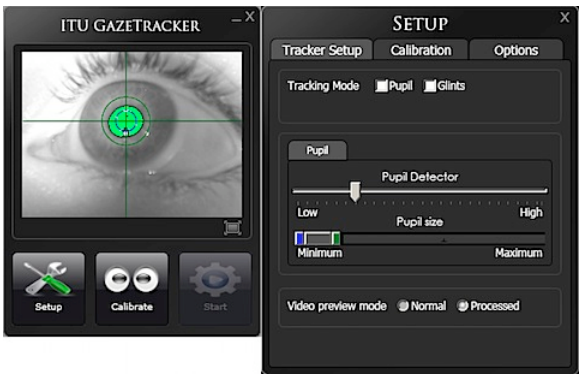


Figure 2 - ITU Gaze Tracker

[6] http://www.gazegroup.org
[7] http://www.processing.org

important in terms of development of their ability.

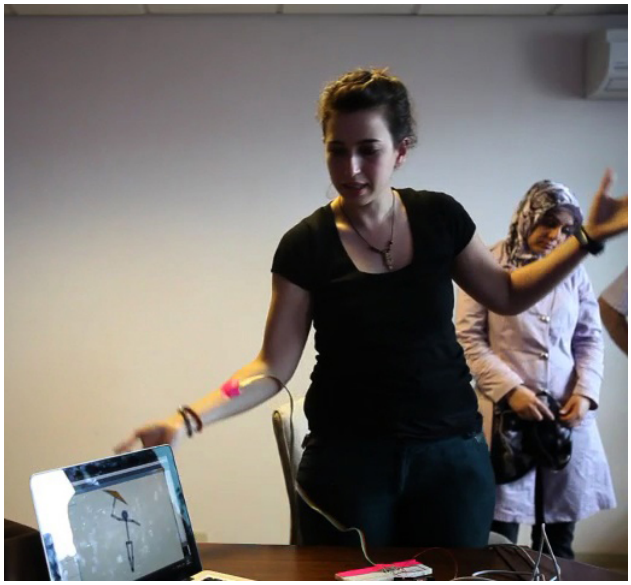
Future Studies

The project's first goal was to control the computer with eye movements, but considering the financial resources regarding the equipment supply it became necessary to move from eye-tracking to the body or head tracking system where cost-effective solution can be produced. When our technical facilities develop in the future we want to reconsider our initial target. We believe that the gaze tracking will provide important facilities for anyone with special needs for computer control. In this way it will be possible to provide opportunities to a wide audience.

Project 2 : Accelerometer T-Shirts: Balancing – Ceren Kayalar[8]

[8] For presentation of the video: http://www.selcukartut.com/teaching/?p=405

Idea Development



Children's accelerometer T-shirt project has evolved over the idea of a rehabilitation game that could help the childeren's balance work. The side idea was to make them to do things that they cannot normally do in everyday life – riding bike, rope acrobacy etc.- The process has evolved through various projects about the rehabilitation process of children that TSCV informed us and the purpose of the project was focused on the subjects to provide balance, especially forearm supination / pronation movements and fro movement of the body.

By using the system we have ensured simultaneous movements of a virtual character by following the movements of arm movements of the children by the acceleration sensor mounted externally to the arms of the children with movement disorder that use the system and transferring the data obtained to a computer. The instructor can also watch these body movements and direct the student. Other body movements could also be observed by replacing the accelerometer.

Technical structure of the project

The project foundationally had two phases as software and hardware. The system was planned to work as wireless in the final phase. A wired pre version of the system was developed in the first stage of hardware phase in order to make a study toward development later. In the wired version the accelerometer was taped on the user's forearm and the collected data were transferred to a computer via a microprocessor. When the user makes arm movements, the same movements could be observed that done by the on-screen virtual arm.

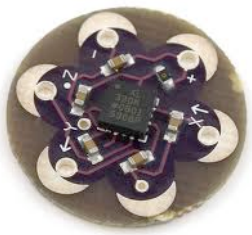


Figure 3 - Accelerometer

At the end of the tests done at TSCV the decision for the system to be developed in wearable and wireless capabilities in

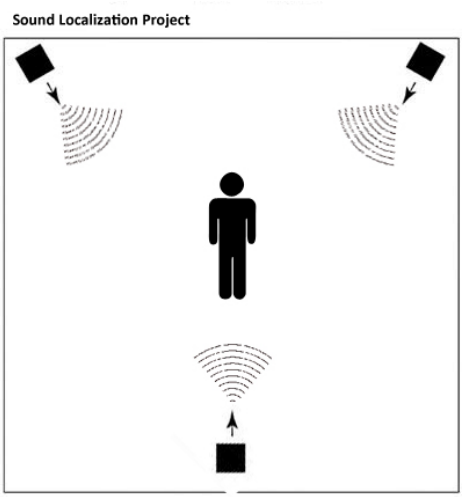
order to make users to be able to move freely was reached. In this way, as the second stage working system was designed as wireless and the accelerometer, data transfer unit, radio that allows wireless and battery unit was sewn to the T-shirt with conductive thread. At this point upper body movements were monitored by attaching the accelerometer to the elbow. When the children were leaning towards their right or left, the human visual was doing the same movements.

Figure 4 - Testing with Children

Future Studies

In the later stage of the project it was understood that battery structure forming the wireless system's power supply should be improved. Otherwise, it was observed that the present system drains the battery very quickly. Ideas such as the visible game part of the application on the screen to pick up free falling objects with the user's body movements would be useful to draw the attention of the children.

Project 3 : Where is this sound coming from? – İhsan Kehribar[9]



Idea Development

The idea of the project appeared at the introductory informative trip that we made to TSCV. We observed there wasn't any application regarding sound at the hearing room. In addition we were told that some children experienced problems in hearing and localizing sound. So it was determined that some problems arise in society regarding socialization. In particular necessity to localize and define the sound that came from hazards that may be around - for example a moving car - was discussed. It was decided to develop a system in this project that will enable children to localize a sound that can be checked by trainers through loudspeakers placed in the facility.

[9] For video presentation of the project: http://www.selcukartut.com/teaching/?p=405

Technical structure of the project

A sound system that can operate with any mp3 player with 3.5 mm audio input jack and that we can direct the sound to any one of the three separate loudspeakers placed in the facility by using simple buttons was developed as a prototype. The children were asked to know from which direction the sound was coming when various audio sounds played on the mp3 player by the trainer. In this way, a hide and seek game on sound has been developed. When the prototype produced tested with children at TSCV it was observed that the children were quite interested. Also the educators were able to easily provide training on sound localization.

Figure 5 - User Testing

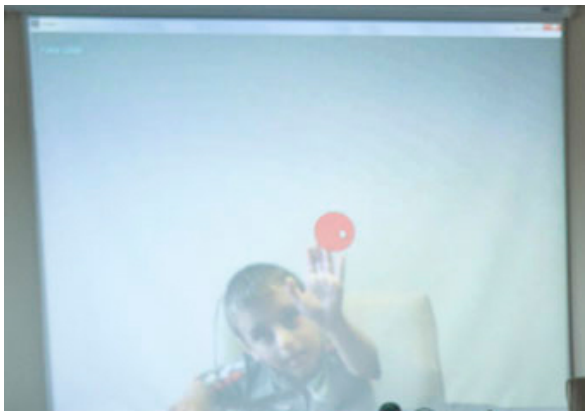
Future Studies

In the later stages the interface based on the electronic circuits can be mounted in a sturdy box where it will not take damage from vibration and shock and placed in the sensory room.

Project 4 : Catch the Ball – Murat Cansoy

Idea Development

Catch Ball Game that can be played with the entire body is a pretty simple game. Participants produce random notes by touching round colorful shapes they see on the screen. These shapes are either placed in the desired location on the screen by the trainer or they appear on the screen at random locations and speed depending on the difficulty variable.



The idea of the project was based on making motor movement exercises fun for the kids. In addition, to ensure the participants motivated while doing these movements was considered as an important criterion.

Technical structure of the project

Development of the project can be analyzed in two parts. In the first part, the mechanism of touching the round colorful shapes created on the screen has been resolved. We were able to detect touch by the background subtraction method which is the most common image processing method. After a shape appears on the screen, the screenshot is perceived as the background and removed from all subsequent frames. When the color value of the pixels at the area of the shape created changes over a certain level the system detects that there is movement in that area and interprets it as a touch on the shape on the screen.

In the second part of the project, game structure was created in various titles such as creating a score, producing different notes, development of different modes of play. Notes timbre character and tempo of the game in the note production were important points of the game in providing user motivation.

As a result of technical tests applied we observed that the game is easily played even with an average quality webcam. If a simple and poor quality camera is used, it is possible to implement the game by improving the lighting conditions of the room and simplifying the background. In the tests carried out on users, children in the 7-12 age

groups were observed to find the game fun and rewarding. In addition we have observed a lot more attention for older ages.

Future Studies

At the continuation of the project, development of visual effects and converting into a competition format may be possible. For example, instead of rounded shapes, visual materials such as mosquitoes or balloon may be used. Also recording of the notes produced, played later and users to control the notes might be considered in the development process.

Project 5 : Dum Tek – Serdar Hasan Adalı

Idea Development

Dum Tek project was designed to improve the coordination of children's rhythm.

Technical structure of the project

With piezoelectric sensors placed on any flat surface, interacting with Dum Tek is a fairly simple process. While any song is playing on a music system the sound

created by the users by hitting the desk transmitted to a computer and strong sound converted to dum and weak sound converted to tek creation of various percussion instruments such as cowbell and bongos is provided. Following of the song by the user is provided by visualizing the rhythm of the song with objects on the screen. To conform to the rhythm of the song the user is required to hit the surface at the right time. Whether its the correct timing or not is specified on the screen visually. It can be defined as a simpler version of the Guitar Hero.[10]

Future Studies

As a result of the tests we have performed with the children, the rhythm visualization portion of the project needs to be improved in terms of visual design to ensure children's concentration. Illustrated character shapes can be tried instead of round simple shapes.

It was also noted that the children needed a fun feedback when they were successful. In addition, the use of two hands can be evaluated in terms of the development of the project. Another option would be to give the users opportunity to change the game speed as they want.

[10] http://hub.guitarhero.com/

Project 6 : Fruit Picking – Servet Ulaş[11]

Idea Development

Fruit Picking Game is aiming to collect as much as possible of the various fruits by a bird flying in the sky in screenshot flowing sideways. There are no obstacles or losing in the game.

The game is played with a specially designed control device. A sphere object was used as the handler in this control device. The user can change the height of the bird by turning this sphere to right and left. Spheres of various sizes can be used and thus wrist and retention exercises of children living with CPU can be performed in different stages.

[11] For video presentation of the project: http://www.selcukartut.com/teaching/?p=405

Future Studies

The necessity of strengthening the hardware structure of the control arm used in the game and shock resistance against hard impacts arose. In later versions of the game informing players which fruits should be collected may add as different kind of fun to the game.

General Evaluation

The point the project has reached in a 2.5 months period carries the signal of promising developments. Curiosity of children for computers today is observed in a significant way. In all the projects we prepared we have tried to prevent isolation of children from their physical world conditions as much as possible. Today, its a fact that children continue their normal life in front of their computers and in a sense they create obstacles for themselves. In all the projects produced we have set target to ourselves to provide children to develop themselves according to their needs in real life.

In the scope of our project we think that we have staged important advances in an area that we didn't try before thanks to the warm information sharing with the TSCV Instructors. VA555 Physical Interaction courses students have involved in a real life issue in the scope of the course taken. It should be noted that no funding or financial support was used during the project. Our hope at the end of this effort which can be called as the first step of a larger project is recognition of the point we have reached by others and assisting institutions in research. Universities should act jointly in real-life projects.

It also should be noted that the projects produced as well as studies on the topic will create the opportunities for the business world in providing skilled labor in these matters. In addition projects converted to real life will be perceived by the community and these developments to increase visibility on the topic are inevitable.

References

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