The 11th International Conference on

Disability, Virtual Reality and Associated Technologies

Proceedings

Edited by:

Paul Sharkey
Albert 'Skip' Rizzo

20 to 22 September, 2016

Los Angeles, California, USA

ICDVRAT 2016

The papers appearing in this book comprise the proceedings of the 11th International Conference on Disability, Virtual Reality and Associated Technologies, held between the 20th and 22nd of September, 2016 in Los Angeles, California, USA. 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

Monday, 20 September, 2016

09:00 – 17:00	Pre-Conference Workshop on Virtual Reality and Pain Management

Tuesday, 20 September, 2016

08:00	Registration/Information Desk opens from 08:00
08:50	Welcome
09:00 – 10:00	Session I: Stroke Rehabilitation
10:00	Coffee
10:30 – 11:30	Keynote: Simon Richir *on* Laval Virtual Vision 2025
11:30 – 12:30	Session II: Neurodisability/Behaviour
12:30	Lunch
14:00 – 15:00	Session III: Interaction
15:00	Coffee
15:30 – 16:50	Session IV: Healthcare Design
18:30	Reception

Wednesday, 21 September, 2016

08:30	Registration/Information Desk opens from 08:30
09:00 – 10:00	Session V: Visual Impairments
10:00	Coffee
10:30 – 12:30	Session VI: Psychology/Communication
12:30	Lunch
13:00	Lunchtime Talk: Roy Taylor, Corporate Vice-President, AMD
14:00 – 14:40	Invited Speaker: Mónica Cameirão *on* Stroke Virtual Rehabilitation
14:40 – 15:10	Short Paper Podium Presentations
15:10 – 16:50	Poster Presentations *&* Interactive Demo Session
15:30	Coffee
c. 20:00	Conference Dinner

Thursday, 22 September, 2016

08:30	Registration/Information Desk opens from 08:30
09:00 – 10:20	Session VII: System Design/Self-management
10:20	Coffee
10:50 – 12:10	Session VIII: Stroke/General Rehabilitation
12:10	[*Conference Closed*]
13:00 – 17:00	Post-Conference Workshop on Virtual Reality and Wounds of War

Contents

Abstracts & Information on Los Angeles

Keynote I   Simon Richir *on* Laval Virtual Vision 2025

Keynote II   Mónica Cameirão *on* Stroke Virtual Rehabilitation

Session I   Stroke Rehabilitation

Session II   Neurodisability/Behaviour

Session III   Interaction

Session IV   Healthcare Design

Session V Visual Impairments

Session VI Psychology/Communication

Session VII   System Design/Self-management

Session VIII   Stroke/General Rehabilitation

Short Papers

Internet address references within the papers presented in this volume were accessed and checked to be valid during the week 1–7 August 2016.

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Conference Series Archive

Paul Sharkey, University of Reading, UK

Introduction

The 11th International Conference on Disability, Virtual Reality and Associated Technologies (ICDVRAT 2016) provides 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 20th 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), Viña del Mar/Valparaíso, Chile (2010), Laval, France (2012), and Gothenburg, Sweden in 2014.

After peer review process, the International Programme Committee selected 30 Full Papers for presentation at the conference, collected into 8 plenary sessions: Stroke Rehabilitation, Neurodisability/Behaviour, Interaction, Healthcare Design, Visual Impairments, Psychology/ Communication, System Design/Self-management, and Stroke/General Rehabilitation. There will be an additional 30 Short Papers presented at a Poster Session. The conference will be held over three days between the 20th and 22nd September at the Millennium Biltmore Hotel in downtown Los Angeles, California, USA.

For the 2016 conference, there will be two invited presentations. The first will be a Keynote Address from Simon Richir of Arts et Metiers Paris Tech and Laval Virtual, introducing the concept of the Laval Virtual Vision 2025, a shared vision of the future of immersive technologies, the main challenges to be overcome and how this might be achieved. The second invited presentation will be from Mónica Cameirão, inaugural recipient of the ISVR Early Career Researcher Award in 2016, who will present a personal reflection on 10 years researching in the area of stroke virtual rehabilitation.

The Conference will host two workshops: a pre-conference workshop, held on Monday, September 19, sponsored by the Mayday Fund, will focus on Virtual Reality and Pain Management, whilst a post conference workshop on the afternoon of Thursday, September 22, will discuss Virtual Reality and Wounds of War.

Abstracts from this conference and full papers from the previous conferences are available online from the conference web site *www.icdvrat.org*.

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 2016, we welcome all delegates to the Conference and sincerely hope that delegates find the conference to be of great interest.

Skip Rizzo and Paul Sharkey

Conference Sponsors

The main sponsors of ICDVRAT 2016 are:

> The University of Reading, UK
>
> USC Insititute for Creative Technologies, USA
>
> University of Southern California, USA
>
> *and*
>
> The Mayday Fund, USA

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

> International Society for Virtual Rehabilitation
>
> Bright Cloud International Corp
>
> Neurobehavior Services Inc.

Additional help in publicising the conference has been gratefully received from vrpsych-l@mymaillists.usc.edu, and the ISVR and VRPSYCH-L facebook pages, amongst many others.

Conference Prizes

The conference awards 4 prizes: Best Paper, Best Student Paper, Best Short Paper and Best Student Short Paper.

Bright Cloud International Corp (www.brightcloudint.com) is the 2016 sponsor for Best Full Paper and Best Short Paper awards.

The International Society for Virtual Rehabilitation (www.isvr.org) is the 2016 sponsor for Best Student Full Paper and Best Student Short Paper awards.

Student papers are papers where the student is affirmed to be the primary author and where the paper is presented by that student at the confereence. These papers are identified prior to the conference on submission of the final paper.

Hidden Los Angeles

Compiled by Paul Sharkey

A tradition of this conference series is to include a short essay about the location of the conference, allowing delegates a greater understanding of the historical and cultural developments over the years that shaped the host town or city into what is seen today.

In brief, Downtown Los Angeles has traditionally been seen as the main business and govenermental centre of the wider Los Angeles metropolitan area, and is well known for its parks and theatres, a diverse residential neighbourhood, and perhaps more infamously for its own 'Skid Row'; east of Main Street, Los Angeles' Skid Row is said to have one of the USA's largest stable populations of homeless people (between 3–6,000). In recent years Downtown Los Angeles has been through a resurgence, with once empty but yet intact historical buildings being repurposed, allowing the centre to blossom with new inverstment and increases in residential populations.

However, with a city as expansive and diverse as Los Angeles, the second biggest city in the United States, any short essay would surely be left wanting – an alternative approach is required …

And so, compiled below is but a small selection of the oddities and curiosities available at the Atlas Obscura website, concentrating on the downtown district, centred around Pershing Square, many of which are within comfortable walking distance of the Millennium Biltmore conference hotel. Images and text (edited) are with the kind permission of Atlas Obscura*.

The Last Bookstore   453 S. SPRING STREET
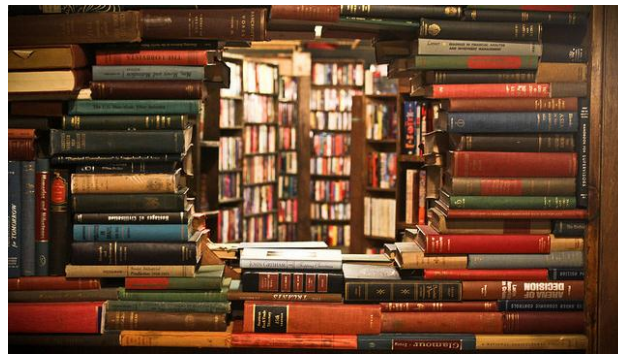
The Last Bookstore is an iconic LA bookstore housed in the grand atrium of what was once a bank. The marble pillars and mile-high ceiling remain from the old bank, but in place of patrons and guarded stacks of cash, bookshelves line the walls and artful displays of books abound. The bookstore specializes in reasonably priced used books, and takes great pride in offering a selection of well-kept vintage books as well. Anyone who's ever loved a vintage book will know exactly what that means for the musty, decadent smell that hangs in the air in this seemingly sacred place (6 minutes walk).

Space Shuttle Endeavour   CALIFORNIA SCIENCE CENTER, 700 EXPOSITION PARK DRIVE

The fifth and final space shuttle that NASA built, Endeavour was an orbiter that flew its first mission in 1992. Built to replace the doomed Challenger shuttle after it was lost during launch, Endeavour represented hope and perseverance, a symbol of the bravery displayed by the men and women who persisted in exploring the unknown, despite the strong odds against them (30 mins by cab).

Angels Flight   351 SOUTH HILL STREET

Established in 1901, the historic funicular Angels Flight railway has carried millions of Angelenos up and down the steep incline of Bunker Hill. Though the 315-foot trip only lasts thirty seconds, it is believed that Angels Flight has carried more passengers per mile than any other railway in the world, making it not only the shortest in length, but also the most traveled (6 mins walk).

Bob Baker Marionette Theater   1345 W. 1ST STREET

Bob Baker is an established puppeteer, and with the help of his 3,000 handmade marionettes, has been entertaining audiences for over 70 years. Baker was a key activist in establishing union status for puppeteers, and his theater serves as a training ground for many puppet-makers who go on to work in fantasy films. With a long history of working in Hollywood, Baker's creations have been featured in TV shows such as Star Trek and Bewitched, and films such as Bluebeard, A Star is Born and Close Encounters of the Third Kind (25 minutes walk/4 mins by cab).

Clifton's Cafeteria   648 SOUTH BROADWAY

Clifton's Cafeteria, a cabinet of curiosities, where you can "*Dine for Free Unless Delighted*" (7 mins walk).

Blurring the lines between digital and physical worlds

Simon Richir

Arts et Metiers ParisTech/Laval Virtual, FRANCE

ABSTRACT

The recent evolution of immersive technologies, such as Virtual Reality (VR) and Augmented Reality (AR) as well as Mixed Reality (MR), leads to the emergence of new immersive experiences occurring in blended spaces constituted of both digital and physical worlds. This paper, based on the outcomes of the first edition of the Laval Virtual Seminar on Vision 2025, explores Immersive Virtual Environments (IVE), its related technologies, and more particularly addresses the potential increase of the immersion quality. It also discusses the main IVE elements and tries to foresee their key challenges and needs towards envisioned future developments.

BIO-SKETCH

Simon Richir, M.Eng, Ph.D., is one of the pioneers and the most recognized leaders in French VR research and its practical application. A Professor at Arts et Metiers ParisTech (ENSAM), the renowned French School of Engineering, Simon Richir is also the head of the "Presence & Innovation" research team (LAMPA Lab, EA1427). His research and teaching activities concentrate on technological innovation, engineering design process, innovative projects, and innovative uses of new advanced technologies such as Virtual Reality or Augmented Reality. In addition to these activities, Professor Richir is also the co-founder and the current scientific chair of one of the world's most prestigious international events in Virtual Reality – the annual Laval Virtual International Conference (ACM VRIC). Simon Richir also served as the essential collaborator in the development of augmented virtual reality environments in medical training and practical operations – an approach that ultimately gained the status of a "routine approach" in medical education. For 20 years, he has been developing new uses of virtual reality across a wide range of application areas.

Invited Presentation: Mónica Cameirão
Recipient of the 2016 ISVR Early Career Investigator Award

Insights from 10 years of stroke virtual rehabilitation – a personal perspective

Mónica Cameirão

University of Madeira/Madeira Interactive Technologies Institute, PORTUGAL

BIO-SKETCH

Mónica is an Invited Assistant Professor and researcher at the University of Madeira (UMa) and the Madeira Interactive Technologies Institute (Madeira-ITI) in Portugal. Mónica holds a PhD in ICT from the Universitat Pompeu Fabra (Spain) and a MSc in Applied Physics from the Universidade de Aveiro (Portugal). She is currently the Portuguese coordinator of the Professional Masters on Human-Computer Interaction program that UMa/Madeira-ITI offers in conjunction with Carnegie Mellon University in Pittsburgh, USA. In the past she worked as research assistant at the SPECS Laboratory of the Universitat Pompeu Fabra and at the Institute of Neuroinformatics, ETH-Zürich, Switzerland; and was visiting scholar at the Quality of Life Technologies center of Carnegie Mellon University.

Since Mónica arrived in Madeira in 2011, she has been co-principal investigator and co-founder of the NeuroRehabLab Research Group, a research group created in the context of the Madeira-ITI with over 15 members, including PhD students, technicians, MSc students and other faculty members. The NeuroRehabLab is an interdisciplinary research group that investigates at the intersection of technology, neuroscience and clinical practice to find novel solutions to increase the quality of life of those with special needs.

In recent years, Mónica has been involved in the development and clinical assessment of virtual reality technologies for stroke rehabilitation and her work gave rise to a number of high impact publications in journals such as Stroke, Restorative Neurology and Neuroscience, and the Journal of Neuroengineering and Rehabilitation. Mónica's work in VR explores specific brain mechanisms that relate to functional recovery to approach motor and cognitive stroke rehabilitation by means of non-invasive and low-cost technologies. Her research addresses aspects such as serious gaming, personalization of training, integrative motor-cognitive tasks, physiological computing or the emotional content of training stimuli. More recently, Mónica also started applying these principles to technology mediated fitness training for the elderly population.

Cameirão, M S (2016), Insights from 10 years of stroke virtual rehabilitation – a personal perspective, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 9–10, Los Angeles, California, USA, 20–22 Sept. 2016.

Impact of combined cognitive and motor rehabilitation in a virtual reality task: an on-going longitudinal study in the chronic phase of stroke

A L Faria, J Couras, M S Cameirão, T Paulino, G M Costa, S Bermúdez i Badia

Universidade de Coimbra/Madeira Interactive Technologies Institute, Funchal/Centro Médico da Murtosa, Aveiro/Universidade da Madeira, Funchal, PORTUGAL

ABSTRACT

Stroke is one of the most common causes of acquired disability, leaving numerous adults with cognitive and motor impairments, and affecting patients' capability to live independently. Virtual Reality (VR) based methods for stroke rehabilitation have mainly focused on motor rehabilitation but there is increasing interest towards the integration of cognitive training for providing more effective solutions. In this work we present a VR cognitive and motor training task – the Reh@Task – and the preliminary results from an ongoing one-month longitudinal intervention. We show the results from twelve patients divided in two groups: experimental and control. Both groups were enrolled in conventional occupational therapy, which mostly involves motor training. Additionally, the experimental group performed a specific attention and memory training with the Reh@Task and the control group performed time-matched conventional occupational therapy. This VR-based task consists of performing adapted arm reaching movements and has difficulty progression levels implemented with guidelines from a participatory design study. We assessed the impact of both interventions post-treatment (4-5 weeks) and at 4 weeks follow-up through the Montreal Cognitive Assessment, Single Letter Cancellation, Digit Cancellation, Bells Test, Fugl-Meyer, Chedoke Arm and Hand Activity Inventory, Modified Ashworth Scale and Barthel Index. A within groups analysis revealed significant improvements with respect to baseline in the global cognitive functioning in both groups, but only the patients who used the Reh@Task improved significantly in attention and memory. With respect to the motor domain, the control group showed greater improvements. Nevertheless, both groups improved significantly in the functional recovery of the hand and arm scores, revealing that both interventions had an impact in the use of the hand and arm in the activities of daily living. Overall, results are supportive of the viability of tools that combine motor and cognitive training, such as the Reh@Task.

Interaction with the Reh@Task through the AnTS tracking software.

Longitudinal study of integrative virtual rehabilitation use in skilled nursing facility maintenance programs for residents with chronic stroke

G House, G Burdea, N Grampurohit, K Polistico, D Roll, F Damiani,
S Keeler, J Hundal, S Pollack

Bright Cloud International Corp, Highland Park, NJ/Roosevelt Care Center, Edison, NJ/JFK
Hartwyck at Edison Estates, Edison, NJ/Hundal Neuropsychology Group, Watchung, NJ/Data
Driven Innovation, Westhampton, NY, USA

ABSTRACT

The objective of this 45-week longitudinal controlled study was to examine the effects of integrative virtual rehabilitation with BrightArm Duo System for the maintenance of skilled nursing facility programs for elderly residents with chronic stroke. The experimental group trained intensely for 8 weeks followed by 3 booster periods at 8-week intervals. The sessions were supervised by an occupational therapist. The control (n=3) and experimental (n=7) groups both received standard-of-care maintenance. The improvement for the experimental group was significantly better than the controls in standardized assessments of UE range of motion (p=0.04), strength, and function (p=0.035), and for cognition and emotion (p=0.0006).
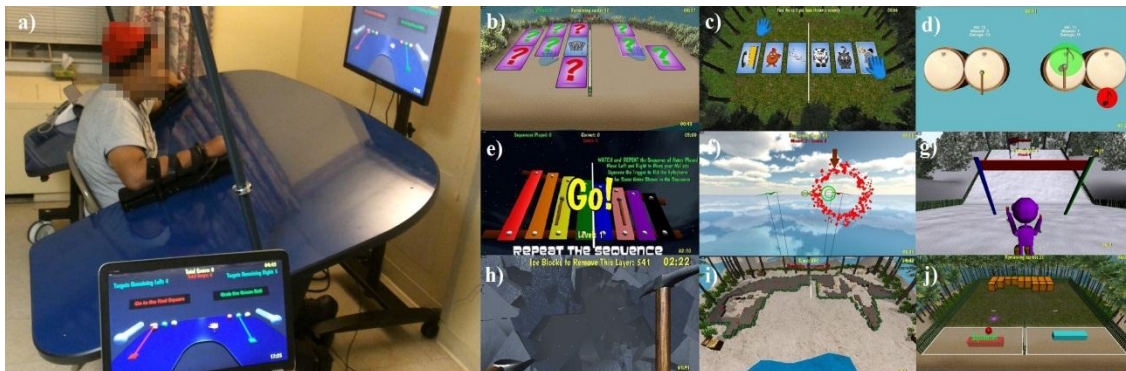
a) BrightArm system with subject training bimanually on Pick & Place game. Additional games: b) Card Island; c) Remember that Card ; d) Musical Drums; e) Xylophone; f) Kites; g) Arm Slalom; h) Avalanche; i) Treasure Hunt; and j) Breakout 3D.

Competition improves attention and motivation after stroke

R Llorens, M D Navarro, E Noé, M Alcañiz

Universitat Politècnica de València/ Fundación Hospitales NISA,
Valencia/Univesity of Jaume I, Castellón, SPAIN

ABSTRACT

Cognitive deficits are a common sequelae after stroke. Among them, attention impairments have the highest incidence and limit functional recovery and quality of life. Different strategies to improve attention have been presented through the years, even though its effectiveness is still unclear. Basing on the human competitive nature, competitive strategies have been proposed to increase motivation and intensity. However, this approach has been never applied to train attention after stroke. In this paper, we present a randomized controlled trial that evidences the important role of competition in cognitive functioning. Our results support that competitive strategies combining virtual reality-based and paper and pencil tasks can improve attention and motivation after stroke to a greater extent than non-competitive paper and pencil tasks.
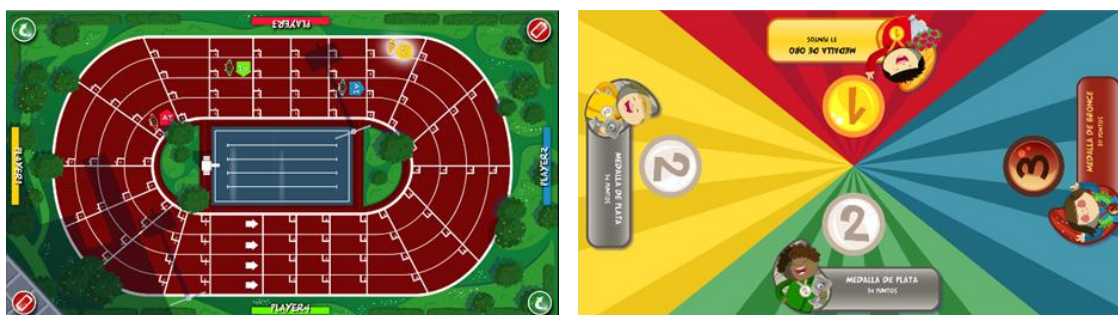
Snapshots of the main screen (left) and the results screen after each exercise (right).

Current issues and challenges in research on virtual reality therapy for children with neurodisability

W J Farr, I Male, D Green, C Morris, H Gage, S Bailey, S Speller, V Colville, M Jackson, S Bremner, A Memon

Sussex Community NHS Foundation Trust, Brighton/Oxford Brookes University/University of Exeter/Sussex Community NHS Foundation Trust, Brighton/University of Surrey/Brighton and Sussex Medical School, Brighton, ENGLAND

ABSTRACT

A PICO (population, intervention, comparison, outcome) approach is adopted to discuss issues and challenges in virtual reality therapy research in community health settings. Widespread variation within and between populations, e.g. co-morbid conditions, complicates treatment fidelity and applicability. Interventions require flexible dose and frequency to fit into children's family circumstances, with clearly employed specialist paediatric research staff. Comparisons require adaptation to digital technology, and keep pace with development. Outcomes may overstate the impact of virtual reality therapy and technological novelty, while not fully unpacking hidden digital effects. A wide set of agreed, flexible, and patient-centred outcome measures are required to establish positive clinical baseline.
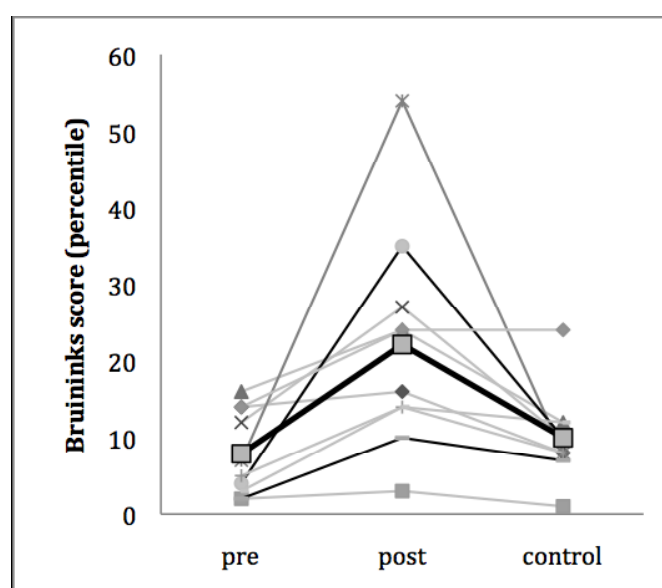
Change in BOT-2 percentile for individual children using the Wii Fit as a treatment for DCD in a school setting; group A in a crossover study received intervention initially and then acted as controls. Mean result shown by thickened black line.

Using virtual interactive training agents with adults with autism and other developmental disabilities

T Bresnahan, A A Rizzo, S L Burke, M Partin, R M Ahlness, M Trimmer

The Dan Marino Foundation, Fort Lauderdale/ University of Southern California – Institute for Creative Technologies, Los Angeles/Florida International University, Miami, USA

ABSTRACT

Conversational Virtual Human (VH) agents are increasingly being used to support role-play experiential learning across a range of use-cases and populations. This project examined whether use of the Virtual Interactive Training Agent (VITA) system would improve job interviewing skills in a sample of persons with autism or other developmental disability. The study examined performance differences between baseline and final interviews in face-to-face and virtual reality conditions, and whether statistically significant increases were demonstrated between interviewing conditions. Paired samples t-tests were utilized to examine mean changes in performance by interview stage and in the overall difference between baseline and final interview stages. The preliminary results indicated that VITA is a positive factor when preparing young adults with autism or other developmental disability for employment interviews. Statistically significant results were demonstrated across all pilot conditions and in all but one post-assessment condition.

User interacting with components of the VITA system.

Bresnahan, T, Rizzo, AA, Burke, SL, Partin, M, Ahlness, RM, and Trimmer, M (2016), Using virtual interactive training agents with adults with autism and other developmental disabilities, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 49–56, Los Angeles, California, USA, 20–22 Sept. 2016.

Clinical interviewing by a virtual human agent with automatic behavior analysis

A A Rizzo, G Lucas, J Gratch, G Stratou, L-P Morency,
R Shilling, A Hartholt, S Scherer

Institute for Creative Technologies, University of Southern California, USA

ABSTRACT

SimSensei is a Virtual Human (VH) interviewing platform that uses off-the-shelf sensors (i.e., webcams, Microsoft Kinect and a microphone) to capture and interpret real-time audiovisual behavioral signals from users interacting with the VH system. The system was specifically designed for clinical interviewing and health care support by providing a face-to-face interaction between a user and a VH that can automatically react to the inferred state of the user through analysis of behavioral signals gleaned from the user's facial expressions, body gestures and vocal parameters. Akin to how non-verbal behavioral signals have an impact on human-to-human interaction and communication, SimSensei aims to capture and infer user state from signals generated from user non-verbal communication to improve engagement between a VH and a user and to quantify user state from the data captured across a 20 minute interview. As well, previous research with SimSensei indicates that users engaging with this automated system, have less fear of evaluation and self-disclose more personal information compared to when they believe the VH agent is actually an avatar being operated by a "wizard of oz" human-in-the-loop (Lucas et al., 2014). The current study presents results from a sample of military service members (SMs) who were interviewed within the SimSensei system before and after a deployment to Afghanistan. Results indicate that SMs reveal more PTSD symptoms to the SimSensei VH agent than they self-report on the Post Deployment Health Assessment. Pre/Post deployment facial expression analysis indicated more sad expressions and fewer happy expressions at post deployment.

User with SimSensei virtual clinical interviewer.

Impact of the visual representation of the input device on driving performance in a power wheelchair simulator

A Alshaer, D O'Hare, S Hoermann, H Regenbrecht

University of Otago, Dunedin, NEW ZEALAND/University of Sydney, AUSTRALIA

ABSTRACT

Virtual reality-based power wheelchair simulators can help potential users to be assessed and trained in a safe and controlled environment. Although now widely used and researched for several decades, many properties of virtual environments are still not yet fully understood. In this study, we evaluated the effects of the visual representation of the input device in a virtual power wheelchair simulator. We compared the virtual display of a standard gaming joystick with that of a proprietary power wheelchair joystick while users used either of the real world counterparts, and measured the effects on driving performance and experience. Four experimental conditions comprising two visual virtual input modalities and their two real counterparts as independent variables have been studied. The results of the study with 48 participants showed that the best performance was obtained for two of three performance indicators when a virtual representation of the PWC joystick was displayed, regardless of what type of joystick (real PWC or gaming joystick) was actually physically used. Despite not explicitly being made aware of by the experimenter, participants reported noticing the change in the visual representation of the joysticks during the experiment. This supports the theory that the effects of virtual reality representations have a significant impact on the user experience or performance, and visual properties need to be carefully selected. This is specifically important for applications where the transfer effects to real world scenarios is sought and ecological valid simulation is aimed for.

Experiment setup (left): Alienware laptop, gaming joystick, and PWC joystick; an outside view of the house environment used in our simulation (right).

Influence of navigation interaction technique on perception and behaviour in mobile virtual reality

W Powell, V Powell, P Brown, M Cook, J Uddin

University of Portsmouth, UK

ABSTRACT

In recent years the development of affordable virtual reality has opened up enormous possibilities for virtual rehabilitation, and the introduction of ultra-low cost mobile VR such as Google Cardboard has real potential to put virtual rehabilitation right into patient's homes. However, the limited interaction possibilities when a mobile phone is mounted into a headset mean that these devices are generally used for little more than passive viewing. In this paper we present an evaluation of three approaches to supporting navigation in mobile VR, and discuss some of the potential hazards and limitations.

The six target locations visited in the study in sequence from left to right, before returning to the starting location (top); the experimental setup (below).

Study of stressful gestural interactions: an approach for assessing their negative physical impacts

S Ahmed, L Leroy, A Bouaniche

Université Paris, FRANCE

ABSTRACT

Despite the advantages of gestural interactions, they involve several drawbacks. One major drawback is their negative physical impacts. To reduce them, it is important to go through a process of assessing risk factors to determine the interactions' level of acceptability and comfort so as to make them more ergonomic and less tiring. We propose a method for assessing the risk factors of gestures based on the methods of posture assessment in the workplace and the instructions given by various standards. The goal is to improve interaction in virtual environments and make it less stressful and more effortless.
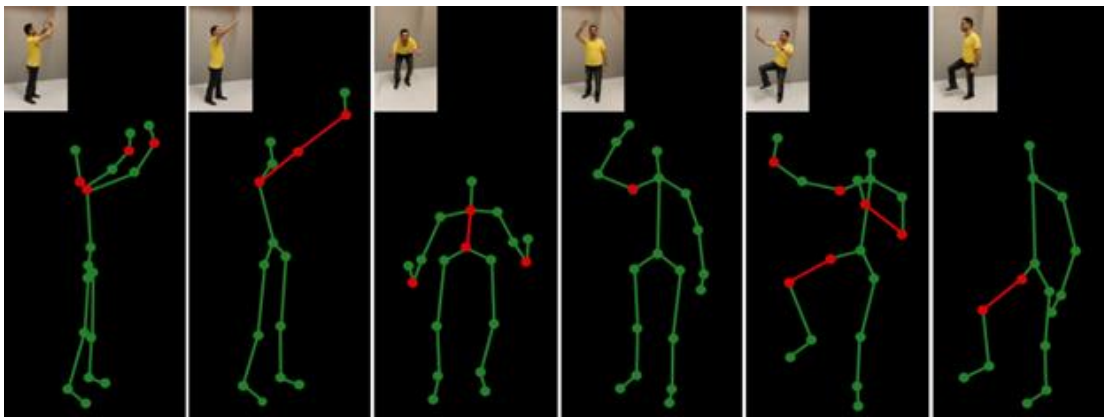
Stressed joints, colored red in the application real-time output (simulated).

Ahmed, S, Leroy, L, and Bouaniche, A (2016), Study of stressful gestural interactions: an approach for assessing their negative physical impacts, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 83–91, Los Angeles, California, USA, 20–22 Sept. 2016.

Open rehabilitation initiative: design and formative evaluation

S Bermúdez i Badia, J E Deustch, R Llorens

Universidade da Madeira, Funchal, PORTUGAL/ Rutgers University, Newark, NJ, USA/Universitat Politècnica de València/Fundación Hospitales NISA, Valencia, SPAIN

ABSTRACT

Development and testing of virtual environments for rehabilitation is a lengthy process which involves conceptualization, design, validation, proof concept testing and ultimately, if appropriate, randomized controlled trials. Ironically, once vetted, many of these VEs are not available to clinicians or their patients. To address the challenge of transferring research grade technology from the lab to the clinic the authors have created the Open Rehabilitation Initiative. It is an international independent online portal that aims to help clinicians, scientists, engineers, game developers and end-users to interact with and share virtual rehabilitation tools. In this paper, the conceptualization, development and formative evaluation testing are described. Three groups of developers of VEs (n=3), roboticists who use VEs for robot interactivity (n=10) and physical therapists (n=6) who are the clinicians end-users participated in the study. Interviews, focus groups and administration of the System Usability Scale (SUS) were used to assess acceptability. Data were collected on three aspects: 1) discussion of what a resource might look like; 2) interaction with the site; and 3) reaction to the proposed site and completion of the SUS. Interviews and focus groups were recorded and transcribed. Data from the SUS was analyzed using a One-way ANOVA. There was no significant difference by groups. However, the clinicians' mean score of 68 on the SUS was just at the acceptable level, while the developers and roboticists scored above 80. While all users agreed that the site was a tool that could promote collaboration and interaction between developers and users, each had different requirements for the design and use. Iterative development and discussion of scaling and sustaining the site is ongoing.

The Open Rehab Initiative content is organized according to the following taxonomy: Upper Limb, Balance, Mobility, Cognition and Fitness.

Remote communication, examination and training in stroke, Parkinson´s and COPD care: work in progress testing 3D camera and movement recognition technologies together with new patient centered ICT services

M Rydmark, J Broeren, J Jalminger, L-Å Johansson, M Johanson, A Ridderstolpe

The Sahlgrenska Academy, University of Gothenburg/
Alkit Communications, Mölndal, SWEDEN

ABSTRACT

This paper describes strategy and work in progress. The combination of patient centered care where many care and nursing units are collaborating with focus on, and in concordance with the patient, the ability to project information focused on the patient total situation and needs independent from where the information was created, the ability to use sensor technology to collect a wide range of aspects of the individuals health situation, the ability to use sensor technology to assess movements both for assessment and intervention purposes, to keep the care and nursing process together through module based information services and a structured care plan containing goals, sub goals, defined activity types and a wide range of health status data involving great opportunities for patients having chronic diseases. This group of patients causes extensive resource consumption for society. Well-structured data and semantic definition of data is a key for communication between different types of multi-professionals actors with different background. New technology, such as a wide range of sensor types, allows the possibly to capture large amounts of data both for assessment and intervention purposes in a continuous way over time. One example is how each planned patient activity has been performed and resulting health status aspects. This research group has worked on these issues for several years and some important milestones have been reached. From a chronic point of view three groups of patients are the focus: stroke patients, chronic obstructive pulmonary disease (COPD) patients and patients with Parkinson's disease. Collaboration approaches, communication technology and adapted information services allow new ways to perform home based care. Integrated monitoring services of planned activities like motion activities using 3D sensors allows professionals and patient to, in an exact way, follow planned and executed motion activities which are of great importance to many patient needs.

Authenticating the subjective: a naturalistic case study of a high-usability electronic health record for virtual reality therapeutics

H J Moller, L Saynor

University of Toronto/OCAD University, Toronto/PRAXIS Holistic Health, Toronto, CANADA

ABSTRACT

Using data from our established Technology-Enhanced Multimodal Meditation (TEMM) stress-reduction program employing the electronic health record system Wellpad, we illustrate the value of developing a qualitative data-analysis approach to inform clinical practice in the rapidly emerging field of immersive therapeutics. In examining "rich data" of a naturalistic 50-patient TEMM cohort, indicates that, as with design of VR therapeutics, there is a highly salient role for immersive diagnostics, which ultimately relates to consumer satisfaction, both for patient and health-care practitioner.
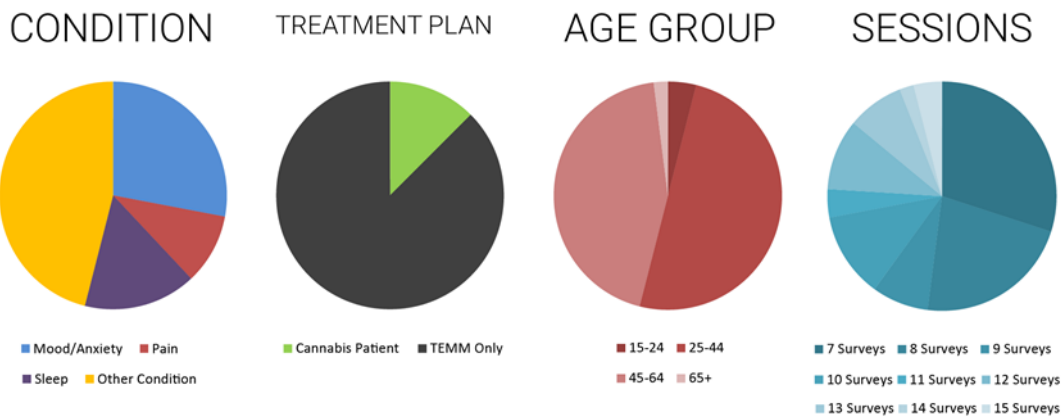
Various proportional classifications of the 50-patient sample.

Moller, HJ, and Saynor, L (2016), Authenticating the subjective: a naturalistic case study of a high-usability electronic health record for virtual reality therapeutics, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 107−112, Los Angeles, California, USA, 20−22 Sept. 2016.

Applying Bayesian modelling for inclusive design under health and situational induced impairments

B I Ahmad, P M Langdon, S J Godsill

University of Cambridge, UK

ABSTRACT

Predictive pointing enables realising smart interfaces, which are capable of inferring the user intent, early in the pointing task, and accordingly assisting the on-display target acquisition (pointing and selection). It adopts a Bayesian framework to effectively model the user pointing behaviour and incorporate the present perturbations induced by situational impairments as well as inaccuracies in the utilised sensing technology. The objective of the predictive pointing system is to minimise the cognitive, visual and physical effort associated with acquiring an interface component when the user input is perturbed due to a situational impairment, for example, to aid drivers select icons on a display in a moving car via free hand pointing gestures. In this paper, we discuss the ability of the predictive pointing or display solution to simplify and expedite human computer interaction when the user input is perturbed due to health induced impairments and disability, rather than a situational impairment. Examples include users with tremors, spasms, or other motor impairments. Given the flexibilities acceded by the Bayesian formulation, the applicability of the predictive pointing to inclusive design in general is addressed. Its intent prediction functionality can be adapted to the user's physical capabilities and pointing characteristics or style, thereby catering for wide ranges of health induced impairments, such as those arising from ageing. It is concluded that predictive displays can significantly facilitate and reduce the effort required to accomplish selection tasks on an interactive display when the user input is perturbed due to health or physical impairments, especially when pointing in 3D with free hand pointing gestures.
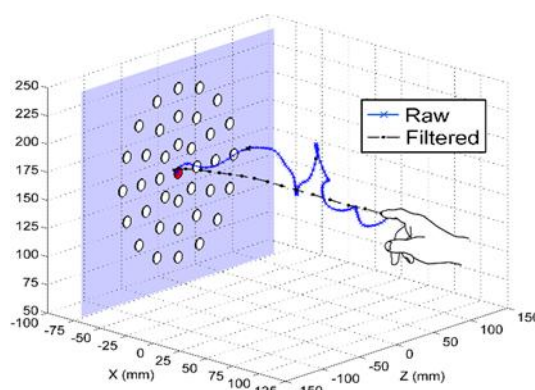
3D pointing track before (blue) and after (dashed) applying a variable rate particle filter.

Tele-guidance based orientation and mobility system for visually impaired and blind persons

B Chaudary, P Pulli, I Paajala, E Keino

University of Oulu, FINLAND

ABSTRACT

The design and development of tele-assistance services have received great consideration in the domain of healthcare lately. Telecare solutions are seen as a potential means of addressing the future care needs of ageing societies. With the growing proportion of dependent people (ageing, disabled users), tele-assistance and tele-monitoring platforms will play a significant role to provide efficient and less-costly remote care and support. It will allow aged and disabled persons to maintain their independence and lessen the burden and cost of caregiving. In the case of visually impaired persons (VIP) and blind persons, guide dogs and white canes provide them a fair degree of independence. However, those are very limited in guiding the user towards a specific desired location, especially in an unknown environment. The assistance of other people presents a feasible solution, though it does not improve the idea of autonomous guidance and privacy. The concept of proposed tele-guidance system is based on the idea that a blind pedestrian can be assisted by spoken instructions from a remote caregiver who receives a live video stream from a camera carried by her. The assistive tools have reportedly acceptance issues by VIP. The paper also presents a qualitative study using a modified version of UTAUT-2 (Unified Theory of Acceptance and Use of Technology) to find out causes for acceptance issues in navigation tools for visually impaired. Another goal of the study was to validate the UTAUT2-model as suitable for researching acceptance issues of navigation assistance tools of VIP.

Tele-guidance system concept.

Computer model based audio and its influence on blind students' learning about gas particle behavior

N Hagab, O Lahav, V Talis

Tel Aviv University, ISRAEL

ABSTRACT

This paper focuses on the need of students who are blind to access science curriculum learning materials. Net Logo is a widely used computational agent-based modelling language that enables exploring and constructing models of complex systems. The Listen-to-Complexity environment is based on Net Logo and involves sonified feedback that was adapted to users who are blind. This study examines the scientific conceptual knowledge, systems reasoning, and Kinetic Molecular Theory of gas in chemistry that were learned as a result of interaction with the Listen-to-Complexity environment by people who are blind as shown in their answers to a pre- and post-test. Five participants who are blind volunteered to participate in this research. The preliminary findings are encouraging with regard to the sonified model's efficacy in providing access to central and difficult scientific concepts, even when the target phenomenon is complex. The benefits of this longitudinal research are likely to have an impact on science education for students who are blind, supporting their inclusion in the K-12 academic curriculum on an equal basis with sighted users.
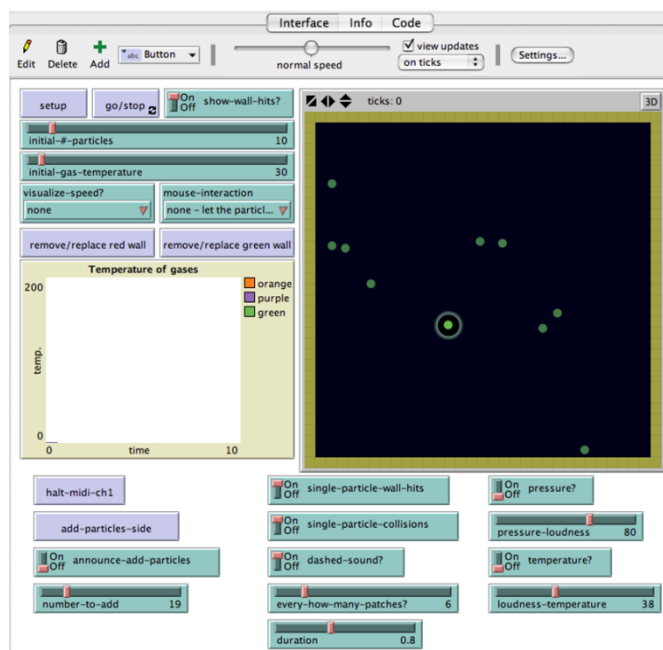
L2C sonified model of gas particles in a container.

Visual impairment simulator for auditing and design

G Stewart, R J McCrindle

University of Reading, UK

ABSTRACT

Individuals within the visually impaired community often have difficulty navigating environments due to the different ways in which they view the world, with even apparently simplistic locations frequently being challenging to traverse. It is therefore important when designing architecture or environments, to take into account the perspectives of people with visual impairments in order to ensure that design outcomes are inclusive and accessible for all. Although there is documentation regarding guidance and procedures for design of inclusive spaces; architects, designers, and accessibility auditors often find it hard to empathize with visually impaired people. This project aims to make the process of inclusive design easier through the development of a mobile app, VISAD (Visual Impairment Simulator for Auditing and Design), which enables users to capture images or import CAD designs and apply image distortion techniques in order to replicate different visual impairments.
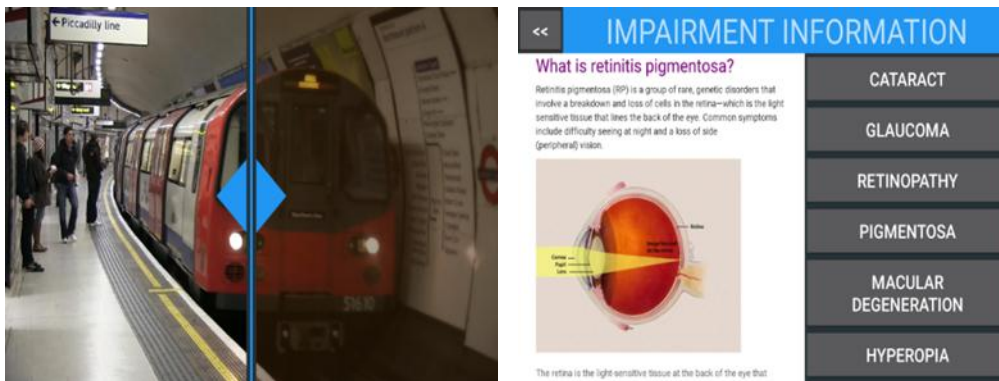
Comparison tool (left); information tool (right).

Differential effect of neutral and fear-stimulus virtual reality exposure on physiological indicators of anxiety in acrophobia

P Maron, V Powell, W Powell

University of Portsmouth, UK

ABSTRACT

This paper presents a study which explores the physiological and behavioural indicators of anxiety during exposure to a virtual reality environment. Using 10 participants (5 with acrophobia and 5 control) the study aimed to determine whether an increase in heart rate (HR) from baseline to VR exposure is a sufficient measure for effectiveness of a virtual reality exposure therapy (VRET) stimulus, or whether there is a mediating effect of neutral VR exposure which should be taken into account. The participants all explored an immersive cityscape at ground level and at height, and both subjective and objective measures of physiological arousal were recorded. It was found that the VRET was successful in inducing an anxiety response in the participants with acrophobia, and moreover demonstrated that an increase in HR from baseline to VRET on its own should not be considered a reliable indicator of VRET efficacy, but that there should be an adjustment for the effect of neutral VR exposure on physiological arousal.

The motion capture suit with optical markers.

Bringing the client and therapist together in virtual reality telepresence exposure therapy

D J Roberts, A J Fairchild, S Campion, A S Garcia, R Wolff

University of Salford, Salford, UK

ABSTRACT

We present a technology demonstrator of the potential utility of our telepresence approach to supporting tele-therapy, in which client and remote therapist are immersed together. The aim is to demonstrate an approach in which a wide range of non-verbal communication between client and therapist can be contextualised within a shared simulation, even when the therapist is in the clinic and the client at home. The ultimate goal of the approach is to help the therapist to encourage the client to face a simulated threat while keeping them grounded in the safety of the present. The approach is to allow them to use non-verbal communication grounded in both the experience of the exposure and the current surroundings. While this is not new to exposure therapy, the challenges are: 1) to do this not only when the threat is simulated; and 2) when the client and therapist are apart. The technology approach combines immersive collaborative visualisation with free viewpoint 3D video based telepresence. The potential impact is to reduce dropout rate of exposure therapy for resistant clients.

3D reconstruction of a human in our telepresence system, showing lines from each camera derived from silhouettes.

Experimental pain reduction in two different virtual reality environments: a crossover study in healthy subjects

N Demeter, D Pud, N Josman

University of Haifa, ISRAEL

ABSTRACT

The literature on unique virtual reality (VR) attributes impacting pain reduction is scarce. This study investigated the effect of two VR environments, with differing cognitive load (CL) demands, on experimental pain levels. Sixty-two students underwent psychophysical thermal pain tests, followed by exposure to tonic heat stimulation under one of three conditions: low CLVR (LCL), high CLVR (HCL), and a control. Significantly greater pain reduction occurred during VR compared to the control condition. Cognitive components predicted pain reduction during HCL only. Cognitive load involved in VR may influence the extent of pain decrease, a finding that may improve treatment protocols and promote future research.
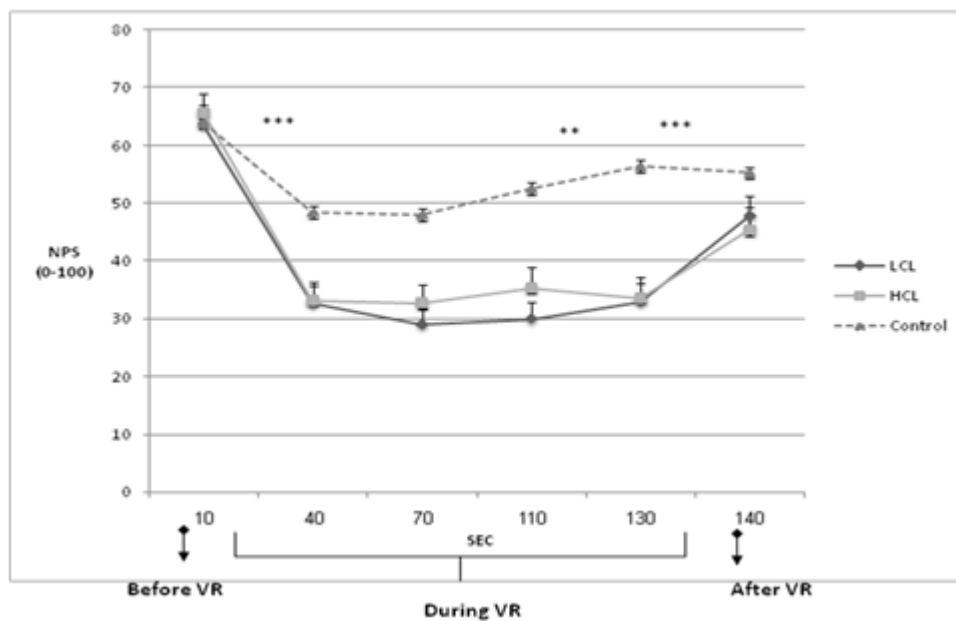
Heat pain intensity during three study conditions (mean±SEM). Asterisks represent differences between the two VR conditions and control within two adjacent time points. LCL=low cognitive load VR, HCL=high cognitive load VR.

Demeter, N, Pud, D, and Josman, N (2016), Experimental pain reduction in two different virtual reality environments: A crossover study in healthy subjects, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 165–172, Los Angeles, California, USA, 20–22 Sept. 2016.

Integrative virtual reality therapy produces lasting benefits for a young woman suffering from chronic pain and depression post cancer surgery: a case study

G House, G Burdea, N Grampurohit, K Polistico, D Roll,
F Damiani, J Hundal, D Demesmin

Bright Cloud International Corp, Highland Park, NJ/Roosevelt Care Center, Edison, NJ/Hundal
Neuropsychology Group, Watchung, NJ/University Pain Medicine Center, Summerset, NJ, USA

ABSTRACT

This case study was part of an evaluation of the BrightArm Duo Rehabilitation System for treating the effects of chronic upper body pain following breast cancer surgery. The subject was a 22-year old woman with burning and stabbing pain in the right upper arm. Training consisted of playing custom bimanual 3D games while seated at the gravity-modulating robotic table for 16 sessions over 8 weeks. Standardized assessments demonstrated a meaningful improvement in motor, cognitive and emotive domains with a statistically significant reduction in pain. Gains transferred to daily activities enabling the subject to resume full time employment, driving and socializing.

BrightArm Duo Table tilted upwards with two arm supports for user interaction and therapist laptop rendering Pick & Place game to the 27″ monitor.

House, G, Burdea, G, Grampurohit, N, Polistico, K, Roll, D, Damiani, F, Hundal, J, and Demesmin, D (2016), Integrative virtual reality therapy produces lasting benefits for a young woman suffering from chronic pain and depression post cancer surgery: a case study, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 173–182, Los Angeles, California, USA, 20–22 Sept. 2016.

Does mixed reality influence texting while walking among younger and older adults?

T Krasovsky, P L Weiss, R Kizony

University of Haifa/Sheba Medical Center, Tel Hashomer, ISRAEL

ABSTRACT

Young and older adults have difficulties in performance of an additional task while walking (dual task). This feasibility study investigates the dual task costs of texting on a mobile phone and walking among young and older adults, as well as the potential of a mixed reality app, which projects the real world onto the background of the mobile display, to modify these costs. Seven young (age 26.4±4.5 years) and 7 older (age 69.9±3.9 years) adults were asked to walk while texting on a custom-written mobile android app (with and without mixed reality display), as well as to perform each task (walking, texting) separately. Preliminary results show that dual task interference of both tasks is similar in both groups. Using a mixed reality display does not modify these costs, but does affect the subjective experience of the groups differently. This may be due to different levels of familiarity with mobile phone use in the two groups. Additional data is currently being collected.

An example of an off-the-shelf application (Type n walk, www.type-n-walk.com) projecting the real world view captured by the smartphone camera behind a data layer (e.g., used for writing text).

Designing a location-aware augmented and alternative communication system to support people with language and speech disorders

M S Hossain, M Takanokura, K Nakashima

Kanagawa University, Yokohama, JAPAN

ABSTRACT

Working with those who have speech and language disorders can be a great challenge for researchers. Language difficulties can significantly affect a user's ability to communicate with others. Our aim is to design an Augmentative and Alternative Communication (AAC) system based on current location for people with language disorders in order to support communication in their everyday life. In this paper, we design a location based AAC system that provides a list of images that is able to assist in communication.
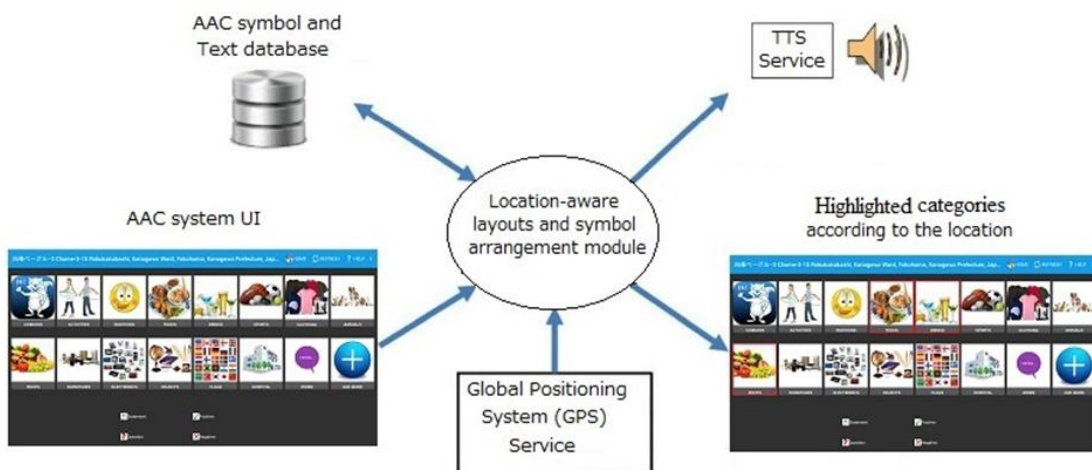
Architecture of the proposed location-aware AAC system.

Comparison of functional benefits of self-management training for amputees under virtual world and e-learning conditions

S L Winkler, J A Kairalla, R Cooper, I Gaunaurd, M Schlesinger, A Krueger, A Ludwig

James A Haley VA Hospital, Tampa, FL/University of Florida, Gainesville/
Nova Southeastern University, Fort Lauderdale, FL/Miami VA Medical Center, FL/
Virtual Ability, Inc., Aurora, CO, USA

ABSTRACT

Amputation is a life-long condition. Throughout their lifespan, amputees will need health, wellness and prosthetic-related information. This project used a randomized design to compare two methods of disseminating an evidence-based self-management intervention: avatar-based virtual world and e-learning environments. Of the 57 subjects randomized, 37 (65%) completed the study. The virtual world group had a significantly higher drop-out rate than the e-learning group. Both groups marginally improved on self-efficacy, perceived social support, pain interference, and functional status outcomes with no significant results found between the groups.
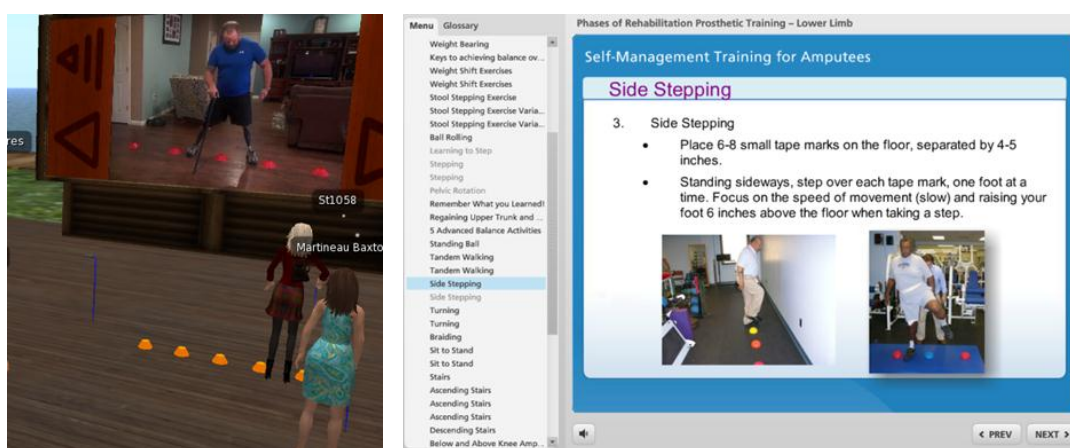
A side-stepping balance exercise in the virtual world condition (left) and the e-learning condition (right).

Winkler, SL, Kairalla, JA, Cooper, R, Gaunaurd, I, Schlesinger, M, Krueger, A, and Ludwig, A (2016), Comparison of functional benefits of self-management training for amputees under virtual world and e-learning conditions, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 201−208, Los Angeles, California, USA, 20−22 Sept. 2016.

Choosing virtual and augmented reality hardware for virtual rehabilitation: process and considerations

S T Koenig, B S Lange

Katana Simulations Pty Ltd, Henley Beach South/Flinders University, Adelaide, AUSTRALIA

ABSTRACT

Virtual and Augmented Reality hardware has become much more affordable in the past three years, largely due to the availability of affordable sensors and smartphone displays as well as financial investments and buy-in through the entertainment industry. Many new consumer devices are becoming available to researchers, clinicians and software developers. With so many options available, planning a Virtual Rehabilitation project and selecting appropriate hardware components can be a challenge. This paper presents a stepwise selection process for Virtual and Augmented Reality hardware. The process is described through an example project and clinical and technical implications of each hardware choice are discussed.

Virtual Classroom scenario.

Usability and performance of Leap Motion and Oculus Rift for upper arm virtual reality stroke rehabilitation

D E Holmes, D K Charles, P J Morrow, S McClean, S M McDonough

Ulster University, Coleraine/Jordanstown, UK

ABSTRACT

Intensified rehabilitation is important for stroke survivors but difficult to achieve due to limited access to physiotherapy. We present a virtual reality rehabilitation system, Target Acquiring Exercise (TAGER), designed to supplement center-based physiotherapy by providing engaging and personalized exercises. TAGER uses natural user interface devices, the Microsoft Kinect, Leap Motion and Myo armband, to track upper arm and body motion. Linear regression was applied to 3D user motion data using four popular forms of Fitts's law and each approach evaluated. While all four forms of Fitt's Law produced similar results and could model users effectively, it may be argued that a 3D tailored form provided the best fit. However, we propose that Fitts's Law may be more suitable as the basis of a more complex model to profile user performance. Evaluated by healthy users TAGER proved effective, with important lessons learned which will inform future design.

Experimental setup.

Expanded sense of possibilities: qualitative findings from a virtual self-management training for amputees

R Cooper, S L Winkler, M Schlesinger, A Krueger, A Ludwig

Nova Southeastern University, Fort Lauderdale, FL/James A Haley VA Hospital, Tampa, FL/Virtual Ability, Inc., Aurora, CO, USA

ABSTRACT

This paper presents the procedures and results of a qualitative study that was part of a larger study comparing two methods of accessing a self-management training for amputees: e-learning and a virtual world. Interviews were conducted in Second Life with ten subjects who completed the training in the virtual world and seven subjects who completed e-learning training. Interpretative Phenomenological Analysis (IPA) was used for qualitative data analysis, leading to the identification of 14 themes within five major categories. An overarching theme of the Second Life experience resulting from analysis was that of an expanded sense of possibilities.

		SL n=13	e-learning n=4
Age		52	62
Race/ethnicity	White	13	3
	Black	0	1
Gender	Male	10	2
	Female	3	2
Amputation	Unilateral UL	2	0
	Unilateral LL	10	3
	Bilateral LL	1	1
	Unilateral UL & Bilateral LL	0	0
Years since first amputation	0-5	9	3
	6-10	1	1
	11-15	1	1
	16-20	1	0
	>25	1	0
Etiology	Trauma	4	0
	Dysvascular	3	0
	Disease	6	4
Prosthetic use	Daily	9	3
	Weekly	0	1
	Did not use prosthesis	4	0

Cooper, R, Winkler, SL, Schlesinger, M, Krueger, A, and Ludwig, A (2016), Expanded sense of possibilities: qualitative findings from a virtual self-management training for amputees, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 227–232, Los Angeles, California, USA, 20–22 Sept. 2016.

Face to face: an interactive facial exercise system for stroke patients with facial weakness

P Breedon, P Logan, D Pearce, J Edmans, B Childs, R O'Brien

Nottingham Trent University/University of Nottingham/Barker Brettell LLP, Birmingham/Maddison Product Design Ltd, Fittleworth, UK

ABSTRACT

Each year 152,000 people in the UK have a stroke. Almost all have an initial facial weakness. Many resolve in the first few days but it is estimated that 26,000 people experience some kind of long-term paralysis in their face. This may impact on their eating, drinking, speaking, facial expression, saliva management, self-image and confidence. A survey of 107 UK based clinicians found that routine treatment of facial weakness was provision of exercises with a written instruction sheet. The UK National Stroke Clinical Guidelines recommend that patients undertake 45 minutes of therapy per day, but anecdotal evidence suggests that patients have poor adherence to the exercises because they find them boring and there is no feedback to help them see a difference. A multidisciplinary team, which includes patients, researchers and therapists have produced a working prototype system to improve facial weakness. It is called Face to Face and includes a Kinect sensor, a small form PC and a monitor. Patients follow exercises given by a therapist on the screen; the system records and simultaneously gives feedback, with a facial recognition algorithm providing tracking data for each captured frame of the user's face. Results from our small clinical trial indicate that the system is more successful at getting patients to complete their exercises than using a mirror, patients liked it, and they said it had helped improve their facial symmetry. Therapists said Face to Face encouraged patients to exercise daily, they liked the fact that it could be individually programmed and could record how much the patient had exercised. Based on the initial project work and positive outcomes Face to Face aims to help patients practice their facial muscle exercises to speed their recovery, providing direct benefits in terms of costs and time, and offering patients significant improvements.
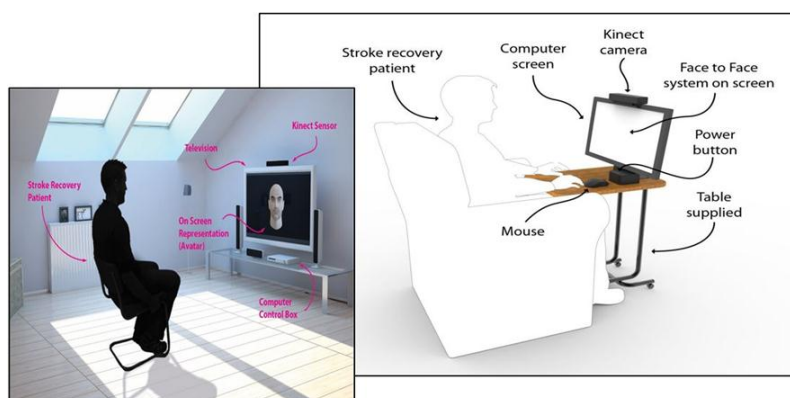
Initial concept (inset) and PPI informed system design.

Evaluating automated real time feedback and instructions during computerized mirror therapy for upper limb rehabilitation using augmented reflection technology

J Pinches, S Hoermann

University of Otago, Dunedin, NEW ZEALAND/University of Sydney, AUSTRALIA

ABSTRACT

The use of Virtual and Augmented Reality (VR/AR) in physical rehabilitation can provide better control, improved user motivation, and flexibility in how therapy is offered. Mirror therapy is a therapeutic intervention that has been shown to be beneficial for upper limb stroke rehabilitation. However it requires, in its clinical application, the constant presence and attention of a skilled therapist who provides instructions. This paper presents an AR mirror therapy system that provides automatic instructions and feedback. A within-subjects design user study with healthy volunteers was conducted to evaluate the usability (System Usability Scale), perceived suitability (Suitability Evaluation Questionnaire for Virtual Rehabilitation Systems), satisfaction (subset of Usability Satisfaction Questionnaire), general experience (Mixed Reality Experience Questionnaire) and participants' performance and preference. We compared two conditions where the system automatically instructed the participants and (i) where the system additionally provided feedback, or (ii) the system did not provide feedback. All participants were able to complete the automated mirror therapy intervention. Participants significantly rated the usability and suitability of the automated intervention as positive. The comparisons between the two conditions on user experience and satisfaction indicated preferences for the feedback condition; however it was not statistically significant. In the direct comparison between systems, participants showed a strong and significant preference for the feedback condition. A few participants reported a mild level of discomfort attributed to the sitting position, exercises and placement of their hands on the table. With this study, further progress towards an automated system for the provision of mirror therapy was achieved and successfully evaluated with healthy participants. Preparations for clinical evaluations using this automated system with patients suffering from motor impairments after stroke can now commence.
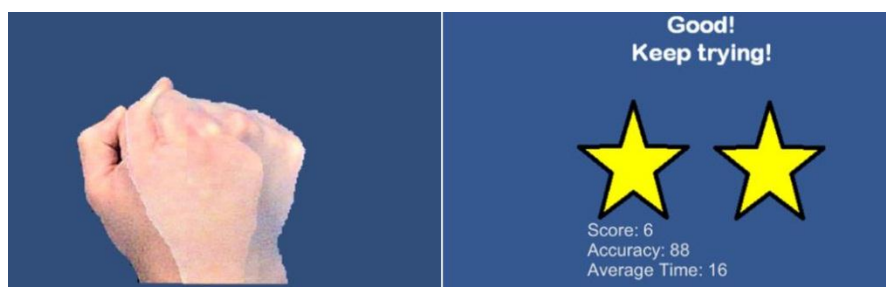
The half-transparent image of the exercise and the actual hand of the user (left), post-phase feedback (right).

Augmented feedback approach to double-leg squat training for patients with knee osteoarthritis: a preliminary study

M Al-Amri, J L Davies, P Adamson, K Button, P Roos, R van Deursen

Cardiff University/Cardiff and Vale UHB, UK/CFD Research Corporation, Huntsville, AL, USA

ABSTRACT

The aim of this preliminary study was to explore the effects of two types of augmented feedback on the strategy used by healthy participants and patients with knee osteoarthritis (OA) to perform a double-leg squat. Seven patients with knee OA and seven healthy participants performed three sets of eight double-leg squats: one without feedback, one with real-time kinematic feedback and one with real-time kinetic feedback. Kinematic and kinetic outcome measures (peak knee flexion angle, peak knee extensor moment, and symmetry of the support knee moment between the injured and non-injured knees) demonstrate the potential influence of real-time kinetic feedback on the motor strategy used to perform a double-leg squat in both groups. This feedback could be used to develop more efficient and effective motor strategies for squatting in patients with knee OA and further evaluation is warranted.
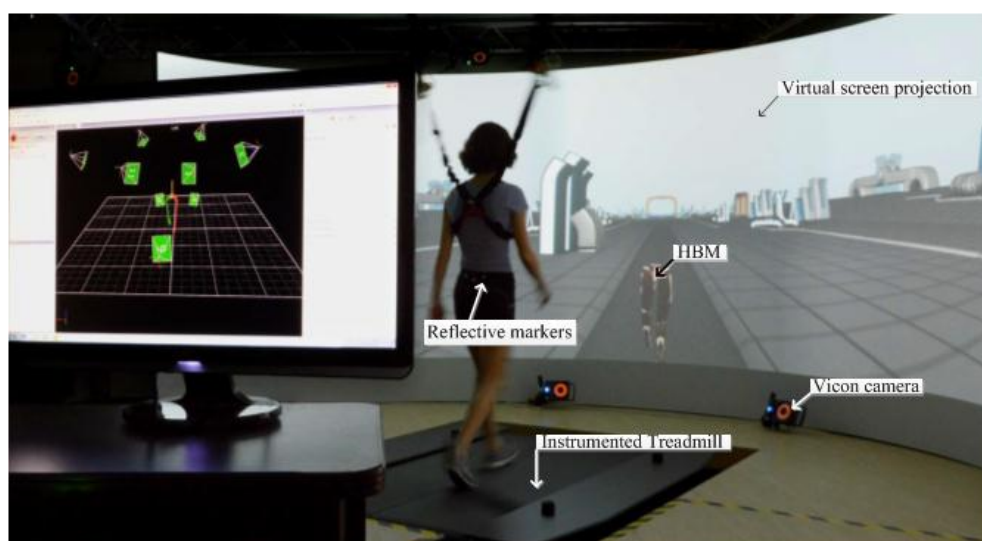
Cardiff Gait Real-time Analysis Interactive Lab.

Home based virtual rehabilitation for upper extremity functional recovery post-stroke

Q Qiu, A Cronce, G Fluet, J Patel, A Merians, S Adamovich

Rutgers University/New Jersey Institute of Technology, University Heights, Newark, NJ, USA

ABSTRACT

After stroke, sustained hand rehabilitation training is required for continuous improvement and maintenance of distal function. An ideal home-based telerehabilitation system has to be low cost, easy to set up, effective in motivating the user to use it every day, generate progress reports to the user for self-tracking, and provide daily monitoring to remote clinicians. In this paper, we present a system designed and implemented in our lab: the NJIT Home-based Virtual Rehabilitation System (NJIT HoVRS). A single subject proof of concept study was conducted and demonstrated that this system is easy to access and effective in motivating subjects to train at home.
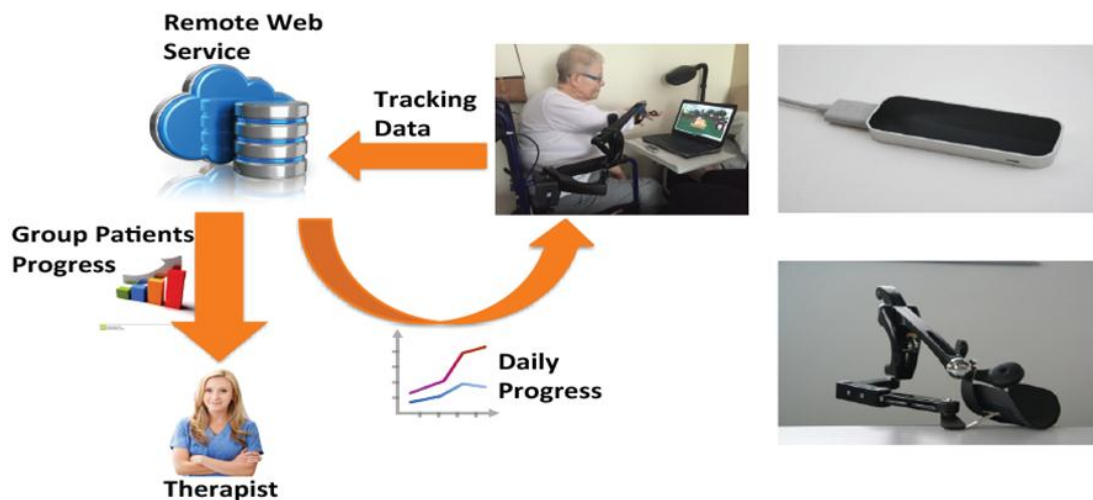
Left: RAVR-Home architecture design. Upper right: Leap Motion Controller. Lower Right: Armon Edero™ arm support.

Qiu, Q, Cronce, A, Fluet, G, Patel, J, Merians, A, and Adamovich, S (2016), Home based virtual rehabilitation for upper extremity functional recovery post-stroke, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 259–265, Los Angeles, California, USA, 20–22 Sept. 2016.

Short Papers ~ Abstracts

Kinect controlled game to improve space and depth perception, **D Bekesi**, **C Sik-Lanyi**, University of Pannonia, HUNGARY

Space perception is one of the most important skills of human life. Space perception is not a congenital faculty of human beings, but it evolves during the first few years of life. Experts are of the opinion that depth perception can be improved during the first 15-16 years of life. It is essential to perform depth perception in several occupations. We have developed virtual reality game with animations that were used by students to practice space perception tasks and to acquire better space perception. The game is controlled via Kinect sensor.

Bekesi, D, and Sik-Lanyi, C (2016), Kinect controlled game to improve space and depth perception, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 267–270, Los Angeles, California, USA, 20–22 Sept. 2016.

Influence of point of view and technology in presence and embodiment, **B A Borrego**, **J Latorre**, **R Llorens**, **E Noé**, **M Alcañiz**, Universitat Politècnica de València/Fundación Hospitales NISA, Valencia/Univesity of Jaume I, Castellón, SPAIN

Presence and embodiment have been reported to modulate the experience in virtual worlds. However, while these perceptions are presumably interconnected, little research has been done to unveil the nature of this relationship. In this study we show how presence and embodiment are modulated by the point of view of a virtual body and the enabling technology while being engaged in a virtual task.

Borrego, BA, Latorre, J, Llorens, R, Noé, E, and Alcañiz, M (2016), Influence of point of view and technology in presence and embodiment, , *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 271–274, Los Angeles, California, USA, 20–22 Sept. 2016.

Application of a rehabilitation game model to assistive technology design, **J Boureaud**, **D E Holmes**, **D K Charles**, **S McClean**, **P J Morrow**, **S M McDonough**, University of Limoges, FRANCE/Ulster University, UK

Games are increasingly used by physiotherapists in rehabilitation and the gamification of rehabilitation processes is an increasingly common practice. A key motivation for injecting playful or gameful activities into rehabilitation is to enhance engagement for home rehabilitation exercises by making them more fun. Multi-disciplinary cooperation is important in designing gameful activities. However, system design and development can be challenging between software engineers, health professionals, and academics due to terminology and knowledge differences. Sometimes skill and knowledge levels are also not optimal within the team. In both cases a comprehensive Rehabilitation Game Model (RGM) built on established principles, with an associated tool, can facilitate an effective design process. Factors that can be missed without use of a structured process include the potential impact of symptoms and variation in user demographic, personality or interaction preference. Our RGM helps game designers put a greater focus on variations between people in designing rehabilitation games. In this paper we provide an overview of the RGM and extend it to include rehabilitation aspects. We apply it to upper arm stroke rehabilitation. We present a representation of the output from the RGM that can form the basis for advice and guidance to serious game designers of upper arm stroke rehabilitation games.

Boureaud, J, Holmes, DE, Charles, DK, McClean, S, Morrow, PJ, and McDonough, SM (2016), Application of a rehabilitation game model to assistive technology design, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 275–278, Los Angeles, California, USA, 20–22 Sept. 2016.

Case study using virtual rehabilitation for a patient with fear of falling due to diabetic peripheral neuropathy, **K E Carroll**, **D J Galles**, St. Mary's Medical Center, San Francisco/University of San Francisco, USA

The purpose of this case study is to report the effects of using virtual rehabilitation (VR) to facilitate improvement of gait stability and endurance in a patient recovering from diabetic neuropathy who also experienced fear of falling. Timed Up and Go (TUG) testing revealed objective improvements and the subject's gait appeared more stable and fluid. She reported increased confidence in walking and endorsed increased confidence on the Activity-specific Balance Confidence Scale (ABC). This study also establishes how VR games can be inexpensively made and tailored to specific therapy needs since games were made by undergraduate Computer Science students for credit.

Carroll, KE, and Galles, DJ (2016), Case study using virtual rehabilitation for a patient with fear of falling due to diabetic peripheral neuropathy, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 279–282, Los Angeles, California, USA, 20–22 Sept. 2016.

Application of invisible playground theory to assistive technology design for motivating exercise within activities of daily living, **G Chaponneau**, **D E Holmes**, **D K Charles**, **S McClean**, **P J Morrow**, **S M McDonough**, University of Limoges, FRANCE/Ulster University, UK

Regular exercise promotes safe mobility for people affected by stroke, multiple sclerosis, and other disability related health conditions. It is also important for the prevention of falls among older people. Recent research investigates the use of indoor technology such as virtual reality (VR) and games to support and motivate regular exercise. Other research considers the use of mobile and wearable technology to track and promote exercise within the home and outdoors. In this paper we propose an approach that uses ideas from both contexts to develop a more persistent connected health system for encouraging more enduring exercise associated behaviour change. We utilise gameful design principles and play research to blend home-based VR and Serious Games with wearable, mobile tracking and reminder system approaches that are integrated into activities of daily living. In particular, we utilise ideas about the Invisible Playground from play theory to frame our interactive multi-modal exercise system. Our hypothesis is that by establishing a gamified, information rich feedback loop between structured system based exercise indoors and tracked activities of daily living outdoors, that motivation to exercise regularly may be improved. In this paper we summarise key relevant literature, discuss the Invisible Playground, and present the system architecture, APPRAISER, which will be used for the system development.

Chaponneau, G, Holmes, DE, Charles, DK, McClean, S, Morrow, PJ, and McDonough, SM (2016), Application of invisible playground theory to assistive technology design for motivating exercise within activities of daily living, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 283–286, Los Angeles, California, USA, 20–22 Sept. 2016.

Visual elements influence on navigation in virtual environments, **C Croucher**, **V Powell**, **A Molnar**, **W Powell**, University of Portsmouth, UK

Virtual rehabilitation often incorporates an element of travel in a virtual environment. Whether patients are transported automatically through the environment, or whether they have navigational control, it is important to understand how the design of the environment itself can supply navigational cues, and how the processing of these cues may influence perception, behaviour and task performance. This paper explores the literature, which might inform application design, and presents a case study using a think-aloud protocol to explore the perception of users to visual cues within a running game. We conclude with some preliminary suggestions for positive and negative navigational cues.

Croucher, C, Powell, V, Molnar, A, and Powell, W (2016), Visual elements influence on navigation in virtual environments, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 287–290, Los Angeles, California, USA, 20–22 Sept. 2016.

Development of a low-cost upper limb rehabilitation system using BCI, eye-tracking and direct visual feedback, **A Duenser, D Rozado, B Howell, G Rosolen, M Callisaya, M Lochner, M Cochrane**, CSIRO, Hobart, AUSTRALIA/ Otago Polytechnic, Dunedin, NEW ZEALAND/University of Tasmania, Hobart/Swinburne University of Technology, Melbourne AUSTRALIA

We are developing a novel system to improve arm function in stroke patients who have no, or only residual upper limb movement. Such a system fills an important gap in treatment options for people with little-to-no upper limb movement after stroke, and for whom regular treatments often are unsuitable. The system provides real-time visual and proprioceptive feedback of the arm plus the ability for participants to steer the movement direction of the arm through an assistive movement platform. The patient controls the system by simply looking at stimuli and engaging in motor imagery. The patient gaze is monitored with an eye tracker and motor output intentions are monitored with an EEG-based brain computer interface. Stimuli are presented as games in order to create a motivating rehabilitation environment. In this paper we discuss our motivation and design of the system.

Duenser, A, Rozado, D, Howell, B, Rosolen, G, Callisaya, M, Lochner, M, and Cochrane, M (2016), Development of a low-cost upper limb rehabilitation system using BCI, eye-tracking and direct visual feedback, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 291–294, Los Angeles, California, USA, 20–22 Sept. 2016.

Human cognitive enhancement tested in virtual city environments, **I Fajnerova, L Hejtmanek, H Rydlo, J Motyl, I Oravcova, T Zitka, J Hranicka, J Horacek, E Zackova**, National Institute of Mental Health (NIMH), Klecany/University of West Bohemia, Plzeň, CZECH REPUBLIC

The presented study focuses on human cognitive enhancement (HCE). Our aim is to map the key moments in interfacing of biology and technology that have the capacity to strongly affect and transform cognitive processes, such as spatial memory and navigation. We hypothesize that long-term use of HCE technology, in our case Augmented Reality (AR) glasses, while navigating through real environment can elicit changes both in spatial memory performance and in brain activity, connectivity and morphology. The proposed experiment focuses on the effect of long-term use (10-12 weeks) of Smart glasses (Vuzix M100). We tested 25 healthy volunteers, who were required to use the Vuzix navigation software when navigating in daily life. Prior to the experiment and during the final 12th week all participants (25 experimental and 25 control subjects) underwent complex prospective evaluation. The following test battery was used in order to study the effect of AR glasses wearing on: 1) vision (Ophthalmology examination); 2) cognitive abilities (RBANS, CPT, TMT); 3) specific spatial abilities (e.g. Money Road Map test, Perspective Taking Test); 4) eye-movements (eye-tracking) in the route-following and way-finding navigation performance in complex virtual city environment; and 5) brain activity (fMRI navigation task in virtual city, resting state fMRI) and morphology (VBM, DTI).

Fajnerova, I, Hejtmanek, L, Rydlo, H, Motyl, J, Oravcova, I, Zitka, T, Hranicka, J, Horacek, J, and Zackova, E (2016), Human cognitive enhancement tested in virtual city environments, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 295–298, Los Angeles, California, USA, 20–22 Sept. 2016.

Remediation of cognitive deficit in neuropsychiatric disorders using virtual carousel task and episodic memory task, **I Fajnerova**, **K Sedlakova**, **V Vorackova**, **A Dorazilova**, **L Hejtmanek**, **A Plechata**, **M Rodriguez**, **K Vlcek**, National Institute of Mental Health (NIMH), Klecany, CZECH REPUBLIC

The impairment of cognitive functioning represents a characteristic manifestation in various neuropsychiatric disorders, such as schizophrenia (SZ). Previous studies demonstrated mild to severe deficit almost in all cognitive domains. Our results obtained in the virtual analogue of the carousel maze also demonstrate impairment of spatial memory and cognitive flexibility in schizophrenia patients. In addition, results of the episodic-like memory task (EMT) also support the hypothesis of episodic memory deficit in schizophrenia. The aim of the presented study is to improve these impaired cognitive functions using remediation methods based on similar methods in a complex virtual environment. The remediation plan will be presented together with preliminary data obtained in a small group of schizophrenia patients.

Fajnerova, I, Sedlakova, K, Vorackova, V, Dorazilova, A, Hejtmanek, L, Plechata, A, Rodriguez, M, and Vlcek, K (2016), Remediation of cognitive deficit in neuropsychiatric disorders using virtual carousel task and episodic memory task, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 299–302, Los Angeles, California, USA, 20–22 Sept. 2016.

Motion sickness related aspects of inclusion of color deficient observers in virtual reality, **D A Gusev**, **R Eschbach**, **T Westin**, **J Yong**, Purdue University, USA/Norwegian National University for Science and Technology, Gjøvik, NORWAY/Monroe Community College, Rochester, New York, USA/ Stockholm University, SWEDEN

Color blindness is one of the most common forms of disability. Virtual reality (VR) development has increased recently, and it is important not to exclude people with impairments or other limitations. Visually induced motion sickness (VIMS) can be worse due to color versus black, white and gray environments. Can non-color factors in dynamic environments be excluded by performing color deficiency impacted tasks and comparing them to the equivalent static and dynamic tasks performed by a color-sighted person? Would a color-based experiment causing VIMS produce different results for a color deficient observer (CDO)? This paper advocates a novel approach to color blindness and motion sickness in VR based on psychophysical experiments. The aim is to find solutions and develop recommendations that will improve accessibility of VR for the colorblind.

Gusev, DA, Eschbach, R, Westin, T, and Yong, J (2016), Motion sickness related aspects of inclusion of color deficient observers in virtual reality, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 303–306, Los Angeles, California, USA, 20–22 Sept. 2016.

Labyrinth game with Kinect control, **R Haas**, **V Szucs**, **C Sik-Lanyi**, University of Pannonia, HUNGARY

Stroke changes not only the patients' lives, but also those of their families. The improvement of the active movement of the upper limbs is of great importance after stroke, which helps regain self-sufficiency and the recovery of fine movements. One of the key elements is the development of the active movements of the arm and fingers. The aim of the Flash-based labyrinth game of the article is to develop these motor skills, and that the patients may become self-sufficient in their home environment, or capable of working by the end of the rehabilitation. The Labyrinth Game is focusing on the movement of arms and elbows, out of the 17 exercises of Wolf Motor Function Test's (WMFT) upper limb rehabilitation tasks. The game uses simple forms and colours, and contains understandable and useable menus for more efficient usability.

Haas, R, Szucs, V, and Sik-Lanyi, C (2016), Labyrinth game with Kinect control, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 307–310, Los Angeles, California, USA, 20–22 Sept. 2016.

Gaming for health: an updated systematic review and meta-analysis of the physical, cognitive and psychosocial effects of active computer gaming in older adults, **S C Howes**, **D Charles**, **K Pedlow**, **J Marley**, **A Matcovic**, **P Diehl**, **S M McDonough**, Ulster University, Newtownabbey/Coleraine, NORTHERN IRELAND

Active computer gaming (ACG) is method of enabling physical activity in older adults. This review aimed to determine the effect of ACG on health outcomes in older adults. Four electronic databases were searched to identify 24 eligible randomised controlled studies: 1049 participants; 72.2% female; mean age 78±5 years. Data were pooled for six outcomes, with small to moderate effects observed in favour of ACG for functional mobility and balance outcomes. A large effect was observed in favour of ACG for cognitive function. This review presents evidence that ACG is effective in improving physical and cognitive function in older adults.

Howes, SC, Charles, D, Pedlow, K, Marley, J, Matcovic, A, Diehl, P, and McDonough, SM (2016), Gaming for health: an updated systematic review and meta-analysis of the physical, cognitive and psychosocial effects of active computer gaming in older adults, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 311–314, Los Angeles, California, USA, 20–22 Sept. 2016.

Pirate adventure autism assessment app: a new tool to aid clinical assessment of children with possible autistic spectrum disorder, **E Jordan**, **W Farr**, **S Fager**, **I Male**, University of Sussex/Sussex Community NHS Foundation Trust, Haywards Heath/Cell Software Services, Brighton, UK

Diagnostic assessment of possible Autistic Spectrum Disorder requires multidisciplinary assessment incorporating information from various settings, including psychometric assessment of the child. The Pirate Adventure Autism Assessment App includes a number of these psychometric tests adapted into a pirate adventure storyline. Early experience, presented here, suggests the tool is a useful adjunct to parental history and school questionnaire obtained at initial clinic, in determining the need for the child to proceed to a full, time consuming, expensive, diagnostic assessment.

Jordan, E, Farr, W, Fager, S, and Male, I (2016), Pirate adventure autism assessment app: a new tool to aid clinical assessment of children with possible autistic spectrum disorder, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 315–318, Los Angeles, California, USA, 20–22 Sept. 2016.

Effects of reintroducing haptic feedback to virtual-reality systems on movement profiles when reaching to virtual targets, **M A Just**, **P J Stapley**, **M Ros**, **F Naghdy**, **D Stirling**, University of Wollongong, AUSTRALIA

Virtual reality (VR) has been shown to have significant impacts on the efficacy of rehabilitation, improving a patient's motivation and participation, as well as improving scores in functional assessments when used to enhance traditional therapy. However, movements in VR have been demonstrated to have significant differences in movement profiles whilst performing simple reaching tasks compared to their real counterparts. The lack of tactile perception in VR systems is often attributed to be one of the causes of these differences. Therefore, to investigate the degree to which the lack of haptic feedback impacts movement profiles in VR, we have reintroduced the sense of touch through vibration motors on the fingertips. Participants were required to reach to virtual targets, both with and without haptic feedback. Their movements were quantified using motion capture, and the virtual targets were rendered using the Oculus Rift. The motions to both targets were compared using a number of measures to characterize the velocity profiles. Preliminary results suggest that the reintroduction of haptic feedback improves performance based indicators in virtual reaching tasks, such as the time to complete a reach, and the stability of the reaching hand whilst touching the virtual target.

Just, MA, Stapley, PJ, Ros, M, Naghdy, F, and Stirling, D (2016), Effects of reintroducing haptic feedback to virtual-reality systems on movement profiles when reaching to virtual targets, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 319–322, Los Angeles, California, USA, 20–22 Sept. 2016.

Step in time: exploration of synchrony and timing correction in response to virtual reality avatars for gait re-training, **O Khan, I Ahmed, M Rahhal, T N Arvanitis, M T Elliott**, University of Warwick/University Hospitals Coventry and Warwickshire NHS Trust, UK

This study investigates the use of virtual reality avatars as exercise cues for retraining gait. A feasibility test was conducted by asking participants to step in time with the avatar viewed through a virtual reality headset. We observed that a temporal perturbation (a speeding up or slowing down of one step cycle) applied to the avatar resulted in a significant corrective response in participants' own step timing. If this response can extend to spatial perturbations, we suggest that virtual reality avatars have the potential to assist in the targeted rehabilitation of neuromuscular or other disorders and retraining of gait post-surgery.

Khan, O, Ahmed, I, Rahhal, M, Arvanitis, TN, and Elliott, MT (2016), Step in time: exploration of synchrony and timing correction in response to virtual reality avatars for gait re-training, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 323–326, Los Angeles, California, USA, 20–22 Sept. 2016.

Do user motivation and attention influence performance of a postural reaching task in a virtual environment?, **D Levac, A Kelly, M Polizzano, S Saffee**, Northeastern University, USA

Practice in a virtual environment (VE) can enhance motivation and attention, but the relationship between these constructs and motor skill acquisition requires exploration. This study evaluated the impact of motivation (as measured by the Intrinsic Motivation Inventory) and attention to a task-irrelevant visual distraction (as measured by proxy via recall) on performance of a postural reaching task in a 2D VE in 27 young adults. Higher motivation was associated with higher scores, while poorer attention to task was associated with lower scores. Findings suggest that motivation and attention can impact VE practice; subsequent research will include retention and transfer tests.

Levac, D, Kelly, A, Polizzano, M, and Saffee, S (2016), Do user motivation and attention influence performance of a postural reaching task in a virtual environment?, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 327–330, Los Angeles, California, USA, 20–22 Sept. 2016.

How do the perspectives of clinicians with and without virtual reality/active video game experience differ about its use in practice?, **D Levac, P Miller, S M N Glegg, H Colquhoun**, Northeastern University, USA/McMaster University/ Sunny Hill Health Centre for Children, Vancouver/University of Toronto, CANADA

Little is known about clinicians' perspectives on the use of virtual reality (VR) and active video games (AVGs) in rehabilitation. We undertook an online survey of VR/AVG experience and learning needs in a sample of 1068 physical therapists and occupational therapists practicing in Canada. Nearly half (47%) had clinical experience with at least one system. While both therapist groups identified challenges and barriers, experienced therapists highlighted VR/AVGs' potential to increase patient motivation and engagement. Respondents without experience identified new potential avenues for VR/AVG use. Findings from this study will inform the content of open-access knowledge translation resources hosted at www.vr4rehab.com.

Levac, D, Miller, P, Glegg, SMN, and Colquhoun, H (2016), How do the perspectives of clinicians with and without virtual reality/active video game experience differ about its use in practice?, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 331–334, Los Angeles, California, USA, 20–22 Sept. 2016.

Development of smart mobile phone application to monitor progress and wellness for Chronic Obstructive Pulmonary Disease patients, **S M McDonough, A Boyd, T Patterson, P McCullagh, I Cleland, C Nugent, M Donnelly, H Zheng, N Black**, Affiliations

A bespoke application (app), 'KeepWell', tuned to chronic obstructive pulmonary disease (COPD) self-management has been developed. The app facilitates goal setting, progress monitoring and personal reporting; features were informed by n=4 clinicians. Eight other clinicians tested usability by undertaking a list of interaction tasks and completing a usability questionnaire. Qualitative comments or problems experienced during the completion of each task were noted. Overall the participants reported high levels of usability. Features that scored consistently well were setting goals, self-reporting and viewing progress. Suggested changes were: setting and editing reminders and ensuring the manual information was consistent with the operation of the KeepWell app.

McDonough, SM, Boyd, A, Patterson, T, McCullagh, P, Cleland, I, Nugent, C, Donnelly, M, Zheng, H, and Black, N (2016), Development of smart mobile phone application to monitor progress and wellness for Chronic Obstructive Pulmonary Disease patients, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 335–338, Los Angeles, California, USA, 20–22 Sept. 2016.

Towards a novel biometric facial input for emotion recognition and assistive technology for virtual reality, **J T McGhee, M Hamedi, M Fatoorechi, D Roggen, A Cleal, R Prance, C Nduka**, Imperial College, London/Emteq Ltd, Brighton/Sussex University, Brighton, UNITED KINGDOM

Preliminary work using facial EMG to identify facial expressions is reported in this paper. Ten subjects performed 14 different facial expressions following an agreed protocol. Facial EMG signals, measured from surface electrodes, were processed and analysed using a machine learning algorithm. Our system is able to differentiate facial expressions for assistive input to a high degree of accuracy (99.25%) and posed emotional responses with 100% accuracy. We conclude facial EMG technology has the potential for both assistive input and emotion detection and could replace conventional assistive input devices or video based techniques for use with VR technologies.

McGhee, JT, Hamedi, M, Fatoorechi, M, Roggen, D, Cleal, A, Prance, R, and Nduka, C (2016), Towards a novel biometric facial input for emotion recognition and assistive technology for virtual reality, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 339–342, Los Angeles, California, USA, 20–22 Sept. 2016.

Physical therapists' opinion regarding the creation of a new virtual game to treat pelvic floor muscles dysfunction amongst children of school age, **M C Moreira, A Lemos**, Federal University of Pernambuco, Recife, PE, BRAZIL

The study aimed to investigate physical therapists' feedback regarding important points that should be added to a new virtual game application which will treat lower urinary tract dysfunction among children. This study used a questionnaire answered by ten physiotherapists, where the majority (80%) considered positively the idea of creating an application, while only 40% use technological devices in rehabilitation. With regards to observing patients progress, the majority (70%) reported a lack of tools that motivate the patient was the biggest problem. Based on that, we concluded that motivating tools are necessary to assist in pelvic floor treatment.

Moreira, MC, and Lemos, A (2016), Physical therapist´s opinion regarding the creation of a new virtual game to treat pelvic floor muscles dysfunction amongst children in school age, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 343–346, Los Angeles, California, USA, 20–22 Sept. 2016.

Mobile application to increase consciousness and strengthening of the pelvic floor muscles, **E C Moretti, M C Moreira, A E S P Souza, A Lemos**, Federal University of Pernambuco – UFPE, Recife, PE, BRAZIL

This research included the development of a computer interface for capturing electromyography signals via Bluetooth enabling the transmission of data to mobile devices combined with a specific virtual gaming application to investigate the biomechanical characteristics of the pelvic floor muscles. The capture of data is performed via electrodes placed at specific anatomic pelvic floor sites. The game was designed based on the evidence available on consciousness and strengthening of the pelvic floor muscles, in addition to coordinating training of the muscles at different levels of demand, according to each user.

Moretti, EC, Moreira, MC, Souza, AESP, and Lemos, A (2016), Mobile application to increase consciousness and strengthening of the pelvic floor muscles, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 347–450, Los Angeles, California, USA, 20–22 Sept. 2016.

Kinect sensor controlled game for early diagnosis of visual problems, **R Nemeth, V Szucs, C Sik-Lanyi**, University of Pannonia, HUNGARY

A serious game was designed for early (preschool-aged) vision-test at home or in kindergartens. It was created with Windows Presentation Foundation framework. This framework is a good choice for developing vision-test game modules, as they can be easily accessed from one main application. The game module is a "Drag and Drop" game, which can be controlled with Kinect v2 sensor. The game is designed to take various objects along the tracks to the suitable finish goal. This type of game will help the user discover visual acuity problems. The game monitors that how long it takes to complete the track with different difficulty settings, while storing the results.

Nemeth, R, Szucs, V, and Sik-Lanyi, C (2016), Kinect sensor controlled game for early diagnosis of visual problems, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 351–354, Los Angeles, California, USA, 20–22 Sept. 2016.

Development and validation of haptic interface for deaf-blind horseback riding, **M Ogrinc, I Farkhatdinov, R Walker, E Burdet**, Imperial College, London/Shadow Robot Company Ltd, London, UNITED KINGDOM

We present a haptic interface to help blind and deaf-blind people to practice horse riding as a recreational and therapeutic activity. Horseback riding is a form of animal assisted therapy which can improve self-esteem and sensation of independence. It has been shown to benefit people with various medical conditions including autism. However, in the case of deaf-blind individuals a therapist or an interpreter must stand by at all times to communicate with the rider by touch. We developed a novel and low cost interface which enables blind and deaf-blind people to enjoy horseback riding while the instructor is observing and remotely providing cues to the rider, which improves their independence. Initial tests of the concept with an autistic deaf-blind individual received very positive feedback from the rider, his family and therapist.

Ogrinc, M, Farkhatdinov, I, Walker, R, and Burdet, E (2016), Development and validation of haptic interface for deaf-blind horseback riding, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 355–357, Los Angeles, California, USA, 20–22 Sept. 2016.

Eyeblink rate during a virtual shopping game performance for cognitive rehabilitation, **S Okahashi**, **R Watanabe**, **Z Luo**, **T Futaki**, Kyoto University/Kobe University, JAPAN

We developed a virtual shopping game having four levels using virtual reality technology for realistic cognitive rehabilitation. The objective of this study was to investigate characteristics in eyeblink rate in relation to task difficulty level. Six healthy adults were asked to buy two specific items in level 1, four items in level 2, six items in level 3, and eight items in level 4 at a virtual mall. Shopping items were daily necessaries which were independent of each other. Task performance, subjective assessments, and eye blinks during the game performance were recorded. As a result, the mean numbers of movements buttons used and the mean time required were higher/longer in level 4 than in level 1. The average subjective assessment scores were higher in level 4 than in level 1. Although the transitions of eyeblink rates were individually different, there was no statistical difference between phases, there were some relationships between subjective assessments and eyeblink rates. It suggests that eyeblink rate could be an index that reflects psychological aspects.

Okahashi, S, Watanabe, R, Luo, Z, and Futaki, T (2016), Eyeblink rate during a virtual shopping game performance for cognitive rehabilitation, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 359−362, Los Angeles, California, USA, 20−22 Sept. 2016.

Nicotine-enhanced responding for chocolate rewards in humans, **A N Palmisano**, **E Hudd**, **C McQuade**, **H De Wit**, **R S Astur**, University of Connecticut, Storrs, CT/University of Chicago, IL, USA

Despite an abundance of evidence illustrating the harmful effects of nicotine use, only a small percentage of users successfully quit. Moreover, current treatments for nicotine cessation produce only a slight increase in the likelihood of successfully quitting, which emphasizes the need for more effective strategies that facilitate smoking cessation. Several studies suggest that difficulty in controlling nicotine use behaviors results from nicotine's ability to enhance the motivating function of cues associated with obtaining rewards. In order to better understand the reward mechanisms that underlie the risk for becoming dependent, the aim of the current study was to examine nicotine's effects on conditioning, extinction, and reinstatement in humans. Using a novel virtual reality translation of the hallmark conditioned place preference paradigm to investigate the aforementioned objectives, our main findings suggest that nicotine (1) increases the sensitivity of reward properties by enhancing the strength of food-reward conditioning, (2) delays the rate of extinction of conditioned preferences, and (3) increases the reinstatement of previous conditioning.

Palmisano, AN, Hudd, E, McQuade, C, De Wit, H, and Astur, RS (2016), Nicotine-enhanced responding for chocolate rewards in humans, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 363−366, Los Angeles, California, USA, 20−22 Sept. 2016.

Face tracking training in children with severe motor impairment: case report, **A Pasquale**, **L Morgia**, **F Cappelli**, **C Vignati**, **E Pasquale**, **S Gazzellini**, **M Sabbadini**, **S Staccioli**, **E Castelli**, OBPG, Roma/IRCCS S. Raffaele, Roma/Sapienza University, Roma ITALY

The article reports an interactive training experience in children with tetraplegia using a face tracking system. Classic assessment scale and specific interactive tasks were used to evaluate and carry out the treatment based on a multimodal approach. The aim of the training was to improve lateral head rotation and oral motor ability with a specific interactive patch connected to the head and face movement. Finally, further trajectory movements and computer control by means of face movement were evaluated. From a descriptive point of view the system proved to be a functional tool to help subjects with severe motor impairment and it empowered the use of their residual functional movements.

Pasquale, A, Morgia, L, Cappelli, F, Vignati, C, Pasquale, E, Gazzellini, S, Sabbadini, M, Staccioli, S, and Castelli, E (2016), Face tracking training in children with severe motor impairment: case report, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 367−370, Los Angeles, California, USA, 20−22 Sept. 2016.

Process and feedback oriented platform for home-based rehabilitation based on depth sensor technology, **A Ridderstolpe**, **J Broeren**, **G Clemons**, **J Jalminger**, **L-Å Johansson**, **M Johanson**, **M Rydmark**, Alkit Communications, Mölndal/The Sahlgrenska Academy, University of Gothenburg, SWEDEN

In this paper a game-based rehabilitation platform for home usage, supporting stroke and chronic obstructive pulmonary disease (COPD) rehabilitation is presented. The main goal is to make rehabilitation more enjoyable and easily accessible for the patients. The platform provides facilities for creation of individualized plans for each patient with a program of game-exercises planned by the patient's caregiver through a web-based planning service. The games are based on specific motion patterns designed in collaboration with rehabilitation specialists. Motion regulations and guidance functions are implemented specifically for each exercise to provide feedback to the user and to ensure proper execution of the desired motion pattern. The caregiver can follow the progression of the rehabilitation and interact with the patient by video conferencing through the web-based service.

Ridderstolpe, A, Broeren, J, Clemons, G, Jalminger, J, Johansson, L-Å, Johanson, M, and Rydmark, M (2016), Process and feedback oriented platform for home-based rehabilitation based on depth sensor technology, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 371−374, Los Angeles, California, USA, 20−22 Sept. 2016.

Comparison of Wii Balance Board and force platform (baropodometry) for the evaluation of plantar pressures among healthy subjects, **A E S P Souza**, **A A L Carneiro**, **L H A N Dutra**, **M C Moreira**, **R M A Cunha**, Federal University of Pernambuco – UFPE, Recife, PE, BRAZIL

This study aimed to compare the use of Wii Balance Board® (Nintendo) with a baropodometer (force platform) to evaluate plantar pressure on healthy individuals. We also analysed the reliability of both platforms and found that, in addition to not being able to validate the data between the two platforms, there not was also a good reliability index in either of the two devices.

Souza, AESP, Carneiro, AAL, Dutra, LHAN, Moreira, MC, and Cunha, RMA (2016), Comparison of Wii Balance Board and force platform (baropodometry) on evaluation of plantar pressures among healthy subjects, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 375−378, Los Angeles, California, USA, 20−22 Sept. 2016.

Reducing impact of stress in patients with psychiatric disorders – a pilot study on the effects of swimming with wild, free dolphins in virtual reality, **W Veling**, **M J Sjollema**, **B C Brada**, University Medical Center Groningen/The Dolphin Swim Club, Leeuwarden, THE NETHERLANDS

In this pilot study, a 360° video VR relaxation program (VRelax) is being developed in order to reduce the impact of stress in patients with depressive, anxiety and psychotic disorders. The relaxing effect of an underwater VR experience with wild, free dolphins will be compared to the effect of an VR experience with natural surroundings such as beach, open fields and dunes and to a 2D experience with video clips of natural surroundings.

Veling, W, Sjollema, MJ, and Brada, BC (2016), Reducing impact of stress in patients with psychiatric disorders – a pilot study on the effects of swimming with wild, free dolphins in virtual reality, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 379–382, Los Angeles, California, USA, 20–22 Sept. 2016.

Can visual stimulus induce proprioceptive drift in the upper arm using virtual reality?, **D Willis**, **V Powell**, **B Stevens**, **W Powell**, University of Portsmouth, UK

Sustained isometric contractions (SIC), such as holding an arm stationary in a space, are often used in upper limb rehabilitation exercises, particularly where it is important to protect the joints and tendons or to reduce patient fatigue. However, visual cues within a virtual environment may have an unanticipated effect on the ability to maintain SIC. This study investigated the influence of background motion within a virtual environment on the ability to maintain a fixed position during an upper limb task. It was found that introducing directional movement had a significant differential effect on the ability to maintain SIC.

Willis, D, Powell, V, Stevens, B, and Powell, W (2016), Can visual stimulus induce proprioceptive drift in the upper arm using virtual reality?, *Proc. 11th Intl Conf. on Disability, Virtual Reality and Assoc. Technologies*, PM Sharkey, AA Rizzo (Eds), pp. 383–386, Los Angeles, California, USA, 20–22 Sept. 2016.