ICDVRAT 2012

The 9th International Conference on Disability, Virtual Reality and Associated Technologies

10 – 12 September 2012
Laval, France

Book of Abstracts & CD Proceedings

Edited by

Paul Sharkey, Evelyne Klinger

The 9th International Conference on

Disability, Virtual Reality and Associated Technologies

Proceedings

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Evelyne Klinger

10 to 12 September, 2012

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The papers appearing in this book comprise the proceedings of the 9th International Conference on Disability, Virtual Reality and Associated Technologies, held between the 10th and 12nd of September, 2012 in the Laval, France. The papers presented reflect the authors' opinions and are published as presented and without change (formatting and minor editing excepted). Their inclusion in this publication does not necessarily constitute endorsement by the editors, ICDVRAT, or the University of Reading.

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Conference Schedule at a Glance

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08:30	Registration opens from 08:30
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09:30 – 10:30	Session I: Stroke Rehabilitation I
10:30	Coffee
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12:00 – 13:00	Session II: Cognitive Rehabilitation I
13:00	Lunch
14:30 – 15:45	Session III: Augmented Reality
15:45	Coffee
16:15 – 17:15	Session IV: Visual Impairment I
17:30 – 18:15	Session V: Hearing & Speech
20:00	Reception

Tuesday, 11 September, 2012

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13:00	Lunch
14:30 – 15:45	Session VIII: Design & Analysis
15:45	Coffee
16:15 – 16:45	Short Paper Podium Presentations
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c. 19:30	Coach departs for Banquet Venue

Wednesday, 12 September, 2012

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15:30	Coffee
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16:45	Conference Closed

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Short Papers

Internet address references within the papers presented in this volume were accessed and checked to be valid during the week 1–8 July 2012.

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Introduction

The purpose of the 9th International Conference on Disability, Virtual Reality and Associated Technologies (ICDVRAT 2012) is to provide a forum for international experts, researchers and user groups to present and review how advances in the general area of Virtual Reality can be used to assist people with Disability.

ICDVRAT is now in its 16th year, with biennial conferences in the series previously held in Maidenhead, UK (1996), Skövde, Sweden (1998), Alghero, Sardinia, Italy (2000), Veszprém, Hungary (2002), Oxford, UK (2004), Esbjerg, Denmark (2006), Maia & Porto, Portugal (2010) and Viña del Mar/Valparaíso, Chile in 2010.

After peer review process, the International Programme Committee selected 50 Full Papers for presentation at the conference, collected into 13 plenary sessions: Stroke Rehabilitation I & II; Cognitive Rehabilitation I & II; Augmented Reality; Visual Impairment I & II; Hearing & Speech; Motor Rehabilitation; Training & Assessment I & II; Design & Analysis; and Interfacing to Virtual Environments. There will be an additional 28 Short Papers presented at a Poster Session. The conference will be held over three days between the 10th and 12nd September at the Hotel Périer du Bignon, Laval, France.

For the 2012 conference, there will be two keynote addresses, the first from Pierre-Alain Joseph addressing the issues of virtual reality for cognitive rehabilitation, and the second from Alma Merians on the topic of movement rehabilitation.

Abstracts from this conference and full papers from the previous conferences are available online from the conference web site *www.icdvrat.org*. We are also pleased to be able to provide the complete ICDVRAT archive on CD-ROM with this volume.

Acknowledgements

The Conference Chairs would like to thank the Programme Committee, for their input regarding the conference format and focus, and for their commitment to the review process, as well as the authors of all the papers submitted to the conference, the Organization Committee, Conference Sponsors, and the students who help out over the period of the conference.

On behalf of ICDVRAT 2012, we welcome all delegates to the Conference and sincerely hope that delegates find the conference to be of great interest.

Evelyne Klinger and Paul Sharkey

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and

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The organisers wish to express their gratitude to the other major sponsors of the conference:

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International Society for Virtual Rehabilitation

Additional help in publicising the conference has been gratefully received from vrpsych-l@usc.edu, amongst many others.

ICDVRAT is a biennial conference of the International Society for Virtual Rehabilitation. The ISVR is the sponsor of the conference Best Student Full Paper and Best Student Short Paper awards.

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Laval ~ Town of Art and History

Evelyne Klinger

Arts et Métiers ParisTech, FRANCE

Classified as a town of art and history, thanks to its rich cultural heritage, Laval is the principal city of the Mayenne department in north-western France. Built around its castle, in the 11th century, Laval has still many of its fortifications intact, and the great chateau, with its distinctive round tower, remains an impressive sight. The River Mayenne runs beside the town and much of the life of Laval centres on this lovely river, especially in the summer. All around the town is the gentle, pastoral landscape of the region, whose rolling fields, pretty woodland and tranquil lakes all set the tone for this peaceful, friendly capital city.

Laval has stood here on the banks of the Mayenne, on the threshold of Brittany, between Normandy and Anjou, for almost a thousand years.

The old castle, around which the town of Laval grew, was built early in the 10th century by Guy II, one of the first lords of Laval. The lords, and later the counts, of Laval, among whom were the Montmorencys and the Montforts, played a prominent role in French history. After the French Revolution the counterrevolutionary Vendéen army, during the Wars of the Vendée at the end of the 18th and beginning of the 19th centuries, twice captured the castle from the Republicans. When the Republicans crushed the insurgents they executed the Prince de Talmont, lord of Laval and general of the Vendéen cavalry, in front of the castle gates.

The old quarters of the town, which have fine 16th- and 18th-century houses, two châteaux, mediaeval walls and gateways are located on the west bank slopes of the Mayenne River and are surrounded by the modern town on both sides of the river. The old castle of the counts of Laval, a medieval stronghold, has been restored and houses the Laval Museum of Naive Art, the finest collection of naive art in Europe. This is a fitting posthumous tribute to one of Laval's sons, the painter *Douanier Rousseau*. The Château Neuf (New Chateau), a Renaissance building also called the Gallery of the Counts of Laval, was restored and enlarged in the 19th century to become the Palais de Justice. The Cathedral of the Trinity with its interesting wall paintings and stone carvings, dating partly from the 11th century, has been considerably reconstructed and enlarged. Then there is the beautiful Basilica Notre Dame d'Avesnieres, notable for its magnificent steeple, and the Perrine Gardens where you will have a beautiful view of the river and the castle. Here you can visit the Alain Gerbault Centre, a tribute to the Laval-born navigator, with the replica of his boat, "the Firecrest", and then the Douanier Rousseau grave. Also well worth a visit are the imposing Porte Beucheresse, which was the gate out of town towards Brittany, and the Maison du Grand Veneur (Head Huntsman's House) at the top of the Grande Rue.

An Active Country Town

Today, Laval still plays the role of a regional market town and administrative centre, but industry has also developed, including the manufacture of machinery, electronics, plastics, and Virtual Reality. Indeed, the town of Laval has developed an academic and industrial technology centre that is at the very forefront of research into virtual reality. Every year the 'Laval Virtual' exhibition attracts specialist companies from all over the world. And on the days when Laval Virtual is open to the public, crowds of visitors come to see the latest virtual reality innovations. When you visit Laval's castle, you'll see an impressive application of this research: a virtual reconstruction of Laval in 1750.

At Laval you are never far from Nature, and the Museum of Milk will take you right to the heart of the French tradition of milk production. This is the world's largest milk and cheese museum, and the museum's ultra-modern, 5,000 square metre exhibition area will give you a full picture of all the different business activities related to milk.

Mayenne, France

Mayenne is a department in northwest France named after the Mayenne River, and is part of the region of Pays de la Loire. Bordered by the rocks and wooded hills of Alpes Mancelles in the north and the huge Parc Naturel Regional de Normandie et Maine, there is an abundance of wildlife and outdoor pursuits close by. The Mayenne River offers an abundance of activitie. From Ambrieres-les-Vallee in the north to Daon in the south, the meandering Mayenne has 85km of towpaths ideal for hikers, mountain bikers and horse riders. Unsurprisingly Mayenne is a fisherman's paradise with 4,500 kilometres of rivers. Kayaking, rambling, cycling and bird-watching are pleasant activities along the meandering river, woodlands and agricultural countryside renowned for its cheese and apples.

Virtual reality for cognitive rehabilitation: from new use of computers to better knowledge of brain black box?

P-A Joseph, J-M Mazaux, E Sorita

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ABSTRACT

Virtual reality based technologies are one of the emerging tools that appear to have great potential for use in cognitive rehabilitation but it still is unclear how brain capacities are involved and what is the best approach to such training. At first, virtual reality was mainly used in single user virtual environments, but social interaction should also be addressed using collaborative virtual environments (CVE). In a CVE, multiple users can interact and collaborate with each other, solve complex tasks and learn with each other. Regarding to impact of behavioral disturbances in family stress and social re-entry, such tools need to have a wider use in future years.

Quantitative aspects are encouraging as some improvement have been shown after few training sessions. Home retraining or telerehabilitation based on VR may bridge the gap between lack of specialized resources and growing number of patients. Qualitative design of VR tools is more questionable. Choice of errorless or errorfull designs may depend on the severity of disturbances. Most VR tools emphasize the explicit component of tasks, even procedural aspects are a main strength of VR retraining programs. VR and augmented reality tools give various stimuli and indicators but their best modalities stay unclear, as most data are coming from learning studies in normal subjects more than rehabilitation studies in brain injured patients. Specific research studies to explore impact of sensorial transmodal effects and emotional involvement in VR tasks are requested. Rehabilitation protocols utilizing virtual environments are moving from single applications to cognitive impairment (i.e. alert, memory, neglect, language, executive functions) to comprehensive rehabilitation programs with the aim of efficient improvement in autonomy and transfer of benefits in real life conditions. A core issue that presents challenges to rehabilitation is decreased ability of persons with brain injury to transfer learning from one situation or context to another. The multicontext approach to cognitive rehabilitation proposes treatment methods for teaching use of strategies across a wide range of meaningful activities to promote generalization and enhance functional performance.

VR offers a very promising and exciting support for cognitive rehabilitation but we have to move from mimicking "in room" or desk rehabilitation practice to specific VR programs to maximize benefits and to get optimal improvement in cognitive and behavioral autonomy of patients.

Movement rehabilitation in virtual reality from then to now: how are we doing?

A S Merians, G Fluet, E Tunik, Q Qiu, S Saleh, S Adamovich

University of Medicine and Dentistry of New Jersey, USA

New Jersey Institute of Technology, USA

ABSTRACT

During the past decade there has been a continuous exploration of how virtual environments can be used to facilitate motor recovery and relearning after neurological impairment. The goals for using virtual environments have been to either improve patients' rehabilitation outcomes beyond our current capabilities, or to supplement labor intensive and time consuming therapies with technology based interventions. After over a decade of investigation it seems appropriate to determine whether we are succeeding in meeting our goals.
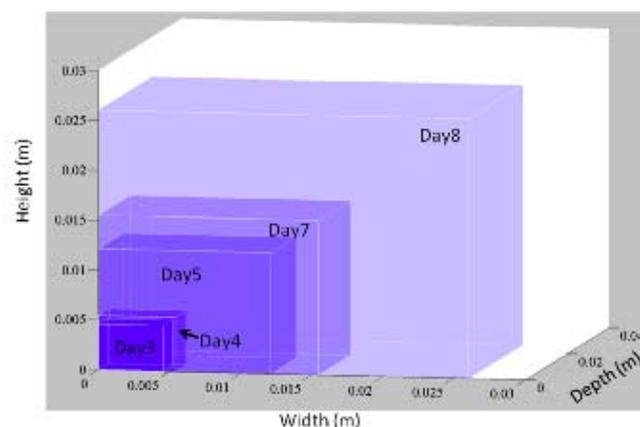
Figure 1. *Workspace expands gradually and continuously throughout the training period.*

Robotic/virtual reality intervention program individualized to meet the specific sensorimotor impairments of an individual patient: a case study

G G Fluet, A S Merians, Q Qiu, S Saleh, V Ruano, A R Delmonico, S V Adamovich

University of Medicine & Dentistry of New Jersey, USA

New Jersey Institute of Technology, USA

ABSTRACT

A majority of studies examining repetitive task practice facilitated by robots for the treatment of upper extremity paresis utilize standardized protocols applied to large groups. Others utilize interventions tailored to subjects but don't describe the clinical decision making process utilized to develop and modify interventions. This study will describe a virtually simulated, robot-based intervention customized to match the goals and clinical presentation of a gentleman with upper extremity hemiparesis secondary to stroke. MP, the subject of this case, is an 85 year-old man with left hemiparesis secondary to an intracerebral hemorrhage five years prior to examination. Outcomes were measured before and after a one month period of home therapy and after a one month virtually simulated, robotic intervention. The intervention was designed to address specific impairments identified during his PT examination. When necessary, activities were modified based on MP's response to his first week of treatment. MP's home training program produced a 3 second decline in Wolf Motor Function Test (WMFT) time and a 5 second improvement in Jebsen Test of Hand Function (JTHF) time. He demonstrated an additional 35 second improvement in JTHF and an additional 44 second improvement in WMFT subsequent to the robotic training intervention. 24 hour activity measurement and the Hand and Activities of Daily Living scales of the Stroke Impact Scale improved following the robotic intervention Based on his responses to training we feel that we have established that, a customized program of virtually simulated, robotically facilitated rehabilitation was feasible and resulted in larger improvements than an intensive home training program in several measurements of upper extremity function in our patient with chronic hemiparesis.

Figure 5. *Subject performing Cup Reaching simulation.*

Can a home based virtual reality system improve the opportunity for rehabilitation of the upper limb following stroke?

P J Standen, K Threapleton, L Connell, A Richardson, D J Brown, S Battersby, F Platts

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Erewash Community Occupational Therapy Service, Derbyshire, UK

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Sherwood Forest Hospitals NHS Foundation Trust, Nottinghamshire, UK

ABSTRACT

Many stroke survivors fail to regain functional use of their impaired upper limb yet access to the rehabilitation required is limited. One route through which this may be achieved is through the adoption of virtual reality and interactive video gaming. We have been developing a home based system that employs infra red capture to translate the position of the hand, fingers and thumb into game play but do the patients actually use it to the recommended level and if not, why not? Performance data collected by the software from three participants allocated to the intervention group in a feasibility RCT indicate that the pattern of play is variable and can fall far short of the recommendations participants were given. Interviews with participants at the end of the intervention and observations by the research team indicate the barriers to recommended use but also some of the characteristics of the intervention that demonstrate its potential for improving the opportunity for rehabilitation of the upper limb following stroke.
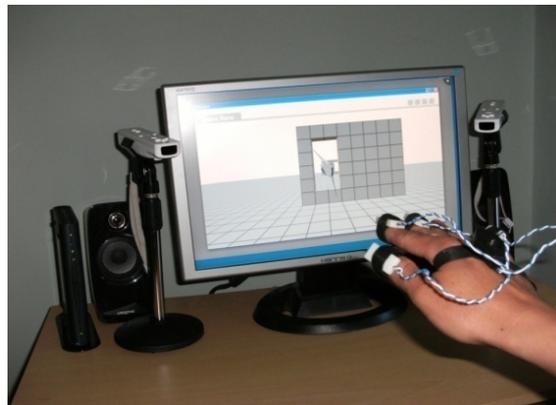
Figure 1. *The virtual glove.*

Development and validation of tele-health system for stroke rehabilitation

P L Weiss, R Kizony, O Elion, S Harel, I Baum-Cohen,
T Krasovsky, Y Feldman, M Shani

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University of Haifa, ISRAEL

Sheba Medical Center, Tel Hashomer, ISRAEL

McGill University, Montreal, CANADA

ABSTRACT

Tele-rehabilitation refers to the use of information and communication technologies to provide rehabilitation services to people in their homes or other environments. The objective of this paper is to present the development, validation and usability testing of a low-cost, markerless full body tracking virtual reality system designed to provide remote rehabilitation of the upper extremity in patients who have had a stroke. The Methods and Results sections present the progress of our work on system development, system validations and a feasibility/usability study. We conclude with a brief summary of the initial stages of an intervention study and a discussion of our findings in the context of the next steps. The validation study demonstrated considerable accuracy for some outcomes (i.e., shoulder "pitch" angle, elbow flexion, trunk forward and side-to-side deviation). In addition positive responses were received from the clients who participated in the feasibility study. We are currently at the process of improving the accuracy of the system as well as conducting a randomized clinical trial to assess the effectiveness of the system to improve upper extremity function post-stroke.

Figure 2. *Screenshot showing the Hamburger short order cook task. The client's order is specified in the conversation balloon and the ingredients are listed to the right of the screen. The top shelf is adjustable to make selections harder or easier.*

Using a virtual supermarket as a tool for training executive functions in people with mild cognitive impairment

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Sheba Medical Center, Tel Hashomer, ISRAEL

School for Special Education, Tzohar Le'Tohar, Rechasim, ISRAEL

Carmel Medical Center, Haifa, ISRAEL

Arts et Métiers ParisTech Angers-Laval, FRANCE

ABSTRACT

Cognitive and executive functions (EF) intervention programs for people with mild cognitive impairment (MCI) has not been studied enough, especially with the use of virtual reality. The purpose of the current study was to examine the effectiveness of using the Virtual Action Planning – Supermarket (VAP-S) to improve performance of a shopping task and EF among people with MCI. Seven participants with non-amnestic or multi-domain amnestic MCI completed the study protocol which followed an ABA single subject design. The outcome measures included the Multiple Errands Test (MET) to assess EF while performing a shopping task and the WebNeuro to assess EF impairments. Results showed that 4 participants improved their EF as assessed by the WebNeuro and 4 improved their performance of the shopping task in the MET. It seems that in some cases a learning effect occurred which explains why some of the participants did not improve. The results point to the potential of using the VAP-S as an intervention tool for training EF in people with MCI.

Rehabilitation tools along the reality continuum: from mock-up to virtual interactive shopping to a living lab

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Sheba Medical Center, Tel Hashomer, ISRAEL

McGill University, Montreal, CANADA

Jewish Rehabilitation Hospital, Laval, Quebec, CANADA

ABSTRACT

The purpose of this study was to compare shopping performance using the 4-item test, between three types of environments; a real environment (small, in-hospital "cafeteria"), a store mock-up (physical simulation) and a virtual environment (Virtual Interactive Shopper-VIS), in a post-stroke group compared to a control group. To date, 5 people with stroke and 6 controls participated in the study. Participants performed the original 4-item test ("buy" 4 items) in the VIS and the store mock-up as well as a modified 4-item test ("buy" 4 items with budget constraints) in all three environments. Results were analyzed descriptively and findings to date, indicate that the post-stroke group performed more slowly than the control group. In addition, in both groups, the time to complete the test within the VIS was longer than in the store mock-up and the cafeteria. Performance in the VIS, the store mock-up and the cafeteria were correlated in the post-stroke group. Finally, participants' responses to their experience in the VIS were positive. The preliminary results of this small sample show that the test within the VIS is complex and realistic and may be used to assess and train the higher cognitive abilities required for shopping.
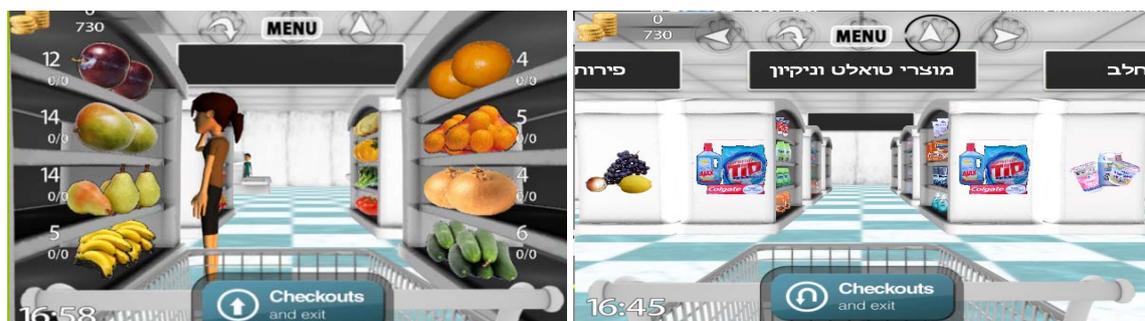
Figure 1. *Two screenshots of the Virtual Interactive Shopper (VIS).*

So much technology, so little time: factors affecting use of computer-based brain training games for cognitive rehabilitation following stroke

B B Connor, P J Standen

Sierra Nevada Memorial Hospital, Grass Valley, CA, USA

University of Nottingham, UK

ABSTRACT

Rehabilitation following stroke typically focuses on regaining use of the affected lower and upper limbs. Impairment of cognitive processes, however, is predictive of rehabilitation outcomes. Stroke survivors and their caregivers report difficulty finding time to practice gait and upper limb training at home due to the time demands of routine activities of daily living (ADL), leaving little time for cognitive retraining. Cognitive activities have become more readily accessible to the home user through web-based games that engage brain functions often disrupted by stroke. With neuropsychological testing, it is possible to "prescribe" brain training that targets the specific cognitive functions disrupted by an individual's acquired brain injury. We asked if computer-based braining training were made available in-home at no cost, would stroke survivors complete the training? Five stroke survivors participated, none completed the recommended 40 training sessions. Interviews with participants and caregivers reveal barriers to training including physical and cognitive limitations, as well as time and fatigue management. Training also showed effects on ADLs and mood.

Figure 1. *Familiar Faces. This game involves the user working as a server in a seaside restaurant. Each visitor has a name and places an order. The server must remember the orders and customer's names to earn a large tip. The game exercises associative memory for verbal and visual information. As performance on the task improves, more characters and more complicated orders are presented. The user must remember names within session and from previous sessions. This screen shot appears courtesy of* [Hardy & Scanlon, 2009].

3D augmented reality applied to the treatment of neuropathic pain

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Erasme Hospital, Brussels, BELGIUM

ABSTRACT

Neuropathic pain is characterized by a permanent or recurrent background pain including stinging, tingling, allodynia, burning, shock or stabbing sensations. It significantly alters the patient quality of life. Such painful conditions are observed in the case of phantom limb pain (PLP) and complex regional pain syndrome (CRPS), and are difficult to treat effectively. Recent studies show the crucial role of the central nervous system in these pathologies and suggest a link to the plasticity of the latter. Mirror visual feedback (MVF) is often used in case of amputation, CRPS or stroke to restore normal cortical organization and to lower pain intensity. We have conceived an augmented reality (AR) system that applies the principle of MVF without requiring the use of a physical mirror. The system strengthens the patient's immersion and concentration by using realistic, natural looking 3D images that are acquired, processed and displayed in 3D, in real time. Our system is based on standard inexpensive hardware and is easy to install and to use. This makes it perfectly suitable for use in a therapist's practice or at home. The preliminary results of clinical tests show that the system can significantly reduce the pain, after only a few training sessions.
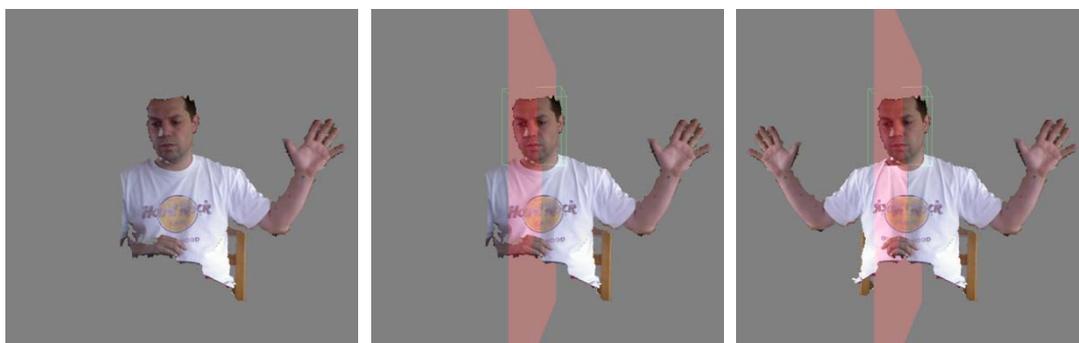
Figure 1. *Application of a virtual mirror to a 3D image. The left part shows the original image. In the middle part we see the virtual mirror in pink and the safe zone in green. The right part shows how the 3D mesh that is on the right side of the mirror is duplicated symmetrically to the left side, except inside the safe zone.*

Augmented reality improves myoelectric prosthesis training

F Anderson, W F Bischof

University of Alberta, Edmonton, CANADA

ABSTRACT

This paper presents the ARM Trainer, a new augmented reality-based system that can be used to train amputees in the use of myoelectric prostheses. The ARM Trainer provides users with a natural and intuitive method to develop the muscles used to control a myoelectric prosthetic. In addition to improving the training process, the new interface has the potential to mitigate psychological issues arising from amputation that are not addressed by existing approaches (e.g., self-image, phantom limb pain). We conducted an empirical study comparing our system to an existing commercial solution (Myoboy) and found the ARM Trainer to be superior along a number of subjective dimensions (enjoyment, perceived effort, competency, and pressure). We also found no significant difference in terms of muscle control development between the two systems. This study shows the potential of augmented reality-based training systems for myoelectric prostheses.
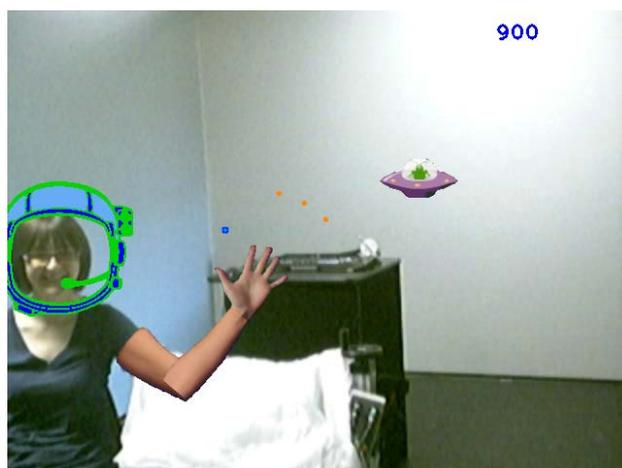
Figure 1. *The ARM Trainer system, as displayed to the user.*

Development of an augmented treadmill for the rehabilitation of children with cerebral palsy: pilot perspectives from young healthy adult users

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ABSTRACT

A Real-time Treadmill Speed Control Algorithm (RTSCA) has been developed for gait rehabilitation of children with cerebral palsy (CP). The objective of the work described in this paper was to investigate the feasibility of the RTSCA prior to use by children with CP. Thirteen healthy subjects aged between 19 and 25 were recruited to walk on the treadmill using conventional speed buttons without the virtual reality (VR) environment, and the RTSCA with and without VR. The participants were asked to undertake three treadmill tests and to complete a questionnaire to provide feedback on the control of the treadmill. The descriptive results show that for 10 participants changing walking speed from stationary when using the RTSCA was similar or more comfortable to using conventional treadmill speed control buttons. For those who found it less comfortable the core issue was insufficient time to practise with the system. All the participants were satisfied with the safety and the performance of the RTSCA when incorporated into the VR scenario. A Wilcoxon test was conducted to examine whether there was a significant difference between walking speeds on the treadmill when using the conventional speed buttons and the RTSCA. The results showed that participants walked at significantly higher speeds when using the RTSCA. This may suggest that they walked more naturally or confidently on the treadmill when using the RTSCA as compared to the use of conventional treadmill speed control buttons.
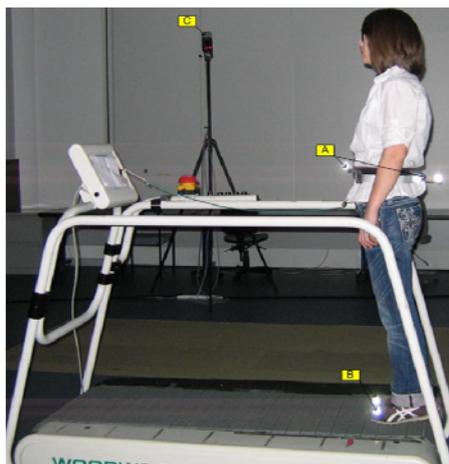
Figure 2. *A participant using the RTSCA. A: pelvis cluster – a sprung loaded frame with 3-point contact to calculate the origin of the pelvis segment; B: markers on feet; C: one of the eight motion capture cameras used.*

Mathematical literacy for everyone using arithmetic games

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ABSTRACT

An innovative mathematics game shown to be effective for low-achieving mainstream students is tested in special education for learners with intellectual disabilities. The game relies on a graphical, intuitive representation for numbers and arithmetic operations to foster conceptual understanding and numbers sense, and provides a set of 2-player games to develop strategic thinking and reasoning skills. The game runs on computers and interactive white boards, and as an augmented reality application at a science centre. We compare its use in special education and mainstream education with respect to usage, performance levels and learning gain. The game has been used by teachers in special educations, with gains in mathematical understanding, strategic thinking and communication skills as effects.
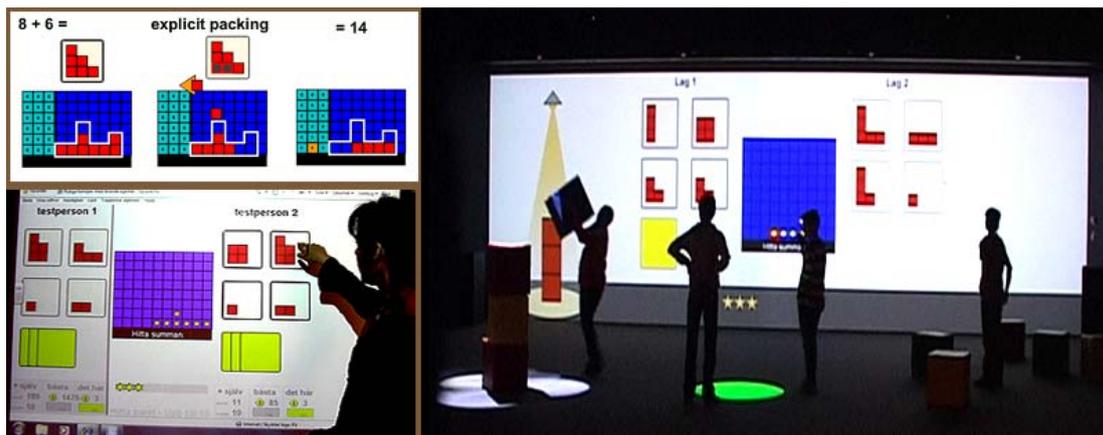
Figure 3. *Explicit carrying operation as packing blocks into boxes (top left), game on interactive white board (bottom left) and game as augmented reality application in science center (right).*

Fitness improved for individuals post-stroke after virtual reality augmented cycling training

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Northeastern University, Boston, MA, USA

VRehab LLC, USA

ABSTRACT

A virtual reality (VR) augmented cycling system was developed to address motor control and fitness deficits. In this paper we report on the use of the system to train fitness for individuals (N=4) in the chronic phase post-stroke who were limited community ambulators. Fitness was evaluated using a sub-maximal bicycle ergometer test before and after training. There was a statistically significant 13% (p = .035) improvement in VO_2 (with a range of 6-24.5 %). For these individuals, VR augmented cycling, using their heartrate to set the avatar's speed, fostered training of sufficient duration and intensity to promote fitness.
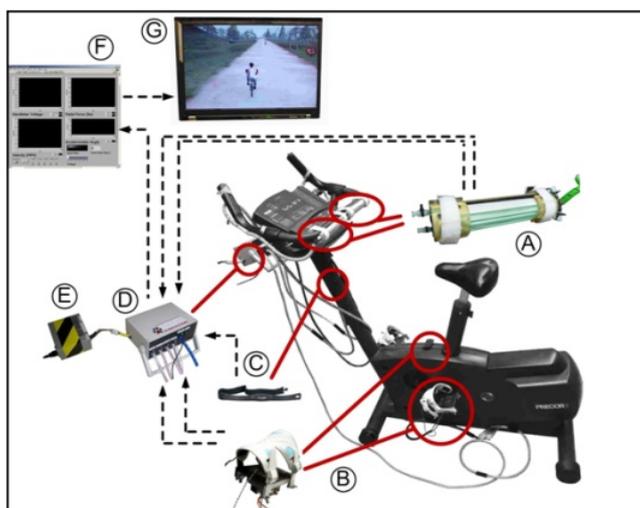
Figure 1. *Virtual Reality Augmented Cycling Kit (VRACK): A: Sensorized handle bars, B: Sensorized pedals, C: Heart Rate sensor and monitor D: Controller E: Power source F: Practitioner interface (where the target heart rate is set) G: Virtual Environment.*

Haptic presentation of 3D objects in virtual reality for the visually disabled

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ABSTRACT

The paper presents an initial research on haptic perception of 3D objects in a virtual reality environment for aiding the visually disabled persons in learning new routes and obstacle identification. The study spans a number of fields, from the very technical, such as scene segmentation and obstacle detection algorithms to psychological aspects such as the effectiveness in utilizing haptic information. The authors constructed a prototype system for the tactile presentation of real objects in a virtual reality.

a)   b)   c)
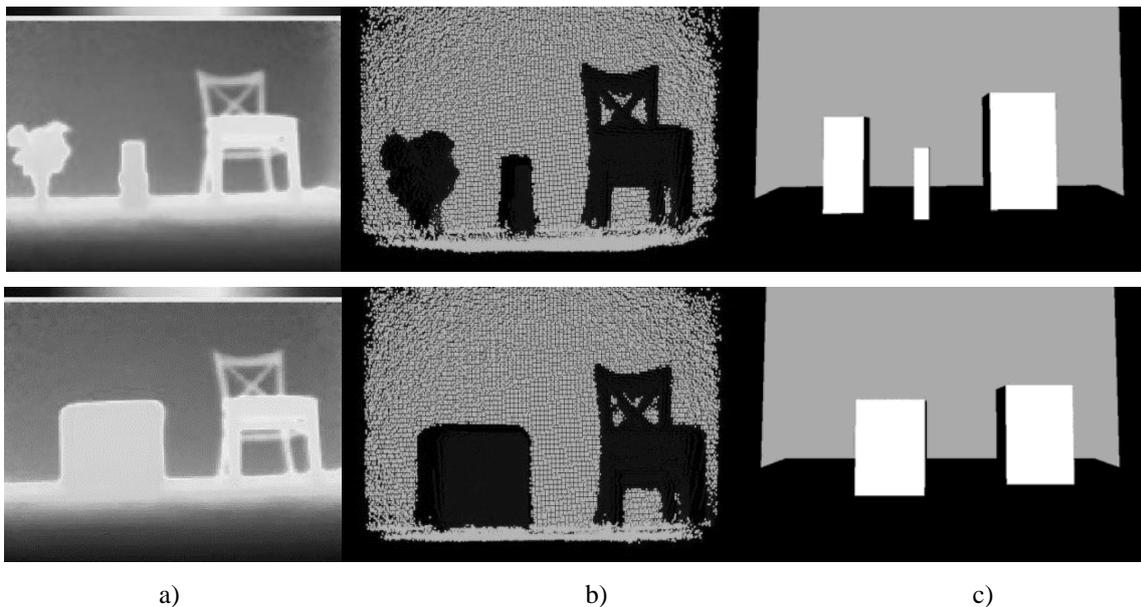
Figure 3. *The virtual scene modeling process: a 2.5D depth map of the scene a), the segmented scene b) (grey – found planes, black – found obstacles), the reconstructed scene for the tactile presentation c) (the obstacles are replaced by cubes, see the text).*

When sighted people are in the skin of visually impaired ones: perception and actions in virtual reality situation

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ABSTRACT

Most of us do not know how a visually impaired person perceives and acts within the environment in everyday life. In this context, an experimental study was conducted using a virtual reality simulation in which sighted people were immersed in low vision situations: Blurred vision, Tunnel vision, central Scotoma. After a brief familiarization procedure with a virtual reality tool called "SENSIVISE" which includes a virtual apartment, 24 adults had to explore two rooms through low vision simulation or full vision (as control group) to identify their location, and then were instructed to find particular targets. Perception and actions performances were measured in terms of time needed to answer questions related to visual perception, and distances between the participants' body and the screen. The results show that low vision simulation impairs perception among sighted people. It was expressed by a statistically significant effect of lower times needed to execute tasks compared to the control condition. Consequently, the sighted individuals realized how it is difficult to perceive and move when vision is limited.

a)   b)
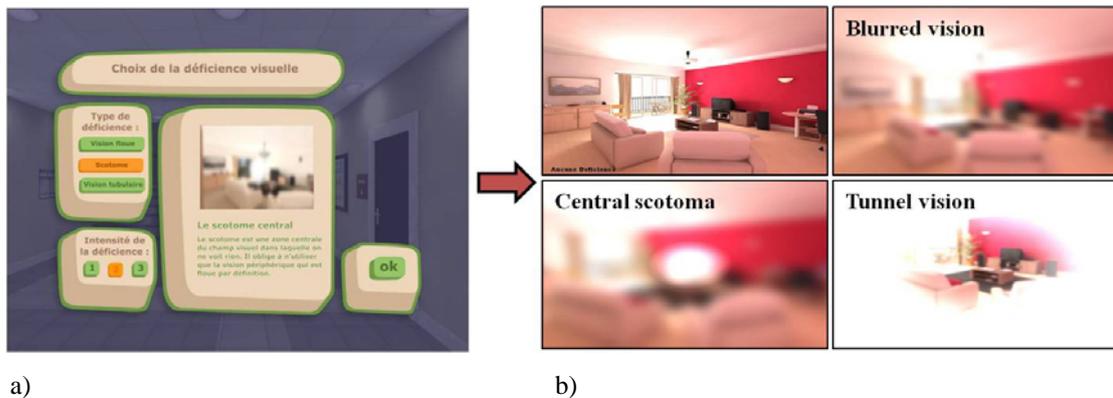
Figure 1*: A snapshot of the environment. a) allows to choose form and intensity of low vision displayed (on the left); and concurrently inform about the selected form (on the right); b) results of the three simulations; Control condition and Blurred vision on the left and right top respectively; central Scotoma and Tunnel vision down left and right respectively.*

Dynamic spatial positioning system based on sounds and augmented reality for visually impaired people

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ABSTRACT

This paper presents an application which intends to exercise spatial association of a three dimensional stimulus with its corresponding motor feedback, inspired on the Ping Pong Game. The application uses a low cost and easily built artifact, enhanced with an augmented reality layer provided by a free authoring tool. The augmented reality resources empower the artifact with sound feedback, so visually impaired people can use it. Besides, the visual feedback can be useful for non-visually impaired people and also for therapists, who can prepare exercises, promoting a therapeutic application and involving social inclusion capabilities.
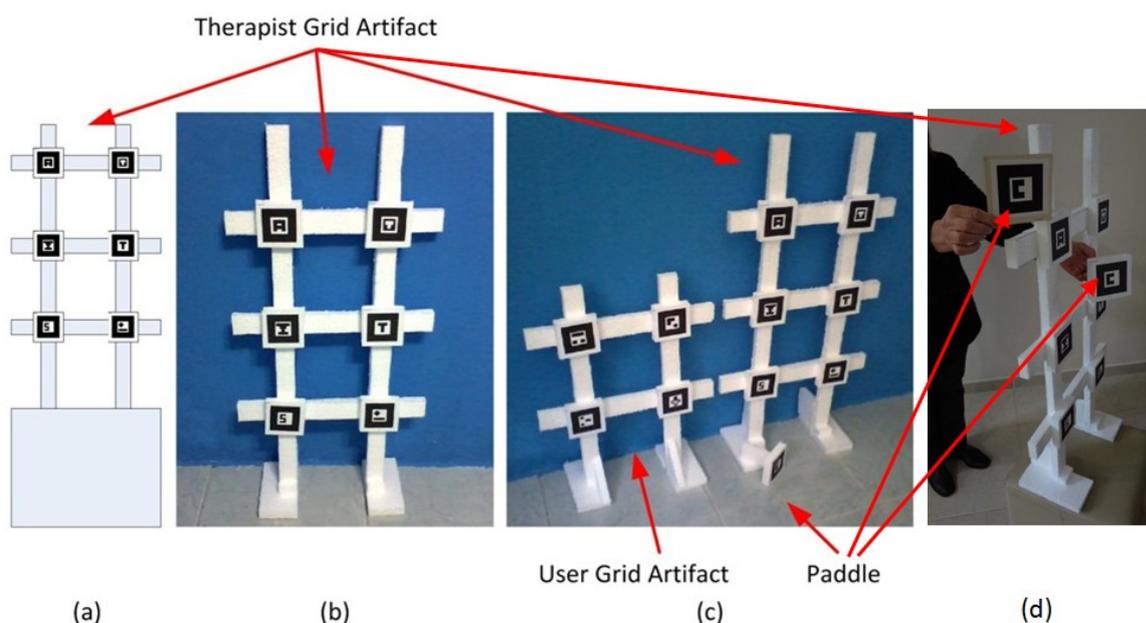
Figure 4. *Artifact Views: (a) Conception; (b) Therapist; (c) User and Therapist; (d) Prototype in action.*

Videogaming for wayfinding skills in children who are blind

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Pontifical Catholic University of Valparaíso, Viña del Mar, CHILE

ABSTRACT

There are several problems faced by people who are blind when navigating through unfamiliar spaces, and especially open spaces. One way to mitigate these problems is by getting to know the spaces prior to actual navigation, through the use of virtual environments represented through audio and haptic interfaces. In exploring the possibilities for further improving navigation through such spaces; it was especially interesting to study the option of simulating the real body movement of a learner who is n during his interaction with a virtual environment. To achieve this the design, implementation and impact evaluation of an audio and haptic-based videogame called MovaWii is proposed, in which a real physical space is represented virtually, where learners who are blind interact through their own body movements and use of the Wiimote controllers of the Nintendo Wii console in order to navigate through unknown virtual spaces. The results demonstrated a videogame that allows for the development of orientation and mobility skills in learners who are blind, as it serves as a supporting tool for the construction of a mental map of the virtual space navigated through the integration of its audio and haptic components. In addition, learners could transfer the information obtained from virtual to the real world physical space, through which they were then able to navigate autonomously and efficiently.
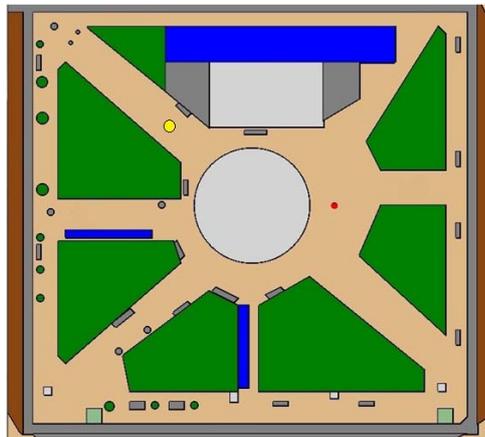
Figure 2. *Graphic interface of the videogame.*

Appreciating speech through gaming

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University of the Philippines Diliman, Quezon City, PHILIPPINES

ABSTRACT

This paper discusses the Speech and Phoneme Recognition as an Educational Aid for the Deaf and Hearing Impaired (SPREAD) application and the ongoing research on its deployment as a tool for motivating deaf and hearing impaired students to learn and appreciate speech. This application uses the Sphinx-4 voice recognition system to analyze the vocalization of the student and provide prompt feedback on their pronunciation. The packaging of the application as an interactive game aims to provide additional motivation for the deaf and hearing impaired student through visual motivation for them to learn and appreciate speech.
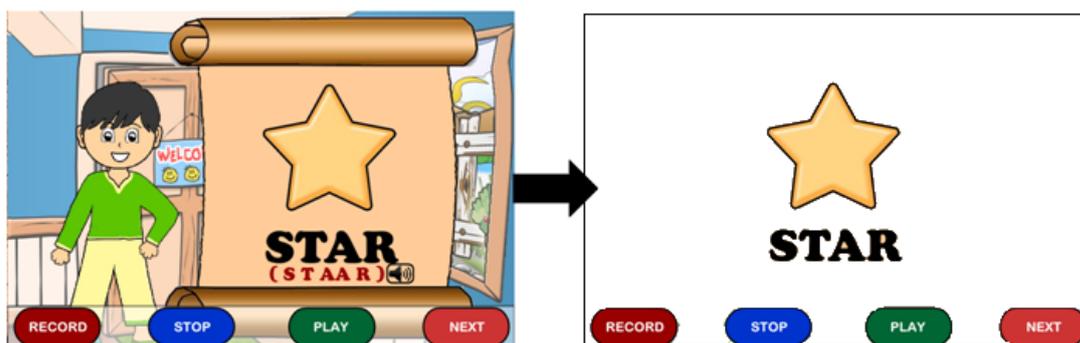
Figure 4. *Proposed simpler interface.*

Helping deaf and hard-of-hearing people by combining augmented reality and speech technologies

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ABSTRACT

Recently, many studies have shown that the Augmented Reality (AR), Automatic Speech Recognition (ASR) and Text-to-Speech Synthesis (TTS) can be used to help people with disabilities. In this paper, we combine these technologies to make a new system, called "ASRAR", for helping deaf people. This system can take a narrator's speech and convert it into a readable text, and show the text directly on AR displays. Since most deaf people are unable to make meaningful sounds, we use a TTS system to make the system more usable for them. The results of testing the system show that its accuracy is over 85 percent, using different ASR engines, in different places. The results of testing TTS engines show that the processing time is less than three seconds and the spelling of correct words is 90 percent. Moreover, the result of a survey shows that more than 80 percent of deaf people are very interested in using the ASRAR system for communication.
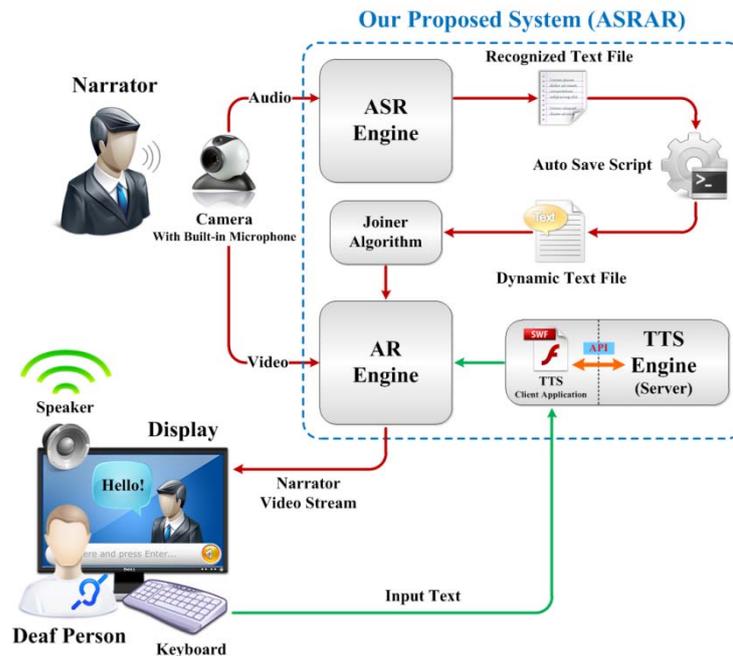
Figure 2. *The ASRAR system structure.*

Evaluation of the prototype mobile phone app *Pugh*: a 3D cartoon character designed to help deaf children to speech read

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German Aerospace Center, Simulation and Software Technology, Brunswick, GERMANY

ABSTRACT

Pugh, a 3D cartoon character, is a prototype smartphone application developed at the University of Salford. Its purpose is to provide speech-reading exercises for hard of hearing and deaf children. This paper discusses the design of the application, the test process and acknowledges that the technological limitations of the platform and the character's non-human characteristics provide some interesting challenges. A preliminary test was conducted to evaluate speech perception and lipreading from *Pugh*. The findings proved that *Pugh* is not an accurate speaker. Further development of the lip movement and facial expressions is required in order to achieve accuracy.

Figure 1. *A screenshot of Pugh as he appears in the iPhone application*

Web-based home rehabilitation gaming system for balance training

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ABSTRACT

Currently, most systems for virtual rehabilitation and motor training require quite complex and expensive hardware and can be used only in clinical settings. Now, a low-cost rehabilitation game training system has been developed for patients with movement disorders; it is suitable for home use under the distant supervision of a therapist. It consists of a patient-side application installed on a home computer and the virtual rehabilitation Game Server in the Internet. System can work with different input gaming devices connected through USB or Bluetooth, such as a Nintendo Wii balance board, a Nintendo Wii remote, a MS Kinect sensor, and custom-made rehabilitation gaming devices based on a joystick. The same games can be used with all training devices. Assessment of the Home Rehabilitation Gaming System for balance training was performed on six patients with Cerebral Palsy, who went through daily training sessions for two weeks. Preliminary results showed balance improvement in patients with Cerebral Palsy after they had completed home training courses. Further studies are needed to establish medical requirements and evidence.
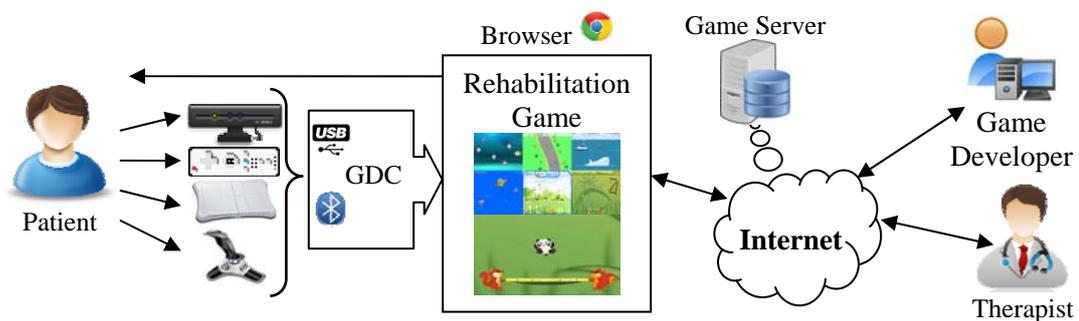
Figure 1. *Scheme of the Web-based virtual rehabilitation system.*

Balance rehabilitation using custom-made Wii Balance Board exercises: clinical effectiveness and maintenance of gains in acquired brain injury population

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Univesity of Jaume I, Castellón, SPAIN
Fundación Hospitales NISA, Valencia, SPAIN

ABSTRACT

Balance disorders are a common impairment of some of the pathologies with the highest incidence and prevalence rates. Conventional physical therapy treatment focuses on the rehabilitation of balance skills in order to enhance patients' self-dependency. In the last years, some studies have reported the clinical benefits of virtual reality systems in the balance recovery. The force platform Wii Balance Board has been adopted with rehabilitative purposes by many services due to its low cost and widespread battery of exercises. However, this entertainment system is oriented to healthy people and cannot adapt to the patient's motor (and possible cognitive) deficits. In previous studies we have developed custom-made adaptive exercises that use the Wii Balance Board with promising results in acquired brain injury population. In this contribution, we present some conclusions derived from the past and undergoing clinical studies.

Figure 2. *Patients interacting with the second prototype of the system*

Upper-body interactive rehabilitation system for children with cerebral palsy: the effect of control/display ratios

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Centre les Capucins, Angers, FRANCE

ABSTRACT

We have developed a virtual reality rehabilitation system using upper-body interaction with Microsoft KinectTM. With the use of KinectTM , the system enables a patient a full-range of avatar movements to adapt the Control/Display (C/D) ratio of a limb's position in 3D space. In this paper, we have explored the effectiveness of C/D ratios in our prototype application to analyze user performance, work load, and user enjoyment with university students without motor impairments. Our findings suggest that the C/D ratio is related to task difficulty, movement strategy, and user motivation.

Figure 1. *Illustration of the system environment.*

Combining virtual reality and a myo-electric limb orthosis to restore active movement after stroke: a pilot study

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Myomo Inc., Cambridge, MA, USA

University of Pittsburgh, PA, USA

ABSTRACT

We introduce a novel rehabilitation technology for upper limb rehabilitation after stroke that combines a virtual reality training paradigm with a myo-electric robotic limb orthosis. Our rehabilitation system is based on clinical guidelines and is designed to recruit specific motor networks to promote neuronal reorganization. The main hypothesis is that the restoration of active movement facilitates the full engagement of motor control networks during motor training. By using a robotic limb orthosis, we are able to restore active arm movement in severely affected stroke patients. In a pilot study, we have successfully deployed and evaluated our system with 3 chronic stroke patients by means of behavioral data and self-report questionnaires. The results show that our system is able to restore up to 60% of the active movement capacity of patients. Further, we show that we can assess the specific contribution of the biceps/triceps movement of the paretic arm to the virtual reality bilateral training task. Questionnaire data show enjoyment and acceptance of the proposed rehabilitation system and its VR training task.
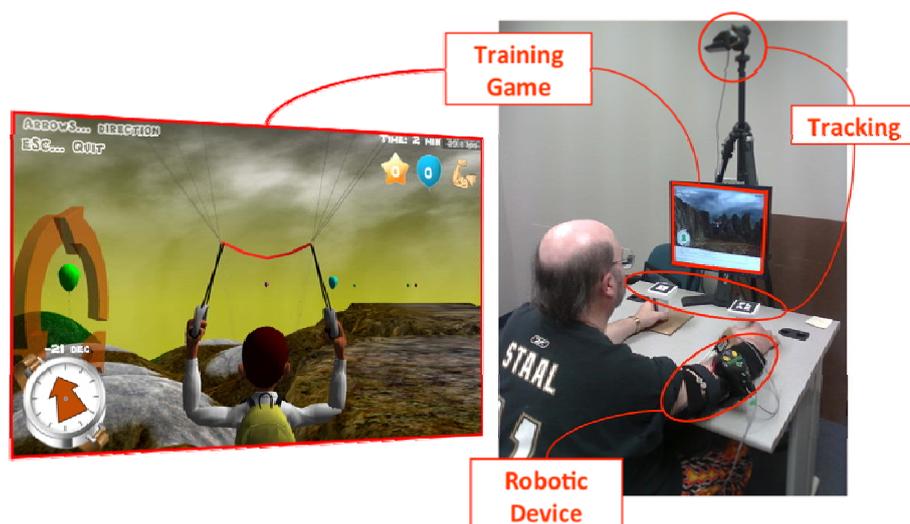
Figure 5. *Prototype of the myo-electric based interactive system for rehabilitation.*

Serious games for physical rehabilitation: designing highly configurable and adaptable games

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Interdisciplinary Institute for Broadband Technology, Ghent, BELGIUM

Université Libre de Bruxelles, Brussels, BELGIUM

ABSTRACT

Computer games have been recognized as a motivational tool in rehabilitation for a decade. Traditional rehabilitation includes exercises which are often considered as repetitive, boring and requires supervision by the therapist. New opportunities in rehabilitation have risen with the emerging popularity of computer games and novel input sensors like 3D cameras, balance boards or accelerometers. Despite active research in this area, there is still lack of available games for rehabilitation mainly due to many different requirements that have to be met for each type of therapy. In this paper we propose a specialized configurable architecture for revalidation games, focusing on neuro-muscular rehabilitation. The proposed architecture enables a therapist to define game controls depending on the patient needs and without any programing skills. We have also implemented a system meeting this architecture and four games using the system in order to verify correctness and functionality of the proposed architecture.
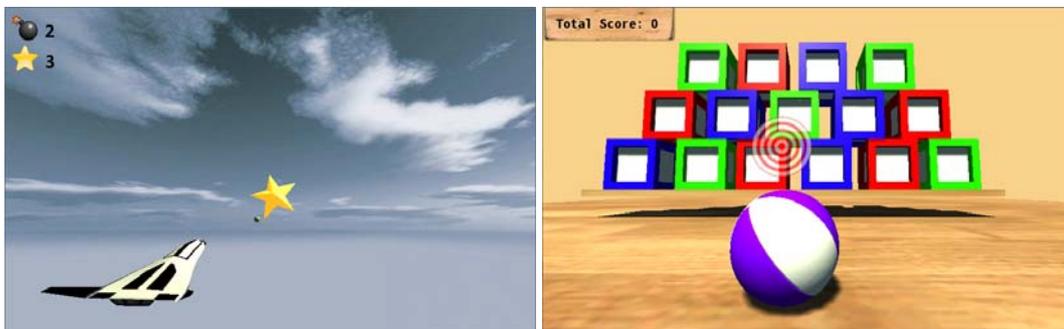
a)   b)

Figure 3. *a) Flying simulator game, b) HitTheBoxes game.*

Developmental cognitive neuroscience perspective on motor rehabilitation: the case for virtual reality-augmented therapy

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ABSTRACT

Developmental disorders and disabilities affecting movement can have far reaching, longer-term consequences for the child and their family, and present a great challenge for intervention. In the case of upper-limb function, in particular, poor compliance and use of repetitive training routines can restrict progress. In this paper we consider how an understanding of the neurocognitive bases of disorders like cerebral palsy and Developmental Coordination Disorder (DCD) can inform the choice of therapeutic techniques. Using a cognitive neuroscience approach, I explore the hypothesis that *motor prediction* is a common, underlying issue in these disorders. I then discuss the role that feedback-based and predictive control plays during the course of normal development and highlight recent applications of *augmented feedback* (AF) in motor therapy. Critically, VR-based technologies afford many options for the provision of multisensory AF. I describe recent examples of this principled approach to treatment, and conclude by suggesting avenues for future development in VR-assisted therapy.

Figure 1. *Sample display from the Elements system: Goal-directed task including (visual) augmented feedback.*

Assessing prospective memory in young healthy adults using virtual reality

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Université Paris Descartes, FRANCE

ABSTRACT

Virtual Reality (VR) is a very relevant tool for the study of complex cognitive functions, such as Prospective Memory (PM; remember to execute an intention at an appropriate time in the future). Thirty-five young subjects performed a PM task while immersed in a virtual city. On a theoretical level, we reached a better characterisation of PM functioning, notably regarding the influence of the link between the "when" and "what" components of PM on performance in event- and time-based PM tasks. This work validates utility of VR in PM assessment and opens perspectives in evaluation and rehabilitation of PM deficits.

Figure 1. *Virtual Environment: figure on the left displays caption of subjects' point of view during the experiment; figure on the right is an example of EBPM cue (i.e. buy a diary at the City Council).*

Measuring the effect of affective stimuli on autonomic responses and task performance in a virtual environment by children with and without cerebral palsy

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Technion – Israel Institute of Technology, Haifa, ISRAEL

Bnai-Zion Medical Center, Haifa, ISRAEL

ABSTRACT

This study examined whether a functional virtual environment (VE) may be used to provide affective stimuli (AS) that lead to changes in the emotional responses and task performance of children with and without cerebral palsy (CP). Fifteen children with CP and 19 typically developing (TD) peers (6 to 12 years) prepared seven virtual meals in a predefined order within a virtual meal-making VE, referred to as the Emotional Meal-Maker (EMM), run on a 2D video capture VR platform. During each of six meals either a negative, positive, or neutral visual stimulus, selected from the International Affective Picture System (IAPS), was displayed. Heart rate (HR) and skin conductance (SCR) were recorded online in synchrony with stimulus onset. These variables were also recorded when the children passively viewed the same sequence of affective pictures displayed onscreen while rating their valence and arousal levels. Autonomic responses were calculated as the amount of change in the autonomic variables compared to baseline. Correlations between behavioural characteristics (i.e., trait and state anxiety) with both autonomic responses and task performance were also calculated. Significant differences were found between groups in task performance and heart rate variability (HRV) components, i.e., a higher "low frequency" (LF) to "high frequency" (HF) ratio in the children with CP during the meals in which a negative stimulus was displayed (U= 59.00, p= 0.011) and during the passive visual display, regardless of type of stimulus. For children with CP, the amplitude of skin conductance response during the passive pictures display was significantly higher for negative stimuli (0.80 ± 0.46 µS) than for positive stimuli (0.52 ± 0.28; Z= -2.38, p= 0.017), but there were no significant changes in autonomic responses as a function of stimuli during meal-making. Positive correlations were found in the CP group between trait anxiety and the LF:HF ratio during virtual meal-making with positive (p< 0.05) and negative stimuli (p<0.01) but not during meals when stimuli were neutral. The implications of these results are discussed.

Stress resilience in virtual environments: training combat relevant emotional coping skills using virtual reality

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USC Institute for Creative Technologies, Playa Vista, CA, USA

ABSTRACT

The incidence of posttraumatic stress disorder (PTSD) in returning OEF/OIF military personnel has created a significant behavioral healthcare challenge. This has served to motivate research on how to better develop and disseminate evidence-based treatments for PTSD. One emerging form of treatment for combat-related PTSD that has shown promise involves the delivery of exposure therapy using immersive Virtual Reality (VR). Initial outcomes from open clinical trials have been positive and fully randomized controlled trials are currently in progress to further investigate the efficacy of this approach. Inspired by the initial success of this research using VR to emotionally engage and successfully treat persons undergoing exposure therapy for PTSD, our group has begun developing a similar VR-based approach to deliver stress resilience training with military service members prior to their initial deployment. The STress Resilience In Virtual Environments (STRIVE) project aims to create a set of combat simulations (derived from our existing Virtual Iraq/Afghanistan PTSD exposure therapy system) that are part of a multi-episode interactive narrative experience. Users can be immersed within challenging combat contexts and interact with virtual characters within these episodes as part of an experiential learning approach for delivering psychoeducational material, stress management techniques and cognitive-behavioral emotional coping strategies believed to enhance stress resilience. The STRIVE project aims to present this approach to service members prior to deployment as part of a program designed to better prepare military personnel for the types of emotional challenges that are inherent in the combat environment. During these virtual training experiences users are monitored physiologically as part of a larger investigation into the biomarkers of the stress response. One such construct, Allostatic Load, is being directly investigated via physiological and neuro-hormonal analysis from specimen collections taken immediately before and after engagement in the STRIVE virtual experience. This paper describes the development and evaluation of the Virtual Iraq/Afghanistan Exposure Therapy system and then details its current transition into the STRIVE tool for pre-deployment stress resilience training. We hypothesize that VR stress resilience training with service members in this format will better prepare them for the emotional stress of a combat deployment and could subsequently reduce the later incidence of PTSD and other psychosocial health conditions.

Towards a real-time, configurable, and affordable system for inducing sensory conflicts in a virtual environment for post-stroke mobility rehabilitation: vision-based categorization of motion impairments

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University of Toronto, CANADA

Toronto Rehabilitation Institute, CANADA

ABSTRACT

Upper body motion impairment is a common after-effect of a stroke. A virtual reality system is under development that will augment an existing intervention (Mirror Box therapy) with a method of inducing a body illusion (Rubber Hand) in order to enhance rehabilitation outcomes. The first phase of the project involved developing algorithms to automatically differentiate between normal and impaired upper body motions. Validation experiments with seven healthy subjects simulating two common types of impaired motions confirm the effectiveness of the proposed methods in detecting impaired motions (accuracy >95%).
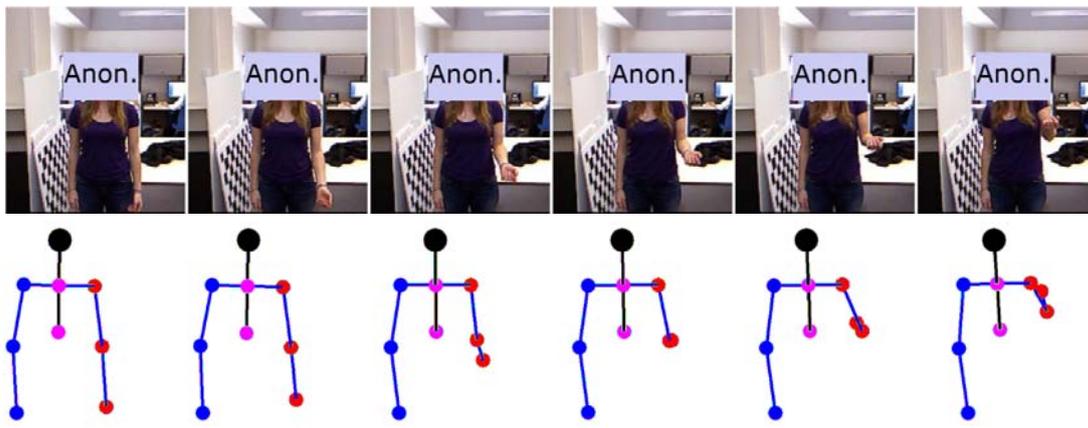
Figure 6. *Sample color, depth, and skeleton tracking images in six representative frames over two sequences of elbow flexion. The top three rows illustrate a "normal" movement pattern while the bottom three rows illustrate a simulated "impaired" motion synergy of hiking the shoulder when flexing the elbow, common among the post-stroke population.*

User-centered development of a virtual reality cognitive assessment

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O Nikelshpur, B S Lange, J DeLuca, A A Rizzo

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Kessler Foundation Research Center, West Orange, NJ, USA

ABSTRACT

In recent years user-centered design, participatory design and agile development have seen much popularity in the field of software development. More specifically, applying these methods to user groups with cognitive and motor disabilities has been the topic of numerous publications. However, neuropsychological assessment and training require special consideration to include therapists and brain-injured patients into the development cycle. Application goals, development tools and communication between all stakeholders are interdependent and outlined in a framework that promotes elements of agile development. The framework is introduced by example of a virtual reality cognitive assessment for patients with traumatic brain injuries. The assessment has seen a total of 20 iterations over the course of nine months including changes in task content, task difficulty, user interaction and data collection. The framework and development of the cognitive assessment are discussed.

Figure 2. *Virtual office environment rendered in the Unity game engine*

User perspectives on multi-touch tabletop therapy

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ABSTRACT

Technology-based activities are becoming increasingly popular in therapy programs. In particular, multi-touch tabletops seem to be well suited for many therapy activities. To better understand the benefits of using multi-touch tabletops during rehabilitation, we examined users' attitudes towards rehabilitation activities on a multi-touch tabletop and on a non-interactive surface. Using a standardized questionnaire and semi-structured interviews, we identified many advantages and limitations of using multi-touch tabletops in rehabilitation. We discuss the implications of user expectations and experiences on the design of future activities.
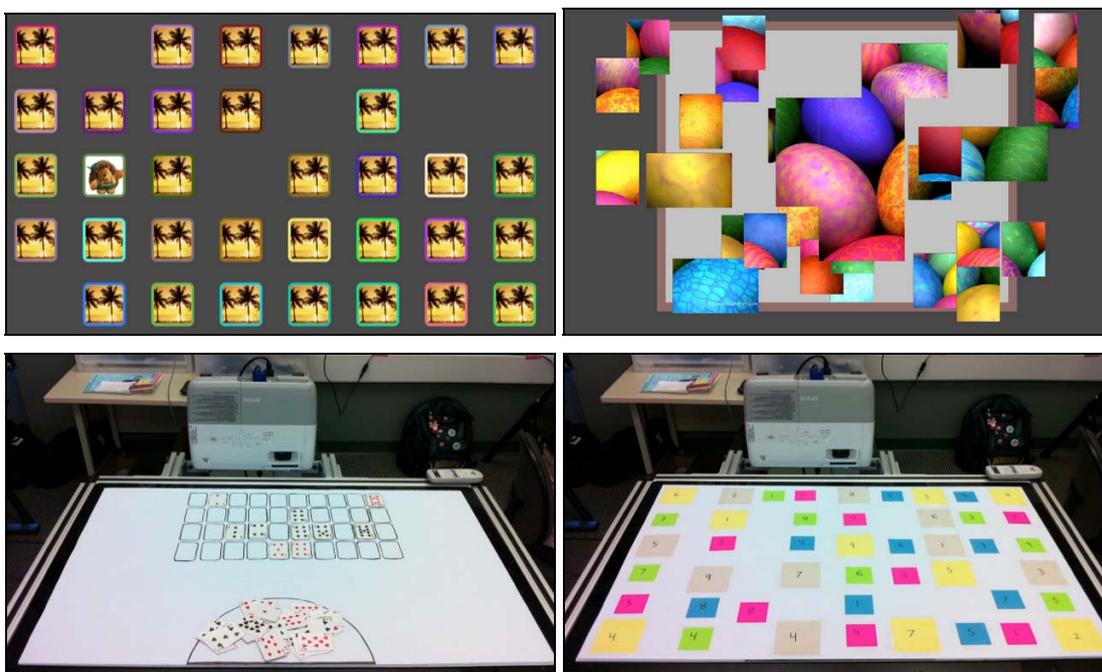
Figure 1. *(Clockwise from top left) The four activities used in the study: Memory (in which participants touched virtual tiles to 'flip them' and reveal images underneath that must be matched), Puzzle (in which participants had to slide tiles on the screen to assemble a large picture), Card Sorting (in which participants had to slide physical cards into ascending order, by suit, onto the grid) and Grid of Stickers (in which participants repeatedly touched the tiles in order, by color).*

Development of a complex ecological virtual environment

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Jewish Rehabilitation Hospital, Laval, Quebec, CANADA

University of Haifa, ISRAEL

Sheba Medical Center, Tel Hashomer, ISRAEL

USC Institute for Creative Technologies, Playa Vista, CA, USA

ABSTRACT

Virtual environments (VEs) provide clinicians and researchers an opportunity to develop and implement an engaging, ecologically valid, complex, life-like interactive 3D simulation, which can be tailored dynamically to characterize and precisely measure functional behaviour in response to different multisensory stimuli. Complex ecological VEs that are based on familiar real-world environments enable participants to relate to the training environment which in turn, may promote translation of functional improvements to real-world tasks. This study describes the development of a systematic and context-specific complex VE using simple computer graphics and modelling tools.

Figure 6. *The virtual environment (right) closely resembled the real environment (left).*

Collaborative virtual environment for conducting design sessions with students with autism spectrum conditions

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ABSTRACT

Young students with autism spectrum conditions (ASC) often find it difficult to communicate with others face-to-face. Virtual reality offers a platform in which students can communicate in a safe and predictable environment where face-to-face communication is not necessary. Participatory design with end-users is an important part of developing successful, usable and enjoyable technology. As designers of technology for young students with ASC, we seek to involve these end-users in the design of software. Therefore, we have developed the Island of Ideas: a collaborative virtual environment (CVE) designed to facilitate participatory design activities with students with ASC. In this paper we report an experimental trial of the Island of Ideas CVE as a meeting space in which a researcher talks with students to find out their views on computer game design and their ideas for new game levels.

Figure 1 (left). *The Island of Ideas CVE*. **Figure 2** (right). *A student and researcher accessing the CVE from separate laptops (Images blurred to protect student identity).*

Development of a low-cost virtual reality-based smart glove for rehabilitation

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ABSTRACT

Presented is the third version of a low-cost bimanual rehabilitation system designed for in-home use by post stroke patients to improve hand and upper extremity function. Companion virtual reality software is still in development. The mechanical characterization and healthy subject (n=24) testing of the system sensors is described. These sensors include potentiometer bend sensors for finger motions and inertial measurement units (IMUs) for hand/arm position and orientation. The system accurately measures larger finger angles and all functional ranges of hand orientation (yaw, pitch, roll). Measurement of small finger angles and position of the hand in space requires further refinement.

Figure 1. *ATLAS bimanual glove system.*

What are the current limits of the Kinect™ sensor?

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ABSTRACT

The Kinect sensor offers new perspectives for the development and application of affordable, portable and easy-to-use markerless motion capture (MMC) technology. However, at the moment, accuracy of this device is still not known. In this study we compare results from Kinect (MMC) with those of a stereophotogrammetric system (marker based system [MBS]). 27 subjects performed a deep squatting motion. Parameters studied were segments lengths and joint angles. Results varied significantly depending on the joint or segment analysed. For segment length MMC shows poor results when subjects were performing movement. Differences were also found concerning joint angles, but regression equations were computed for each joint that produced the same results for MMC and MBS after correction.

Table 3. *Kinect Results before and after correction.*

Difference = Kinect Processed - Vicon

* correlation is significant at percentile 0.01 α p=0.05.

Articulation	Kinect	*Kinect Processed*	Vicon	Difference	P	R
Shoulder	58 (18)	*58 (15)*	58 (16)	0 (6)	0.94	0.93*
Elbow	40 (26)	*30 (10)*	29 (15)	1 (17)	0.75	0.28
Wrist	35 (19)	*19 (5)*	18 (9)	0 (9)	0.92	0.33
Hip	73 (17)	*78 (14)*	78 (16)	0 (7)	0.98	0.94*
Knee	107 (27)	*106 (23)*	107 (22)	-1 (14)	0.78	0.88*
Ankle	90 (36)	*29 (2)*	29 (8)	0 (8)	0.99	0.53*
Trunk	50 (10)	*39 (8)*	39 (16)	0 (16)	0.91	0.45*

Virtual reality learning software for individuals with intellectual disabilities: comparison between touchscreen and mouse interactions

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ABSTRACT

The aim of this article is to analyze the impact of two user interfaces - a tactile interface and a computer mouse - on a virtual environment allowing self-learning tasks as dishwashing by workers with mental deficiencies. We carried out an experiment within the context of a design project named "Apticap". The methods used were an experiment, an identification questionnaire and a post-experimentation interview, with six disabled workers. The results of this study demonstrate the interest of a virtual reality tool associated with a tactile interaction for learning of real tasks by workers with mental deficiencies.

Figure 1. *Reception of dirty dishes.*

Development of a glove-type input device with the minimum number of sensors for Japanese finger spelling

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Kyoto University Hospital, JAPAN

ABSTRACT

A glove-type input device, which can measure hand postures of human beings directly, is one of essential device to develop Virtual Reality environment. The authors have been developing a data-glove which would be able to capture hand postures according to user's demand with the minimum number of sensors. Our previous research estimated the data-glove with six sensors could measure all hand postures for Japanese Finger spellings. Thus, this paper proposes a prototype with six sensors and evaluate whether the prototype glove sensor can distinguish all hand postures of Japanese Finger spellings. This evaluation indicated that data-glove with fewer sensors than conventional number of sensors could distinguish hand postures exactly.

Bending sensor : ① ② ③ ④ ⑤
Contact sensor : ⑥

Figure 3. *Sensor Layout(left) and the prototype(right).*

Camera-based software as a significant tool in rehabilitation/therapy intervention

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ABSTRACT

Use of an affordable, easily adaptable, 'non-specific camera-based software' that is rarely used in the field of rehabilitation is reported in a study with 91 participants over the duration of six workshop sessions. 'Non-specific camera-based software' refers to software that is not dependent on specific hardware. Adaptable means that human tracking and created artefact interaction in the camera field of view is relatively easily changed as one desires via a user-friendly GUI. The significance of having both available for contemporary intervention is argued. Conclusions are that the mature, robust, and accessible software EyeCon is a potent and significant tool in the field of rehabilitation/therapy and warrants wider exploration.
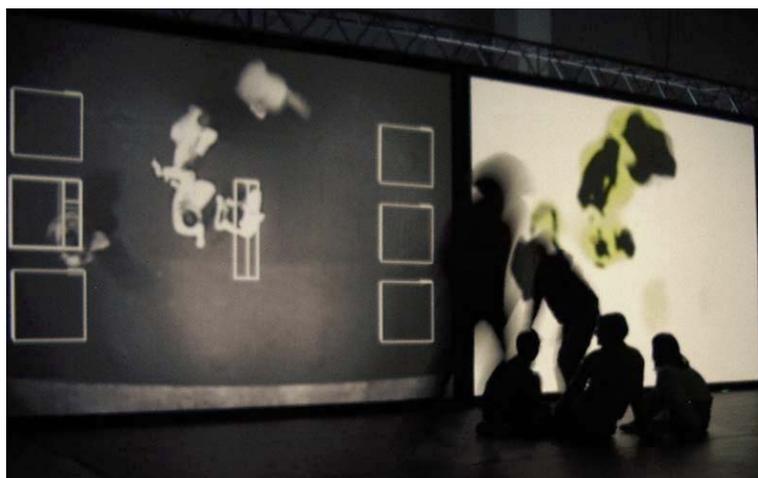
Figure 4. *EyeCon (left screen) plus Eyesweb (right screen) software (split camera feed) - Dynamic zones (rectangles) that are mapped to rhythm music loops and digital painting.*

Augmented reflection technology for stroke rehabilitation – a clinical feasibility study

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ABSTRACT

This paper presents a clinical feasibility study of a novel Augmented Reflection Technology system, called TheraMem. The feasibility of the system for physical rehabilitation of the upper limb and the potential to improve motor impairments following stroke were evaluated. Five patients participated in a total of 20 sessions of upper limb training with the system. Tailored support for patients performing the exercises was provided based on the severity and level of their impairment. Various configurations of the system were evaluated and adjusted to best match the patient's preferences as well as the therapeutic requirements. We found that all patients were able to successfully participate and complete the TheraMem intervention. Patients' engagement and motivation was high over the course of the therapy sessions.
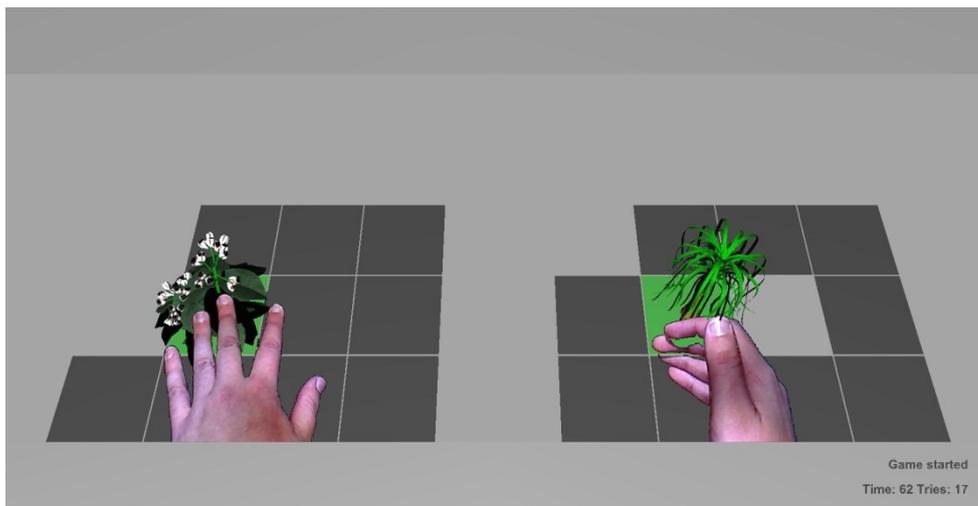
Figure 7. *Gameplay of TheraMem for a patient with an impaired right hand.*

Telerehabilitation for stroke patients: an overview of reviews

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IRCCS Fondazione Ospedale San Camillo, Venice, ITALY

Social and Health Programs, Regione Veneto, Venice, ITALY

Sygheus Vendsyssel Brønderslev Neurorehabiliteringscenter, Brønderslev, DENMARK

Southern Denmark University, Odense, DENMARK

ABSTRACT

The increasing number of survivors following stroke events are enlightening new needs to guarantee appropriate care and quality of life support at home. A potential application of telemedicine is to exploit home care and rehabilitation. Within the framework of an EU FP7 project called Integrated Home Care (IHC) we performed an overview of reviews on the telefacilites for the homecare in stroke patients, in order to plan a clinical trial. A broad literature research was conducted in PUBMED, Web of Science® and The Cochrane Library databases. We included and graded all the reviews matching the following criteria: published in English in peer-reviewed journals, targeting stroke as adult patients (age>18yr.) and considering a homecare setting in the intervention. 6 full-text reviews were included: 1 systematic review with meta-analysis and 5 non-systematic reviews. Despite the absence of adverse effects, no conclusions can be stated on the effectiveness of telerehabilitation compared to other home treatment, due to the insufficient data available, nevertheless strong indications emerged for the inclusion of "all cause mortality" and "hospital admission" as primary outcomes. Besides "QoL", "cost", "adherence" and "patient acceptability" should be included as secondary outcomes, for a complete evaluation of the tele-intervention. This indications should be considered as relevant in planning a telerehabilitation trial, in order to observe the expected effectiveness from a multidimensional point of view in the clinical, financial and social perspectives.

Information and communication technology
– a person-centered approach to stroke care

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The Sahlgrenska Academy, University of Gothenburg, SWEDEN

ABSTRACT

This report describes the possibilities of information and communication technology (ICT) in stroke care, addressing a person-centered care (PCC) approach. Attention is paid to user involvement, design, videogames, and communication between health care professionals mutually as well as with patients, and how to share performance data with an electronic health record. This is the first step towards a supportive ICT system that facilitates interoperability, making healthcare information and services available to citizen's across organizational boundaries.
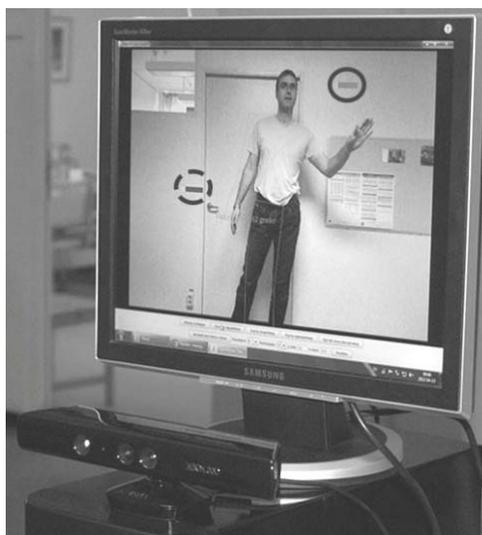
Figure 1. *A screenshot from the player's perspective, in the upper left corner reaching for a red box (black circle) and at the bottom right corner a blue box (dotted circle) flies in.*

Second-hand masculinity: do boys with intellectual disabilities use computer games as part of gender practice?

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ABSTRACT

The process of gendered practice in the pursuit of masculine identity is complex with many obstacles and hegemonic forms to negotiate on the journey. Add to this the multifaceted and diverse nature of intellectual disability (ID) and the opportunity for normalised gendered practice is further complicated. Focused on the talk of boys with ID, this paper offers an account of the development of ideas about masculinity to show how gaming may offer a space for gendered practice not available in other areas of the boys' lives. The paper tentatively argues that gaming may offer an opportunity for the boys and those working with them to explore gendered practice safely to facilitate the construction of their identities as men and to challenge problematic images of the hyper-masculine ideal found in these games.

Using virtual environments to teach coping skills in addiction treatment

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University of Reading, UK

ABSTRACT

This paper presents a novel application of virtual environments to assist in encouraging behaviour change in individuals who misuse drugs or alcohol. We discuss the background and development, through user-led design, of a series of scenes to engage users around the identification of triggers and encourage discussion about relevant coping skills. We then lay out the results of some initial testing of this application that show some positive reaction to the scenes and some positive learning outcomes and discuss the conclusions drawn from these.

Figure 1. *Identifying triggers in a virtual bar.*

Virtual reality exposure therapy for post-traumatic stress disorder patients controlled by a fuzzy logic system

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P Ventura, L A V de Carvalho

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Universidade Federal do Rio de Janeiro, BRAZIL

ABSTRACT

This paper describes the main characteristics of two integrated systems that explore Virtual Reality technology and Fuzzy Logic to support and to control the assessment of people with Post-Traumatic Stress Disorder during the Virtual Reality Exposure Therapy. The integration of different technologies, the development methodology and the test procedures are described throughout the paper.

Figure 2: *The scene of an accident: a person was hit by a bus.*

Virtual exercises to promote cognitive recovery in stroke patients: the comparison between head mounted displays versus screen exposure methods

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Alcoitão Hospital, Alcabideche, PORTUGAL

ABSTRACT

Stroke can be considered as a major cause of death and the consequences are associated with different syndromes of the impaired physical, cognitive, behavioral and emotional domains. The cognitive rehabilitation is often related to improvement on executive functioning through repeated and systematic training in memory and attention exercises, in which virtual reality has proven to be a valid approach. Several devices have been used as visual outputs. Head mounted displays (HMD) and desktop screens displays are amongst them. HMD is usually perceived has being more immersive than screens. However, it presents several shortcomings if a widespread use is the objective. In this way, this study aims at assessing the prospect of opting for screen displays as an alternative to HMD within virtual reality (VR) based applications to rehabilitate memory and attention impairments in stroke patients. A sample of 17 patients with memory and attention deficits resulting from stroke were recruited from the hospital *Centro de Medicina da Reabilitação do Alcoitão*. The patients were randomly assigned to two different groups: (1) HMD based VR; and (2) desktop screen based VR. The patients in the experimental groups underwent a virtual reality (VR) training programme with 12 sessions regarding memory and attention exercises. These patients were assessed before and after the VR training sessionswith the Wechsler Memory Scale for memory and the Toulouse Pieron for attention functioning. The results showed increased working memory and sustained attention from initial to final assessment regardless of the VR device used. These data may suggest better functional independence following VR-based intervention and support the use of non-expensive displays as an alternative to high-end setups commonly used in VR applications devised for rehabilitation purposes.

Design of virtual reality based physical and cognitive stimulation exercises for elderly people

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CIGMA, CIDEVIM, Laval, FRANCE

ABSTRACT

Elderly people are the most growing part of the population in developed countries (Europe, North America and Japan). This population is getting more and more alone and isolating this part of the population is the big issue of this century. This isolation can lead to a lack in physical and cognitive activity. Because virtual reality has given good results in health domain, we decided to design an application that combines physical activities and cognitive stimulation. The "Balade à l'EHPAD" application was then tested on different kind of population. Then, the expectations and needs of elderly people were collected and analyzed. The results clearly indicate that preconceived ideas exist in every people and also in professional caregivers who generally have a better knowledge of this population. Elderly people would like to have raw colors and virtually practice more violent sports (*e. g.*, skiing, rugby). The overall study clearly indicates that more than for younger adults, the involvement of elderly people into the application design process is a prerequisite for the appropriation by this population.
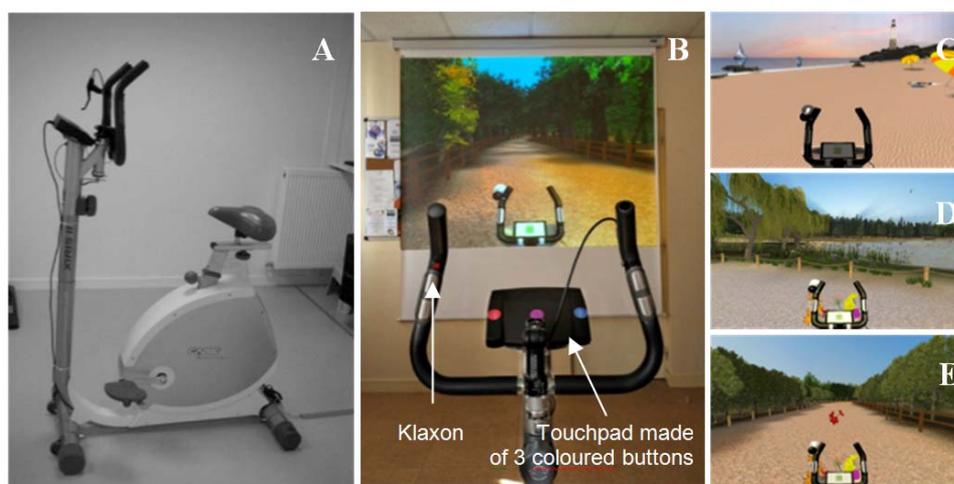
Figure 8. *"Balade à l'EHPAD" provides an interfaced bike (A) for a virtual bike ride (B) in two different environments: the seaside (C) and a forest (D). The participants are suggested to be involved in simple cognitive exercises as collecting flowers (E).*

Study of the impact of added contextual stimuli on the performance in a complex virtual task among patients with brain injury and controls

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EA4136, Bordeaux, FRANCE

ABSTRACT

During the last years, researchers showed the feasibility and the interest of using Virtual Reality (VR) among patients with cognitive impairments for the recovery of capacities. While interacting, the VR system provides various kinds of information for different purposes: display of the virtual environment, understanding of the task, but also highlighting of functionalities or delivery of instructions. Generally, in order to improve the patient performance, additional cues are provided to enhance information saliency, such as arrows, change of colors. We define a "contextual Additional Software Stimulus" (contextual ASS) as any additional information delivered by the virtual system, related to the interaction whose absence in the virtual environment does not have an effect on the unfolding of the task. This work was designed to study the effects of contextual ASS on the performance in a daily living simulated task: purchasing items in the Virtual Action Planning Supermarket (The VAP-S). In this purpose, we started by implementing ASS in the VAP-S then we carried out experiments in which 23 healthy subjects (12 M and 11F) and 12 patients with brain injury (12 M) took part. Results show that the deliverance of contextual ASS during the virtual task improves significantly some parameters describing the performance of healthy subject and patients with brain injury.

Figure 9. *Two examples of curves representing two trajectories of a subject in the conditions C0 (on the left) and C2 (on the right).*

Development of the system for continuous medical rehabilitation for patients with post-stroke and spinal cord injury motor disorders

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Siberian Clinical Center FMBA, Krasnoyarsk, RUSSIA

ABSTRACT

This paper describes an experience of developing a computer system for continuous medical rehabilitation involving patients with post-stroke and spinal cord injury motor disorders. Particular focus is made on the concept of telerehabilitation for this specific group of patients. Telerehabilitation has to be continuous and regular. It is also necessary to provide the possibility of conducting treatment/communication sessions asynchronously. The empirical results of four year implementation of this system in Russia showed high efficiency and revealed some limitations of a distant network rehabilitation program based on electromyographic biofeedback.
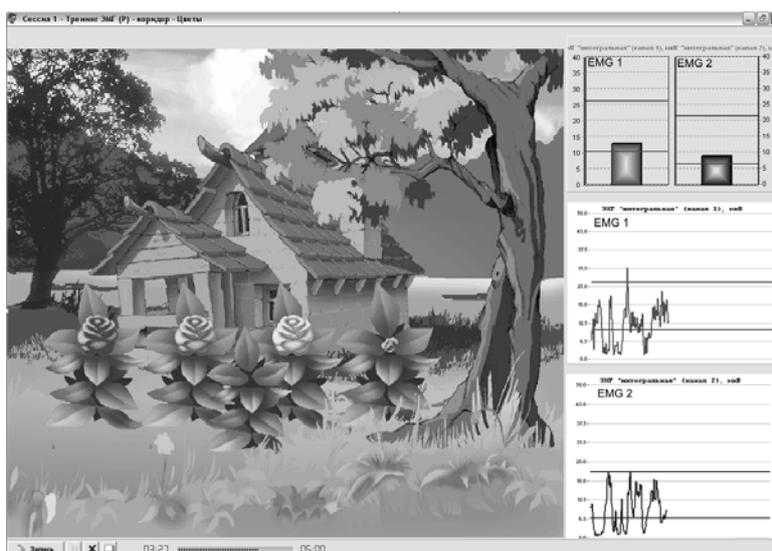
Figure 3. *Screenshot of a game form of EMG biofeedback. If both signals (EMG1 and EMG2) lie in the range between the thresholds in so called target zone a flower grows and blooms.*

Improving orientation and mobility skills through virtual environments for people who are blind: past research and future potential

O Lahav

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ABSTRACT

This presented paper describes and examines 21 virtual environments developed specifically to support people who are blind in collecting spatial information before arrival at a new location and to help people who are newly blind practice orientation and mobility skills during rehabilitation. The paper highlights weaknesses and strengths of virtual environments that have been developed in the past 15 years as orientation and mobility aids for people who are blind. These results have potential to influence future research and development of a new orientation and mobility aid that could enhance navigation abilities.

Development of a visual impairment simulator using the Microsoft XNA Framework

J Lewis, L Shires, D J Brown

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ABSTRACT

This paper describes the development of a visual impairment simulator based upon a virtual environment developed using Microsoft's XNA framework and High Level Shader Language. Shaders were developed to simulate the effects of cataracts, macular degeneration, glaucoma, myopia and hyperopia. These were then used to impair the real time display of an explorable 3D virtual environment. The simulator was evaluated by a qualified optician and trialled with a group of students. The paper concludes that further development is required to fully and accurately represent the impairments, however the simulator remains effective in improving participants level of understanding of visual impairments.
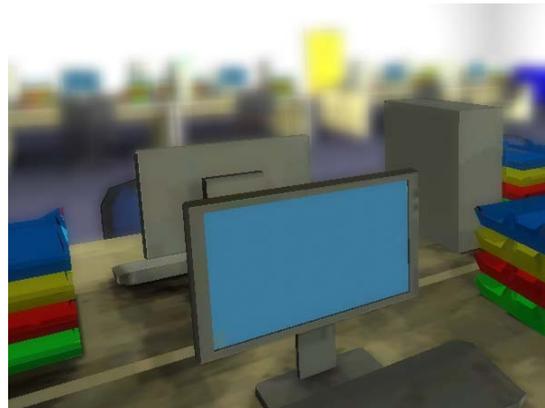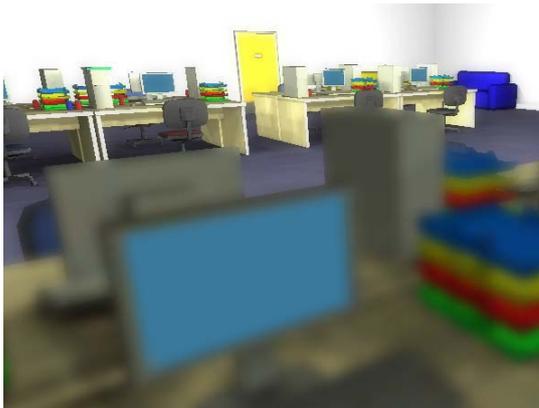
Figure 6. *Implementation of hyperopia.*   **Figure 7.** *Implementation of myopia.*

Chilean higher education entrance examination for learners who are blind

J Sánchez, M Espinoza

University of Chile, Santiago, CHILE

ABSTRACT

In the context of the admissions process for Chilean state universities, there is a knowledge-measuring instrument called the University Selection Test (PSU, for its Spanish acronym). This instrument of evaluation is designed to measure the level of knowledge in various learning sub-sectors such as Language and Communication, Mathematics, History and Social Sciences, and finally Science. For each learning sub-sector, students use a paper facsimile with questions that each have 5 possible answer choices, which are recorded on a separate answer sheet. Based on a contextual analysis of the problems that people who are blind have with participating in the regular admissions process for Chilean universities, the purpose of this study was to design, implement and evaluate a digital pilot system that adapts the Chilean university entrance system, PSU, in the area of Language in Communication for people with disabilities based on audio and haptics. This pilot allowed for the inclusive, equitable and autonomous participation of people with visual disabilities in the university admissions processes. The results demonstrate the creation of a system called AudioPSU, which provides the necessary autonomy and respects the working time that each user needs to respond to the questions in the PSU. In addition, the system is shown to help users to map the structure of the PSU facsimile for Language and Communication. Finally, initial results show that AudioPSU allows for the integration of people with visual disabilities in the admissions process for Chilean universities.
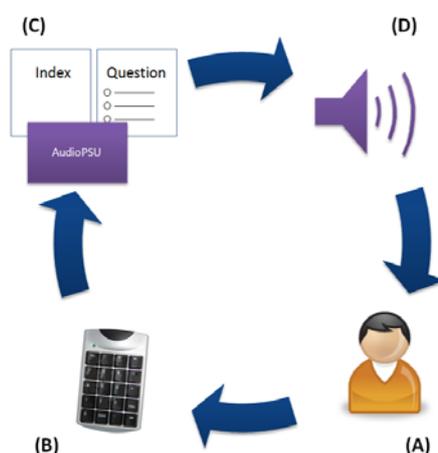
Figure 3. *The User's Interaction with AudioPSU.*

Short Papers ~ Abstracts

Novel electronic musical instrument for persons with cerebral palsy to play and enjoy together, **K Akazawa**, **T Kawai**, **R Okuno**, **T Masuko**, **H Nishida**, **M Horai**, Osaka Institute of Technology/Setsunan University, Osaka-fu/ Mukogawa Women's University, Hyogo-ken/SANYO Electric Co., Ltd., Osaka-fu/Social Welfare Organization Kibounoie Takarazuka, Hyogo-ken, JAPAN

We have developed a novel musical instrument with storing pre-programmed music score in PC, named Cyber Musical Instrument with Score, "Cymis". Using Cymis, persons with neural or motor impairments such as cerebral palsy can play the piece easily. This instrument consists of monitor display, PC, MIDI sound source, speaker and interfaces, such as touch panel, switch and expiratory pressure sensing device. The field experiment commenced in 2008, and at present, ten facilities including National Hospital participate in the experiment. Assessment scales are constructed with 5 levels from 0 (almost no disability) to 4 (almost immobile)，corresponding to the performing devices such as single input device to complex touch panel input method. Assessment was recorded during 27 months from Jan. 2009 to March 2011 in a facility. Results obtained from 44 clients (average age: 54.6) were as follows; no change of level was 24 (55%), dropped 1 level (improved functionally) was 19 (43%), up 1 level (decline functionally) was 1 (2 %). In conclusion, this paper presents the technology that is designed to be attractive to clients, that permits them to do an enjoyable activity that may not otherwise be possible for them, and that has shown some evidence to therapeutic effect.

Virtual rehabilitation system for people with Parkinson's disease, **S Albiol-Pérez**, **J A Lozano-Quilis**, **H Gil-Gómez**, **J A Gil-Gómez**, **R Llorens**, Universidad de Zaragoza, Teruel/Universitat Politècnica de València, SPAIN

Patients that suffer from Parkinson's disease (PD) have different symptoms such as tremors, stiffness and slowness in the execution of first movements and absence of balance control. Traditional therapies show improvements in postural control, mobility and gait. Currently, the use of video games with low cost devices such as Nintendo® Wii Balance Board® and Kinect increases the rehabilitation process in PD patients against traditional rehabilitation. However, video games are designed for healthy people, and they are not appropriate in balance rehabilitation therapy. In this paper, we describe ABAR system, a custom, motivational and adaptive tool to rehabilitate PD patients, to help them recover from balance disorders and regain postural control. To achieve this goal, we will test patients at the beginning and at the end of the clinical study. Clinical tests include: Anterior Reach Test, the Time "Up and Go", the Stepping Test, the 30-second Sit-to Stand Test and functional reach test.

Design of a novel virtual reality-based autism intervention system for facial emotional expressions identification, **E Bekele**, **Z Zheng**, **U Lahiri**, **A Swanson**, **J Davidson**, **Z Warren**, **N Sarkar**, Vanderbilt University, Nashville, TN, USA

A virtual reality (VR)-based system for evaluating facial emotion recognition ability of teenagers with autism spectrum disorders (ASD) is presented. This system is integrated with a non-contact eye tracker that allows investigation of eye gaze and eye physiological indices (e.g., blink rate) of the participants while they seek to identify the emotion displayed by the avatars in the VR environment.

Performance and eye data of 12 participants (6 children with ASD and 6 typically developing children) are presented.

E Bekele, Z Zheng, U Lahiri, A Swanson, J Davidson, Z Warren, N Sarkar, Design of a novel virtual reality-based autism intervention system for facial emotional expressions identification, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 427–430, Laval, France, 10 – 12 Sept. 2012.

Subject anonymisation in video reporting: is animation an option?, **A L Brooks**, Aalborg University, Esbjerg, DENMARK

This short-paper contribution questions the potential of a simple automated video-to-animation rotoscoping technique to provide subject anonymity and confidentiality to conform to ethical regulations whilst maintaining sufficient portraiture data to convey research outcome. This can be especially useful for presenting to young researchers whose limited experiences can restrict their ability to draw association between a treatment and subject profile when solely presented textually and/or verbally. The goal of the paper is to provoke discussions on the subject. It is speculated that given a satisfactory result researchers will more easily be able to illustrate in-session action, responses to treatment, and other outcomes.

A L Brooks, Subject anonymisation in video reporting: is animation an option?, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 431–433, Laval, France, 10 – 12 Sept. 2012.

Markerless motion tracking: MS Kinect and Organic Motion OpenStage, **A L Brooks**, **A Czarowicz**, Aalborg University, Esbjerg, DENMARK/Organic Motion, USA

This contribution focuses on the Associated Technologies aspect of the ICDVRAT event. Two industry leading markerless motion capture systems are examined that offer advancement in the field of rehabilitation. Residing at each end of the cost continuum, technical differences such as 3D versus 360 degree capture, latency, accuracy and other issues are discussed. The plusses and minuses are presented including reflections on the evolution of the MS Kinect to be a stand-alone device for PC with a SDK to offer access for creative programmers to develop systems for disabled users. A conclusion is how the SDK enables half-torso and mirroring calibrations offering new opportunities for wheelchair users.

A L Brooks, A Czarowicz, Markerless motion tracking: MS Kinect and Organic Motion OpenStage, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 435–437, Laval, France, 10 – 12 Sept. 2012.

Perceptual game controllers and fibromyalgia studies, **A L Brooks**, **E Petersson Brooks**, Aalborg University, Esbjerg, DENMARK

This pilot study investigated gesture-based control of video games to promote and motivate self-driven home-based aerobic exercise (AE) training regimes to improve pain threshold associated to fibromyalgia. 10 patients were randomized to 10 sessions each led by a non-medical 'game-savvy' PhD Medialogy student. Control was treatment-as-usual (TAU) patients via the patient's doctor who conducted pre- and post- interviews, tests, and VAS registrations of pain, disturbed sleep, lack of energy, and depression. Included was patient-reported global subjective improvement or otherwise. A Nintendo Wii was used with a sports compilation game 'Sports Resort' with the Wiimote MotionPlus Accessory to increase accuracy of gesture. Facilitator in vivo noted observations and the doctors' research were supplemented by multiple angle (3) video cameras synchronized to the game play for correlation analysis. Outcome measures were at baseline and completion. Short-term results were positive of those patients who completed the study (n = 2). 50% drop out at study commencement suggested a sceptical patient attitude. Further drop outs (n = 3) were due to a car accident (n = 1) and recurrence of pain (n = 2). Both patients who

completed showed significant motion improvements and each purchased a Wii for home training following the study. Follow up interviews and tests are planned to question compliance and long-term outcomes. A follow-on comparative study with 39 patients was conducted with two occupational therapist students replacing the Medialogy student as session facilitator. Three game platforms were studied: the MS Kinect, Sony MOVE, and Nintendo Wii, with 5 game sessions of one hour being played by each patient in regular lab visits (=15 sessions each). This is reported separately with preliminary findings indicating tendencies in line with this short paper. A more detailed report will be included in the publication of the final work as a whole.

A L Brooks, E Petersson Brooks, Perceptual game controllers and fibromyalgia studies, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 439−441, Laval, France, 10 − 12 Sept. 2012.

Advantages of haptic feedback in virtual reality supported balance training: a pilot study, **I Cikajlo**, **A Krpič**, **A Savanović**, **Z Matjačić**, University Rehabilitation Institute, Ljubljana/Smart Com d.o.o., Ljubljana, SLOVENIA

Repetitive and goal based task supported with virtual reality technology have proven successful in balance training of stroke population. However, adding a haptic experience can besides increasing the difficulty level of the task enable postural responses assessment. We demonstrated in a single subject with stroke that haptic feedback can be used not only for interaction with virtual environment, but also for the assessment of postural responses. After the virtual reality and standing frame supported balance training the subject was introduced to the haptic floor. The acceleration of the standing frame/body provided sufficient information to identify the direction of the postural response that could be critical for fall. The outcomes were comparable with neurologically intact population and could be applied for objective postural response evaluation.

I Cikajlo, A Krpič, A Savanović, Z Matjačić, Advantages of haptic feedback in virtual reality supported balance training: a pilot study, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 443−446, Laval, France, 10 − 12 Sept. 2012.

Interactive expressive virtual characters: challenges for conducting experimental studies about multimodal social interaction, **M Courgeon**, **O Grynszpan**, **S Buisine**, **J-C Martin**, LIMSI-CNRS, Orsay/Université Pierre et Marie Curie, Paris/Arts et Métiers Paris Tech, Paris, FRANCE

Advanced studies about social interaction address several challenges of virtual character research. In this paper, we focus on the two following capacities of virtual characters that are the focus of research in human-computer interaction and affective computing research: 1) real-time social interaction, and 2) multimodal expression of social signals. We explain the current challenges with respect to these two capacities and survey how some of them are used in experimental studies with users having Autism Spectrum Disorders (ASD).

M Courgeon, O Grynszpan, S Buisine, J-C Martin, Interactive expressive virtual characters: challenges for conducting experimental studies about multimodal social interaction, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 447−449, Laval, France, 10 − 12 Sept. 2012.

Neurocognitive rehabilitation approach for cerebral palsy syndrome by using the rhythm-based tapping tool to extend fields of perception and motion, **M Fukudome**, **H Wagatsuma**, **K Tachibana**, **K Sakamoto**, Kyushu Institute of Technology, Kitakyushu/RIKEN Brain Science Institute, Saitama/Ibaraki Prefectural University of Health Sciences, Inashiki-Gun Ibaraki/Tohoku University, Sendai, JAPAN

We focus on the difficulty of children with cerebral palsy to perform not only motor skills but also cognitive tasks, and hypothesize that rhythm-based tapping tasks help to enhance abilities of motions and cognitions cooperatively, if a personally-tailored rhythm is provided. In the experiment with the prototype tapping device, we found that a misalignment of the pacemaker with the

internally-comfortable tempo brings subjects a feeling of discomfort and declination of performance if the task is in a rushed condition. This result suggests that a self-motivated rhythm may be enhanced through synchrony with the external rhythm, while it is disturbed by a gap between internal and external rhythms. This is an important step towards developing a rhythm-based rehabilitation method and a design principle focusing on subjects' individual internal rhythms.

M Fukudome, H Wagatsuma, K Tachibana, K Sakamoto, Neurocognitive rehabilitation approach for cerebral palsy syndrome by using the rhythm-based tapping tool to extend fields of perception and motion, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 451−454, Laval, France, 10 − 12 Sept. 2012.

Virtual rehabilitation of the weigh bearing asymmetry in the sit-to-stand movement, **J A Gil-Gómez**, **H Gil-Gómez**, **S Albiol-Perez**, **J A Lozano-Quilis**, Universitat Politècnica de València/Universidad de Zaragoza, Teruel, SPAIN

Weight bearing asymmetry is frequently used as a measure of impairment in balance control, and recovering symmetry in weight bearing is considered an imperative objective of rehabilitation. WBA rehabilitation is especially important for the sit-to-stand movement. Transition between sitting and standing, or vice versa, is one of the most mechanically demanding activity undertaken in daily life. In this contribution, we present a Virtual Rehabilitation system specifically designed for the recovery of the symmetry for this movement. The system has been designed with clinical specialists, and it presents very promising features such as the automatic adaptation to the patient. The paper is a work-in-progress that describes the system and presents the validation study that we will follow in a metropolitan hospital. Currently, we are enrolling patients, and the clinical specialists are very encouraged about the potential of the system.

J A Gil-Gómez, H Gil-Gómez, S Albiol-Perez, J A Lozano-Quilis, Virtual rehabilitation of the weigh bearing asymmetry in the sit-to-stand movement, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 455−458, Laval, France, 10 − 12 Sept. 2012.

Reproduction of plosive sound vocalization by the talking robot based on the visual information, **M Kitani**, **H Sawada**, Kagawa University, JAPAN

The authors are developing a vocalization training system for the auditory-impaired. The training system employs a talking robot which has mechanical organs like a human. With an adaptive learning strategy using an auditory feedback control, the robot autonomously learns the vocalization to speak like a human, and then reproduces the speech articulation from inputted vocal sounds. In the previous study, the training system for 5 Japanese vowels was constructed. The effectiveness was assessed by a training experiment conducted in Kagawa Prefectural School for the Deaf, and significant results were obtained. In the next step, the training system for consonant vocalization is studied. The plosive sounds such as $/p/$, $/t/$ and $/k/$ are produced by sudden opening and closing motions of a mouth, and it is not an easy task to reproduce the vocalization based on the auditory feedback learning. To solve this problem, visual information is employed to reproduce the plosive sound vocalization by the talking robot. In this study the learning method of the plosive sounds is introduced. The reproduced robotic vocalizations are evaluated by an experiment, and we validated that the robot successfully reproduced the vocalizations of the able-bodied.

M Kitani, H Sawada, Reproduction of plosive sound vocalization by the talking robot based on the visual information, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 459−462, Laval, France, 10 − 12 Sept. 2012.

Upper limb tracking using depth information for rehabilitative tangible tabletop systems, **R Lloréns**, **C Marín**, **M Ortega**, **M Alcañiz**, **C Colomer**, **M D Navarro**, **E Noé**, Universitat Politècnica de València/Univesity of Jaume I, Castellón/Hospitales NISA Valencia al Mar y Sevilla Aljarafe, Valencia, SPAIN

The motor impairments that affect the upper limb, such as those following an acquired brain injury, are particularly disabling, since this body segment is involved in the majority of the activities of daily living. Virtual reality systems have been reported to stimulate the clinical effectiveness of the rehabilitative strategies, providing intensive and repetitive exercises in a motivating and controllable environment. The tracking of the upper limb movements in the real world is a challenging task that has traditionally involved different tracking systems. The use of depth sensors can provide a non-invasive solution that can be integrated in tabletop systems.

R Lloréns, C Marín, M Ortega, M Alcañiz, C Colomer, M D Navarro, E Noé, Upper limb tracking using depth information for rehabilitative tangible tabletop systems, *Proc. 9ᵗʰ Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 463−466, Laval, France, 10 − 12 Sept. 2012.

Convergent validation of a virtual reality-based street crossing with neuropsychological tests in neglected and non-neglected stroke patients, **R Lloréns**, **M D Navarro**, **M Alcañiz**, **C Colomer**, **E Noé**, Universitat Politècnica de València/Hospitales NISA Valencia al Mar y Sevilla, Aljarafe/Univesity of Jaume I, Castellón, SPAIN

Unilateral spatial neglect is one of the most common and disabling impairments of stroke. The assessment of this deficit is carried out with paper and pencil tasks that can lack correspondence to everyday activities. Virtual reality can recreate realistic but safe environments that allow the therapists to study how the patients would react in real life situations. This paper presents a virtual street-crossing system that immerses the participants in a recreated street where they are asked to navigate safely. The presented study with chronic stroke patients showed remarkable correlations of the performing variables of the system with standard cognitive scales, which suggests that virtual reality systems can evidence alterations in cognitive skills, such as neglect.

R Lloréns, M D Navarro, M Alcañiz, C Colomer, E Noé, Convergent validation of a virtual reality-based street crossing with neuropsychological tests in neglected and non-neglected stroke patients, *Proc. 9ᵗʰ Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 467−470, Laval, France, 10 − 12 Sept. 2012.

Virtual 3D shape and orientation discrimination using point distance information, **S Maidenbaum**, **R Arbel**, **S Abboud**, **D R Chebat**, **S Levy-Tzedek**, **A Amedi**, The Hebrew University of Jerusalem, ISRAEL

Distance information is critical to our understanding of our surrounding environment, especially in virtual reality settings. Unfortunately, as we gage distance mainly visually, the blind are prevented from properly utilizing this parameter to formulate 3D cognitive maps and cognitive imagery of their surroundings. We show qualitatively that with no training it is possible for blind and blindfolded subjects to easily learn a simple transformation between virtual distance and sound, based on the concept of a virtual guide cane (paralleling in a virtual environment the "EyeCane", developed in our lab), enabling the discrimination of virtual 3D orientation and shapes using a standard mouse and audio-system.

S Maidenbaum, R Arbel, S Abboud, D R Chebat, S Levy-Tzedek, A Amedi, Virtual 3D shape and orientation discrimination using point distance information, *Proc. 9ᵗʰ Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 471−474, Laval, France, 10 − 12 Sept. 2012.

Self-referencing virtual reality programs for neurorehabilitation, **L Mendes**, **A I Mota**, **F Barbosa**, **R Vaz**, University of Porto, PORTUGAL

Virtual Reality (VR) is a recent technology to assist in therapy and neurorehabilitation. In doing so, VR enables a realistic performance, with higher motivation and immersion in the problematic situation. VR increases ecological value and skills generalization; however this technology is still disorder-oriented. Patient's response to treatment differs from patient to patient. So it is relevant to take into consideration a multitude of aspects, self-referencing VR Programs for Neurorehabilitation. We argue the need to create a variety of scenarios that better adapt to psychological, developmental and ecological characteristics of each patient.

L Mendes, A I Mota, F Barbosa, R Vaz, Self-referencing virtual reality programs for neurorehabilitation, *Proc. 9ᵗʰ Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 475−478, Laval, France, 10 − 12 Sept. 2012.

Configuring a mobile platform for daily-life management following brain injury: a case study in ubiquity, agility and ethics, **J R O'Brien**, University College London, UK

This paper offers a case study of a participant experiencing neurological impairments after brain injury who uses his mobile platform to author the management of his daily life. The study draws on the participant's own descriptions to propose delineations of the tropes 'ubiquity' and 'agility' with reference to technology participation in daily life. The study attends to an ethical research matter of privacy in the study of daily-life management, not least where the participant has recorded others' personal details. In conclusion, ethical parameters are established for a closer study of technology ubiquity and agility in daily life after brain injury.

J R O'Brien, Configuring a mobile platform for daily-life management following brain injury: a case study in ubiquity, agility and ethics, *Proc. 9ᵗʰ Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 479−482, Laval, France, 10 − 12 Sept. 2012.

Development of a system for the assessment of a dual-task performance based on a motion-capture device, **K Okamoto**, **H Kayama**, **M Yamada**, **N Kume**, **T Kuroda**, **T Aoyama**, Kyoto University Hospital/Kyoto University, JAPAN

The authors produced a dual-task (DT) which provides a dynamic balance task and a cognitive task in a game system using motion sensors and virtual images. There had been no DT where a cognitive task needs a dynamic balance task which requires full body motions. We developed and evaluated a game system to assess the performance of the DT. The DT is to solve Sudoku using full body motions like Tái Chi. An ability to perform a DT is intimately related to risk of falls. To evaluate the developed system, we compared the performance of elderly people and young people. Generally, elderly people are at a higher risk of falls. 20 elderly community-dwelling adults (mean age, 73.0 ± 6.2 yrs.) and 16 young adults (mean age, 21.8 ± 1.0 yrs.) participated in this study. To compare the two groups, we applied an independent-samples t-test. The time taken for the elderly people was 60.6 ± 43.2 seconds while the time taken for the young people was 16.0 ± 4.8 seconds. The difference is statistically significant ($p < 0.05$). This result suggests that the developed game system is useful for the evaluation of the DT performance.

K Okamoto, H Kayama, M Yamada, N Kume, T Kuroda, T Aoyama, Development of a system for the assessment of a dual-task performance based on a motion-capture device, *Proc. 9ᵗʰ Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 483−486, Laval, France, 10 − 12 Sept. 2012.

Counting repetitions of upper extremity movements while playing video games compared to traditional therapy; implications for stroke rehabilitation, **D Rand**, **N Givon**, **G Zeilig**, **A Nota**, **H Weingarden**, Tel Aviv University/ The Chaim Sheba Medical Center, Tel-HaShomer, ISRAEL

Clinicians are seeking novel methods to increase the number of repetitions of purposeful movements during and following stroke rehabilitation. Video-game consoles encourage active purposeful movement, however, the number of repetitions while playing video games is unknown. We aimed to compare the number of repetitions and accelerometers activity counts of movements of the weak upper extremity of individuals with chronic stroke while playing video games to participants in traditional therapy. Eight participants were included. Differences between groups in the type and number of repetitions and accelerometers activity counts were found. These preliminary findings indicate that video-games facilitate multiple repetitions of fast purposeful movements.

D Rand, N Givon, G Zeilig, A Nota, H Weingarden, Counting repetitions of upper extremity movements while playing video games compared to traditional therapy; implications for stroke rehabilitation, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 487−490, Laval, France, 10 − 12 Sept. 2012.

Promoting ability with interactive artistic environments, **K Sá**, **A M Almeida**, **A Moreira**, University of Aveiro, PORTUGAL

The intention of this project derives from the beauty of the field of arts and from interaction and immersion paradigms, which are today potentiated by multisensory and multimodal feedback in technological environments. We wanted to see the impact of interactive artistic environments on students with special needs, as a form of self-expression and inclusion, in a real school context. Emphasizing the actual Portuguese inclusive school framework, this study was carried out in a public education establishment, with twelve students from individualized special curricula. *Special INPUT* was the concept of different types of environments and interaction approaches were implemented in individual sessions with the participants, which allowed to promote and observe their intellectual, emotional, personal, interpersonal, intrapersonal, psychomotor and artistic skills. At the moment, we have not yet closed the study, so our presentation focuses on the process, as there are no final results.

K Sá, A M Almeida, A Moreira, Promoting ability with interactive artistic environments, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 491−494, Laval, France, 10 − 12 Sept. 2012.

Generative design as a method to foster explorative behaviour in virtual motor rehabilitation, **T Schüler**, University of Osnabrück, GERMANY

The article contrasts the bottom-up with the top-down approach to the development of systems for virtual motor rehabilitation. A research project is presented that uses the top-down approach for the development of a system for virtual neurorehabilitation of amputees suffering from phantom limb pain. Artistic visualisations that are inspired by the field of generative design will be used to constitute the illusion of a moving phantom limb. The coupling between the movements of the patients and the visual effect is not straightforward but needs to be discovered through explorative behaviour. It is assumed that this will help the patients to concentrate on the treatment and therefore a strong therapeutic effect will be achieved.

T Schüler, Generative design as a method to foster explorative behaviour in virtual motor rehabilitation, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 495−498, Laval, France, 10 − 12 Sept. 2012.

Virtual office for students with learning difficulties, **C Sík Lányi**, **G Sádori Pap**, University of Pannonia, Veszprém, HUNGARY

People with learning difficulties often face lack of opportunities in their everyday lives, and less than 10% of them have a job (Brown et al, 2010). This group needs additional support and innovative pedagogical approaches, matched to their needs, to develop skills for work and independent living. We developed a virtual office for students with learning difficulties, which teaches them how to get their first identity or national health insurance card, passport and European health insurance card. In this paper we address questions related to the design and evaluation of games developed to suit the needs of people with individual learning needs.

C Sík Lányi, G Sádori Pap, Virtual office for students with learning difficulties, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 499–502, Laval, France, 10 – 12 Sept. 2012.

Developing serious games for victims of stroke, **C Sík Lányi**, **V Szűcs**, **E László**, **T Dömők**, University of Pannonia, Veszprém, HUNGARY

This study introduces Serious games, which are special games planned within the "StrokeBack" project. The aim of these games is to support the rehabilitation process of stroke patients who have upper limb impairments and damaged psychomotor abilities. In this paper we will present the methodology and ideology of Serious games, and we will prove the importance and necessity of developing such tool.

C Sík Lányi, V Szűcs, E László, T Dömők, Developing serious games for victims of stroke, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 503–506, Laval, France, 10 – 12 Sept. 2012.

Virtual reality and brain-computer interface for joint-attention training in autism, **M Simões**, **P Carvalho**, **M Castelo-Branco**, University of Coimbra, PORTUGAL

Autism Spectrum Disorders (ASD) are characterized by three core behaviours: deficits in social interactions, in communication and repetitive and restricted behaviours. One of the pivotal skills we acquire for social interaction is joint attention, which has been also related to communication skills. The systemizing theory of Autism suggests that these individuals have a preference for computerized systems because of its structure and deterministic functioning. It is hypothesized that Virtual Reality may play an important role for teaching social skills in these individuals, since it can mimic the real world in a more controlled way. In this paper, we propose the use of VR for the training of joint-attention skills in Autism using a Brain-Computer Interface. We developed environments where a virtual human character directs attention to a virtual object in the environment, which the user is supposed to identify by paying attention to it. The subject's brain activity is monitored in real time by electroencephalogram (EEG) and a classifier tries to identify the target object detecting the P300 wave in the EEG. Preliminary results show a classification accuracy of 90% encouraging the approach.

M Simões, P Carvalho, M Castelo-Branco, Virtual reality and brain-computer interface for joint-attention training in autism, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 507–510, Laval, France, 10 – 12 Sept. 2012.

Robotic rehabilitation tool supporting up and down motions in the bathroom – analyses of the catapult-assisted taking-off mechanism, **M Sone**, **H Wagatsuma**, **K Tachibana**, **K Sakamoto**, Kyushu Institute of Technology, Kitakyushu/RIKEN Brain Science Institute, Saitama/Ibaraki Prefectural University of Health Sciences, Inashiki-Gun Ibaraki/Tohoku University, Sendai, JAPAN

Flexibility and quickness of biological muscles are of interest to people developing welfare robots and studying physiotherapy procedures. We focus on the transition process from sitting to standing in human motions, which needs to generate an instantaneous force at the moment of standing, and propose a robotic device to help the up-and-down motion in the bathroom by assisting the force when the backside is taking off from the lavatory basin. Our lightweight construction device allows disabled persons to move easily from the living space to the bathroom and assist its motion from the viewpoint of rehabilitation. In the prototype experiment, the artificial muscle—based on elastic-plastic materials by using rebound characteristics in an S-shaped structure—demonstrated that a cyclic motion triggers a generation of instantaneous force large enough to launch a ball. This suggests that the combination of the movable frame with the human body and the artificial muscle mechanism provide a user-friendly tool for self-supporting life of disabled persons.

M Sone, H Wagatsuma, K Tachibana, K Sakamoto, Robotic rehabilitation tool supporting up and down motions in the bathroom – analyses of the catapult-assisted taking-off mechanism, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 511−514, Laval, France, 10 − 12 Sept. 2012.

Personalised stroke rehabilitation intervention using open source 3D software and the Wii Remote Plus, **E Tsekleves**, **D Skordoulis**, **I Paraskevopoulos**, **C Kilbride**, **A Warland**, Brunel University, Uxbridge, UK

The research presented in this paper proposes a novel low-cost customised Virtual Reality (VR) based, stroke rehabilitation system for the delivery of motivating rehabilitation sessions and evaluation of performance. The described system is designed to capture and monitor human upper limb motion using a low cost and commercially available accelerometer and gyroscope device, the Nintendo Wii remote and open source 3D software. This is the first project to successfully fuse the Nintendo Wii remote acceleration and gyroscope data to offer a real-time one-to-one representation of the controller in a VR environment. A pilot study established a high degree of user acceptability and high levels enjoyment using the tailor made games and personalised exercises in a chronic stroke survivor. Moreover, positive changes were demonstrated in all four outcome measures employed; of particular note were improved wrist control and greater functional use of the hand.

E Tsekleves, D Skordoulis, I Paraskevopoulos, C Kilbride, A Warland, Personalised stroke rehabilitation intervention using open source 3D software and the Wii Remote Plus, *Proc. 9th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 515−518, Laval, France, 10 − 12 Sept. 2012.

Relationship between sensory processing profiles and sense of presence, **H S Wallach**, **M P Safir**, **R Horef**, University of Haifa, ISRAEL

'*Sensory Processing*' is the distinction, modulation and response to sensory input, and combines high or low neurological thresholds and high or low behavioral responses. We examined the impact of sensory processing on sense of presence in a flight VRE. Subjects (85) completed the Adult Sensory Profile, experienced a 10 minute VRE and completed presence questionnaires. According to expectations, Sensory Sensitivity correlated positively with presence for Minority (Arab) participants and those who failed to look at the window, and Sensory Avoidance correlated positively with presence. Contrary to expectations Sensory Sensitivity correlated negatively with presence for Majority (Jewish) participants and Sensory Avoidance correlated negatively with presence for Minority (Arab) participants. We conclude that for high Sensory Sensitivity individuals it is essential to ensure that distracting technological and environmental stimuli are kept to a minimum; for High Sensory Avoidant individuals, control of the environment is important; for those high on Sensory Seeking, interactivity in the VRE is important to enhance presence.

H S Wallach, M P Safir, R Horef, Relationship between sensory processing profiles and sense of presence, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 519−522, Laval, France, 10 − 12 Sept. 2012.

Haptics visualisation of scientific data for visually impaired users, **R J White**, **W S Harwin**, University of Reading, UK

Visualisations of numerical data often used in science, engineering and mathematics are not easily accessible to visually impaired students. This paper describes the development and evaluation of a multimodal system to present graphical data in real-time to those students. Haptic interfaces form the primary interaction, along with auditory feedback allowing graphs to be perceived through touch, sounds and speech. The results show that the system can be used to quickly and accurately obtain information from a graph. It has been demonstrated that haptic devices can be successfully used to allow access to line graph data.

R J White, W S Harwin, Haptics visualisation of scientific data for visually impaired users, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 523−526, Laval, France, 10 − 12 Sept. 2012.
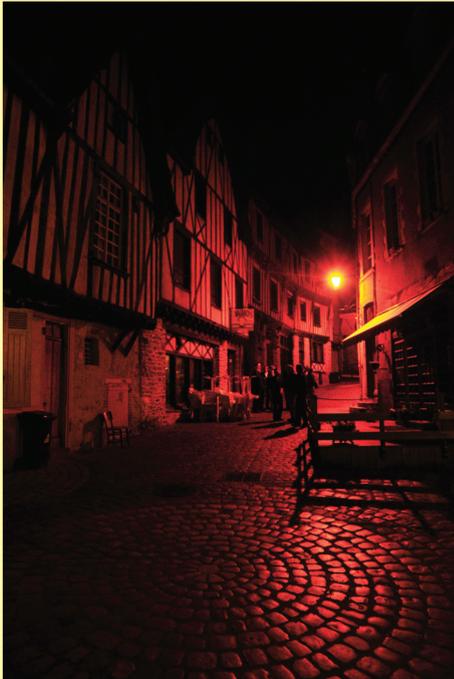
Augmented reality discovery and information system for people with memory loss, **S Wood**, **R J McCrindle**, University of Reading, UK

Augmented Reality (AR) merges computer generated objects with real world concepts in order to provide additional information to enhance a person's perception of the real world. This paper describes the work undertaken for an MEng project to investigate the potential of using AR to assist people who have memory loss with simple everyday tasks such as making a hot drink or cooking basic meals. The aim of the Augmented Reality Discovery and Information System (TARDIS) is to help people live independently in their own homes for as long as possible and without relying as heavily on carer support.

S Wood, R J McCrindle, Augmented reality discovery and information system for people with memory loss, *Proc. 9th Intl Conf. on Disability*, *Virtual Reality and Assoc. Technologies*, P M Sharkey, E Klinger (Eds), pp. 527−530, Laval, France, 10 − 12 Sept. 2012.

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