1st Symposium on Serious Gaming Technology as Clinical Tool in Rehabilitation

Since a few years, the clinical field is interested to integrate serious gaming technology within physical therapy and rehabilitation schemes. We would like to invite you to the ***1st Symposium on Serious Gaming Technology as Clinical Tool in Rehabilitation***. This symposium (that will take place on the 1st of February 2014) will be a good opportunity to learn about state-of-art development and exchange ideas about this exciting new field.
The Scientific Program is of high quality with speakers (from most Belgian universities and from abroad) who will focus on various aspects of rehabilitation using serious gaming technology or methods. The afternoon program will allow attendees to test some of the systems presented during the oral sessions. See below for practical details.

If you are interested to attend, please do not forget to register (this is compulsory for logistic reasons).
Registration should occur through the symposium website: www.ict4rehab.org/symposium.

More details about the symposium, and the presentation summary, are given below.

Organisers

- **Prof. Serge Van Sint Jan**, ICT4Rehab project - Laboratory of Anatomy, Biomechanics and Organogenesis, Université Libre de Bruxelles (ULB)
- **Prof Els Ortibus**, KUL UZ Leuven, Afdeling kinderneurologie en CP referentiecentrum – Centrum voor Ontwikkelingsstoornissen
- **Prof. Bernard Dan**, Hôpital des Enfants Reine Fabiola – Kinderziekenhuis Koniging Fabiola – CIRICU
- **Prof. Bart Jansen**, ETRO – Vrije Universiteit Brussel

Support

This event is made possible thanks to **InnovIris** (Brussels Government) through the ICT4Rehab project.

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Scientific Program

8h30 – Registration and Coffee Greetings **17h00 – End of symposium**

9h00-9h15 – Welcome (chair: S. Van Sint Jan)

9h15-10h45 - Plenary session n°1 (chair: E. Ortibus)

- **Paper 1.** *3D augmented reality mirror visual feedback applied to the treatment of persistent neuropathic pain in the upper extremity*. **D. Moureau, B. Penelle, E. Brassinne, S. Sobczak, A. Nonclercq, T. Tuna, N. Warzée** (Université Libre de Bruxelles, Belgium). Page 4.
- **Paper 2.** *Limits of stability in people after stroke and the relation with balance, gait and mobility*. **M. Van Dijk, N. Ghosh, S. Sandstad, H. Beyens, G. Verheyden** (Katholieke Universiteit Leuven, Belgium). Page 5.
- **Paper 3.** *Learning to use a new virtual environment: a crucial phase for cognitive patients*. **M. Camara-Lopez, G. Deliens, C. Degiorgio, A. Watelet, A. Cleeremans** (Université Libre de Bruxelles, Belgium). Page 6.
- **Paper 4.** *An approach for automatic evaluation of diagnosis exercises in Physical Therapy using depth sensors*. **M.P. Cuéllar, Y. Le Borgne, N. Galiano-Castillo, M. Arroyo, M.C. Pegalajar, M.J. Martín-Bautista, G. Bontempi** (University of Granada, Spain - Université Libre de Bruxelles, Belgium) Page 7.
- **Paper 5.** *The ICT4Rehab project - A "fully"-integrated ICT platform for patient rehabilitation including clinical database, body tracking, serious gaming and data mining*. **S. Van Sint Jan, B. Bonnechère, M. Foé, B. Jansen, Y-A Le Borgne, F. Moiseev, L. Omelina, P. Salvia, V. Sholukha, S. Vansummeren** (Université Libre de Bruxelles, Belgium – Vrije Universiteit Brussel, Belgium). Page 8.

10h45 – 11h15 Break (Coffee, tea, light collation)

11h15 – 12h00 *Keynote Speaker* *(= paper 6)* (chair: S. Van Sint Jan)

- **Paper 6.** *The psychology of rehabilitation: where does new technology fit?* by **Tamar Pincus** *(*Royal Holloway University of London, United Kingdom). Page 9.

12h00 – 13h00 – Lunch being served in the Museum of Medicine

13h00 – 14h40 – Plenary session n°2 (chair: B. Dan)

- **Paper 7.** *Upper limb rehabilitation with the I-TRAVLE system: Designing Serious Play for Playful Training*. **K. Coninx, P. Feys** (Universiteit Hasselt, Belgium) Page 10.
- **Paper 8.** *Hand and arm bimanual intensive therapy including lower extremity (HABIT-ILE) in children with unilateral spastic cerebral palsy: a randomized trial*. **Y. Bleyenheuft, C. Arnould, MB. Brandao, C. Bleyenheuft, AM Gordon** (Université Catholique de Louvain, Belgium - Haute Ecole Louvain en Hainaut, Belgium - Faculdade de Ciências Médicas de Minas Gerais, Brazil - Cliniques Universitaires de Mont-Godinne, Belgium - Department of Biobehavioral Sciences, USA). Page 11
- **Paper 9.** *NeuroPed - a multidisciplinary Pediatric Neurorehabilitation team: The experience in looking for technological solutions.* **L. Zumárraga, I.Sanz, C. Pérez, A. Trillo** (NeuroPed Pediatric Neurorehabilitation Center - Universidad Europea Madrid - Center of Automatics and Robotics, Spain). Page 12.
- **Paper 10.** *The development of a virtual interactive task-dependent assessment and training platform combining physical exercises with cognitive challenges.* **C. Lafosse** (Katholieke Universiteit Leuven, Belgium). Page 13.
- **Paper 11.** *Integration of physical therapy schemes within a clinical pipeline – ICT4Rehab solutions*. **B. Bonnechère, B. Jansen, F. Moiseev, L. Omelina, V. Sholukha, S. Van Sint Jan** (Université Libre de Bruxelles, Belgium – Vrije Universiteit Brussel, Belgium) Page 14.

14h40 – 15h15 – Open discussion about field requirements and future challenges to solve

15h15 – 17h00 – Testing of games by the attendees (with Belgian beers and cheese, coffee and tea) Attendees, including patients, will have the opportunity to try and test themselves some of the rehabilitation systems presented in the plenary sessions. *Note that patients are very welcome to attend the entire symposium* (free entrance are given for patients, see below).

Practical details

Fees

- **Normal** fee is 7 euros.
- **Student** fee is 3 euros (student card will be asked at the symposium registration desk).
- **Speakers and co-authors**: free entrance.
- **Patients**: free entrance.
- **Journalists**: free entrance.
- **Fee includes all sessions, breaks and lunch.**
- **Registration compulsory** (also for free entrance) on www.ict4rehab.org/symposium.

Symposium date and Location

- 1st of February from 8.30 am until 5 pm
- Museum of Medicine, Université Libre de Bruxelles, Erasme Campus (http://brusselsmuseums.be/en/museum/63-museum-of-medicine-museum-of-the-ulb*).*
- *By public transport:*
    - Easy access by metro: line 5, station: Erasme/Erasmus.
    - Train: get out at Central Station then take the metro (line 5, station: Erasme/Erasmus).
- *By car*:
    - Address: 808 Route de Lennik – 808 Lenniksbaan; 1070 Brussels.
    - !!! Take second entrance !!! (the first entrance is for the hospital)
    - A free parking will be available at the second car entrance.

Emergency phone number (logistic issues and in case you are lost on the campus)

- Ms Nicole Willems - (+32)-(0)475 740 957

ABSTRACTS

Paper 1

3D augmented reality mirror visual feedback applied to the treatment of persistent neuropathic pain in the upper extremity.

D. Mouraux[1], B. Penelle[2], E. Brassinne[3], S. Sobczak[1], A. Nonclercq[4], T. Tuna[3], N. Warzée[2]

1. Department of Locomotor Rehabilitation, Erasme Hospital, Université libre de Bruxelles. Route de Lennik 808, 1070 Bruxelles, Belgium
2. LISA Laboratory, Université libre de Bruxelles, 50 av. F-D Roosevelt, 1000 Bruxelles, Belgium
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4. LIST Laboratory, Université libre de Bruxelles, 50 av. F-D Roosevelt, 1000 Bruxelles, Belgium

Objective. Neuropathic pain is very common in Phantom limb pain and complex regional pain syndrome. Recent research reported the benefits of using virtual reality for treating pain which tends to recreate a coherent body image in the brain thanks to the visual feedback. We assessed if pain relief could be present with a new system that combines 3D augmented reality and the principles of mirror visual feedback.

Design. We recruited twenty two subjects who suffered from chronic neuropathic pain. Neuropathic pain was scored by DN4 questionnaire and pain was evaluated using a Visual Analog Scale and McGill pain questionnaire. All patients were assessed before and just after each treatment session and one day after the last treatment. Each patient received 5 treatment sessions of 20 minutes spread over a period of 1 week. From the general population we classified patients in high and low responders.

Results. We observed in the general population that the average pain decrease per session is of about 29% ($p<0.001$). Concerning high and low responders the pain decrease is about 37% ($p<0.001$) and 14 % ($p>0.05$) respectively. We noted that the pain reduction is partially preserved until the next sessions except for low responders. The level of pain at baseline and 24 hours after the last session decreased significantly for the Visual Analog Scale about 37% and 45% ($p<0.001$) for the general population and high responders, respectively .

Conclusions. These findings suggest that 3D augmented reality could be helpful to decrease pain in chronic neuropathic pain.

Paper 2

Limits of stability in people after stroke and the relation with balance, gait and mobility

M. Van Dijk[1], N. Ghosh[2], S. Sandstad[2], H. Beyens[1], G. Verheyden[1,2]

1 Afdeling Niet-Aangeboren Hersenletsel, Dienst Fysische Geneeskunde en Revalidatie, UZ Leuven
2 Departement Revalidatiewetenschappen, KU Leuven

1. Objective

The aim of our study was to investigate limits of stability in standing in people with stroke, and to evaluate the relation between limits of stability and clinical measures of balance, gait and mobility.

2. Participants and setting

Patients are recruited from the rehabilitation wards of UZ Leuven Campus Pellenberg. So far we have recruited 33 participants. Our inclusion criteria are (1) stroke, (2) undergoing inpatient stroke rehabilitation, (3) being able to stand independently for 2 minutes, and (4) being cooperative enough to conduct our protocol.

3. Protocol

Patients are invited for one assessment during their stay on our rehabilitation ward. We use the BioRescue to measure their limits of stability. The BioRescue system is a force plate with real-time feedback via a TV-screen. The patient is asked to stand on the force plate and move his/her bodyweight in eight directions (according to a compass), which is also simultaneously shown on the screen. The different directions are offered in a randomized order. This part of the protocol is conducted five times. For the analyses, we only use the last three measurements.
Furthermore, we measure our subjects with five standardized clinical measures to measure balance, gait and mobility: Berg Balance Scale, 10m walking test, Dynamic Gait Index, Community Balance & Mobility Scale, and the Falls Efficacy Scale – international version. All these measures are validated for people with stroke.

Our hypothesis is that the limits of stability (movements of the bodyweight) in the diagonal direction are more strongly related with the clinical measures than movements in the anterior-posterior and lateral direction.

Paper 3

Learning to use a new virtual environment: a crucial phase for cognitive patients

M. Camara- Lopez[1], G. Deliens[1], C. Degiorgio[2], A. Watelet[2], A. Cleeremans[1]

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2 Hôpital Erasme – Université Libre de Bruxelles, Belgium

Realistic Observations in Game and Experience in Rehabilitation (R.O.G.E.R) is a prototype of a virtual environment where cognitive patients can move freely into a three-room apartment and shift many objects from one place to another. Thanks to the Kinect technology, patients' movements and actions can be recognized by a camera which applies this movement in the environment, making this device a sensori-motor experiment.

We observed a great lack of information in the literature about the way the patient assimilates a virtual environment and becomes familiar with it. In this context, our aim was to highlight, through videos case studies, the difficulties encountered by the patients in R.O.G.E.R. Some of them can be explained by the multiplicity of executive functions involved in this learning. This implies that several functions are needed simultaneously in order to resolve the task. Another possible reason of the failure could be the important memory load needed. Indeed, there are many rules which have to be learned in order to use correctly the environment and this increases more and more the length of the instructions. A third explanation could be the level of accommodation (the feeling that the participants experience when facing the environment). Indeed, even without explaining the rules explicitly, the environment itself gives information about what is done wrong by the user when not performing correctly. Thereby, a kind of learning-by-doing could be involved too.

To conclude, it is undeniable that this discovery phase of a new virtual environment provides, already before testing, much information about the cognitive state of the patient, especially about learning capacities. Based on these case studies, we modified our prototype and we will present the new look and functionalities of the next version of R.O.G.E.R.

Paper 4

An approach for automatic evaluation of diagnosis exercises in Physical Therapy using depth sensors

M.P. Cuéllar[1], Y. Le Borgne[2], N. Galiano-Castillo[3], M. Arroyo[1], M.C. Pegalajar[1], M.J. Martín-Bautista[1], G. Bontempi[2]

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2 Machine Learning Group, Université Libre de Bruxelles, Belgium
3 Department of Physical Therapy, University of Granada, Spain

In this contribution, we outline the advances carried out in the project "Towards Smart Rehabilitation: Proactive Sensing for Remote and Automatic Medical Evaluation". This project addresses the problem of the recognition of human activities in the field of Ambient Intelligence, and more specifically, Ambient Assisted Living.

In our talk, we explore the advances in unobtrusive camera-based technologies as a single sensor for human activity recognition involving motion, and provide a qualitative discussion of our experience. We focus in the design of the tool *'PReSenS'* (Proactive Rehabilitation Sensing System), whose aim is to provide automatic evaluation of physical activity performances. In this application, a depth camera is used as single sensor to acquire human motion data from an expert performer. These recordings are stored into a database, for their later use as exercise templates. New users of the system are then able to select and perform exercise plans, and each performance is automatically evaluated in near real-time by the system. During our talk, we also discuss different technologies that can be used for human activity learning and recognition from the technical point of view, and we distinguish between knowledge-based and data-driven techniques. In the later ones, we show experimentatss carried out using model-based and lazy learning methods, and provide advantages and disadvantages of both approaches from the theoretical and practical point of view.

Finally, we conclude with further work and new opening challenges and technologies that could be addressed to improve assistance in physical therapy.

Paper 5

The ICT4Rehab project - A "fully"-integrated ICT platform for patient rehabilitation including clinical database, body tracking, serious gaming and data mining

S. Van Sint Jan[1], B. Bonnechère[1], M. Foé[2], B. Jansen[3], Y-A Le Borgne[4], F. Moiseev[1], L. Omelina[3], P. Salvia[1], V. Sholukha[1], S. Vansummeren[2]

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Rehabilitation therapists got interested by gaming applications since the availability of the first "physical' games (e.g., Wii, Kinect). The therapists' aim was to find an alternative to conventional therapy in order to (re-)motivate patients to perform their rehabilitation schemes. However, such games have been developed for entertainment, and they are closer to fitness exercises then proper physical rehabilitation. More recently the Serious Gaming field developed so-called "*adapted rehabilitation games*". This later development allowed some good progress, but unfortunately many rehabilitation aspects remain simplified or are simply absent.

The reason of this simplification is a lack of integration of key rehabilitation content within the games. For example, detailed understanding of the patient troubles (i.e., anatomical system(s) involved, underlying pathologies, etc.) and rehabilitation schemes available to therapists should be deeply embedded into the games. Furthermore, the link between the serious games with the remaining of the patient clinical history (anamnesis, clinical treatment, etc.) is required if one wishes to obtain wide clinical acceptance. Dedicated data analysis tools should also be available for clinical research and clinical reporting. The system usability will be demonstrated elsewhere (see Paper 1, page 14) and during the symposium demonstration session.

The ICT4Rehab platform includes interlinked components such as a serious gaming development platform including several rehabilitation aspects, full patient data management through a dedicated database (including most clinical historical data next to patient data generated by serious games), statistical analysis based on data mining, and clinical reporting using conventional clinical and biomechanical conventions. The platform has been developed around Cerebral Palsy, but the underlying architecture allows adaptation to other pathologies linked to motion disorders. The ICT4Rehab project is currently reaching valorization and industrial stages.

Paper 6 – Keynote Speaker

The psychology of rehabilitation: where does new technology fit?

T. Pincus[1]

1 Royal Holloway University of London, United Kingdom

A primary aspect of rehabilitation is exercise. At its broadest application, exercise is a predictor of improved physical and mental being. At a more specific level, exercise is often needed to introduce or re-introduce people to activities that should be part of their living repertoire. This can include improving fitness, balance, or flexibility in general, or working on very specific sets of muscles.

Either way, it is hard to engage people in exercise rehabilitation, noncompliance is high, and failure to turn up to physiotherapy appointments is common and costly. This keynote will outline current evidence from research of motivational triggers during rehabilitation, from both the patient and clinician's aspect. Sub-groups of patients will be described. Although rehabilitation clinicians are often very good at identifying physical risk factors, it is often more difficult to identify psychological factors that form obstacles to recovery, yet these have shown to be robust predictors of outcome in most patient' groups. Common obstacles to rehabilitation include motivation, access, safety and cost, amongst others. Current developments in the vision of rehabilitation will be outlined, with a focus on the use of technology, including serious gaming, to overcome obstacles to committed and effective rehabilitation. Although these offer considerable potential, there are also problems associated with the approach.

Development of rehabilitation technology should always be user-centered, and specific to the target population. Over-coming people's fear about technology is paramount. Clinicians' are understandably wary of technological interventions that aim to mimic their clinical decisions and intuition. Aspects of identifying and feeding back about correct and incorrect execution of movement remains problematic in the absence of human heuristic thinking. In addition, identification of sub-groups who are at high risk because of psychological factors is a challenge to new technology. Nonetheless, there are several cutting edge research projects trying to overcome these problems.

Finally, evaluation of interventions that rely on fast evolving technology is problematic; with the traditional framework for randomized controlled trials stretching of a timespan that would mean that results from trials will only be available after the technology is obsolete. Yet, adopting these interventions without evaluation is not recommended.

The audience will be invited to comment on the utility of new- technology based rehabilitation, their reservations and concerns, and their perceived priorities for future research.

Paper 7

Upper limb rehabilitation with the I-TRAVLE system: Designing Serious Play for Playful Training

K. Coninx[1], P. Feys[2]

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[2]BIOMED-REVAL, Universiteit Hasselt, Belgium

I-TRAVLE, Individualized, Technology-Supported and Robot-Assisted Virtual Learning Environments, is realized by a multidisciplinary consortium (www.i-travle.eu, Interreg IV, IVA-VLANED-1.14, IVA-VLANED-1.58) to train the upper limbs of MS and stroke patients. The rehabilitation robotics system makes use of the MOOG HapticMaster device in a virtual learning environment that was specifically developed for these training programs. The haptic device is equipped with a custom-made ADL gimbal to support mild to severe disabled patients to perform training exercises on activities of daily life. In order to motivate the patients for the training, techniques such as games, social gaming, personalization and adaptivity are applied in the training exercises to enhance their likeability. A special-purpose patient user interface allows the patient to navigate through the exercises of the training program. The therapist user interface assists the therapist in setting up the training program and personalizing the exercises and games.

The presentation highlights the goals of the project and the principles we adhered to when realizing the I-TRAVLE system. The aforementioned techniques to enhance the likeability of the training exercises are described and shown in selected games. The value of social gaming to enhance the patient's motivation is illustrated using the Social Maze serious game. Specific points of attention for home-based rehabilitation versus training in a rehabilitation centre are considered.

The demonstration shows how the I-TRAVLE approach is applied in simple training exercises and in individual as well as social, collaborative games. For practical reasons, the light Falcon haptic device is used rather than the HapticMaster robot that is the kernel of the I-TRAVLE system in its real clinical application. Furthermore, current developments for home-based neurorehabilitation are illustrated.

Paper 8

Hand and Arm Bimanual Intensive Therapy Including Lower Extremity (HABIT-ILE) in Children With Unilateral Spastic Cerebral Palsy: A Randomized Trial

Y. Bleyenheuft[1], C. Arnould[2], MB. Brandao[3], C. Bleyenheuft[4], AM Gordon[5]

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Background: Intensive bimanual training allows improving hand function in children with unilateral spastic cerebral palsy (USCP). However, it is not known whether adding a lower extremity component to bimanual training is beneficial.

Objective: To examine the efficacy of Hand and Arm Bimanual Intensive Therapy Including Lower Extremity (HABIT-ILE) for children with USCP.

Methods: Twenty four children with USCP were randomized, with stratification by age, gender, hemiparetic side and dexterity, to one of the two study arms. In phase 1, one group was assigned to the immediate HABIT-ILE group (10days=90hours), and 12 children to the delayed treatment control group, which continued to receive their traditional/ongoing treatment by their existing physical/occupational therapists for 90 hours. Both groups were assessed before and after their respective treatments. In phase 2, children in the control group were crossed over to receive HABIT-ILE and children of the HABIT-ILE group were followed for 90 hours of conventional therapy. Manual ability was assessed using the Assisting Hand Assessment, the ABILHAND-kids and the Pediatric Evaluation of Disability Inventory. Dexterity and pinch strength were also measured. Locomotor abilities were assessed with the ABILOCO-kids and walking endurance with the 6 minute walk test. Social participation was measured with the life-HABITs.

Results: Primary outcomes and most secondary assessments presented significant improvements following HABIT-ILE, but not conventional therapy.

Conclusion: This first attempt to add a systematic lower extremity component to intensive bimanual training suggests that this combined approach can be useful for improving both upper and lower extremity function in children with USCP.

Paper 9

NeuroPed - a multidisciplinary Pediatric Neurorehabilitation team: The experience in looking for technological solutions.

L. Zumárraga[1], **I.Sanz**[1,2], **C. Pérez**[1,3], **A. Trillo**[1]

[1] NeuroPed Pediatric Neurorehabilitation Center, Madrid, Spain.

[2] Universidad Europea Madrid, Spain

[3] Center of Automatics and Robotics (CAR). Spain

Our daily work in Pediatric Neurorehabilitation, is based on an interdisciplinary model. Clinicians cooperate with families, schools and the community for better quality of life and better social participation of the children. The aim is to achieve a family and children centered rehabilitation program where the clinicians take care of the family decision making based on the children's pathology, treatment goals and the economic and time family effort.

As a Neurorehabilitation center we try to generalize the abilities trained to the daily life, at home, school and the community. Therefore, good technological solutions would be a good support.

One of the big challenges in rehabilitation is to find the good treatments that motivate, both children and clinicians, and improve therapeutic engagement. Serious games, robotics, and technology in general could bring big opportunities to offer evidence based treatments. However, they must solve some key requirements from our experience as clinical partners in I+D Projects.

During our talk we will focus on our experience from testing Standard Video Games (Wii, Kinect, etc), Virtual Reality, "Serious Games", rehabilitation platforms, and robotic platforms.

Our talk will explore the requirements and needs of technology for the therapist, the children and the families in order to develop usable tools for assessment, rehabilitation and monitoring the rehabilitation process.

We conclude technological health solutions in pediatric rehabilitation are a great opportunity for improvement, however have big challenges. Experience recommends thinking from the users' perspective: children, families and clinicians. From families and children: the economical and cultural level. From therapists: standardized platforms and complementarity to actual clinical practice.

At the end, Technology must help society in the improvement of the treatments to be effective and efficient.

Paper 10

The development of a virtual interactive task-dependent assessment and training platform combining physical exercises with cognitive challenges

C. Lafosse[1]

1 Rehabilitation Hospital RevArte, Edegem; KULeuven, Thomas More University College

Introduction. We developed an interactive virtual task-dependent platform that provides motivational exercises in peri- and extra-personal space combining a physical (postural or motor) response with perceptual and cognitive task-dependent challenges in a virtual environment.

Method. A cognitive visual search task is developed containing different stages graded according to both their difficulty and the cognitive factors to be evaluated. For registrating responses in extra-personal space, this cognitive task is presented on a HD flatscreen 5m in front of the patient. We utilize a time-of-flight (TOF) camera that can track the full body movement of a patient in three dimensions. All gross postural/motor movements, like body posture adjustments, arm movements, standing up, sitting down, walking, within a 5x5 meter area can be traced by the system in a 176x144 pixel array in interaction with the cognitive tasks on the flatscreen. The camera input is converted by specially designed software to interpret the patient's movements and convert these into the task elements shown on the screen. For registrating responses in peri-personal space, we use a 22 inch digital tablet (DIN A3) where the patient performs visual scanning and search tasks by a visuomotor response through computerized assisted testing.

Results and conclusion. Our virtual interactive task-dependent platform provides reliable exercises for the patient in extra-personal space combining a physical (postural or motor) response with perceptual and cognitive task-dependent challenges in a virtual environment. By combining a postural or motor response to explore and to react on presented stimuli in far space, this platform more closely approximates the everyday multitasking nature of functional performance.

Acknowledgements. This study was funded in part by the Lundbeck Geriatric Medicine Grant Belgium.

Paper 11

Customizable physical therapy schemes – ICT4Rehab solutions

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1 Laboratory of Anatomy, biomechanics and Organogenesis, Faculty of Medicine, Université Libre de Bruxelles (ULB). Belgium
2 Department of Electronics and Informatics – ETRO, Vrije Universiteit Brussel, Brussels, Belgium

The video game industry is one of the fastest growing sectors in the world. Technologies associated to these games are becoming more and more sophisticated. Dramatic changes in performance of the computer but also, and more important for rehabilitation, the way of playing the video games has changed over the last few years. Thanks to new unconventional gaming controllers (Nintendo Wii Fit™, Microsoft Xbox Kinect™, etc.) the way of playing video games has changed from a passive (the player is seated on a sofa) to an active way: players have to move in order to interact with games. Clinicians have quickly found out the new potential use of these games in rehabilitation and have tested available commercial games with patients suffering from various pathologies (e.g. stroke, Parkinson disease, cerebral palsy). Result of the first tests is that games are not suitable for rehabilitation. Most of the current games are too complex for rehabilitation (e. g. visual complexity or the speed) and lack adaptability. Nevertheless the potential of the new game controllers remains unused since they can provide clinically relevant measurements and convert games into a continuously tracking tool in the home environment.

Within the ICT4Rehab project we designed a platform to overcome limitations of popular modern video games played by a broad public. The platform can be used in combination with a variety of input sensors, including 3D cameras, balance boards, mobile phones or accelerometers. The underlying architecture enables therapists to specify the game controls but also their sensitivity, thereby allowing taking into account the patient-specific needs and capabilities, and make each game unique. The desired modifications can be applied at runtime through an easy to use interface, not requiring any programing skills. We developed also several games with this platform which allow therapists to (i) use different, even custom made, input sensors/devices to control the game (ii) easily adapt each of the games to patients' needs, (iii) track patients' state and progress during the gameplay/therapy.

The above ICT4Rehab rehabilitation platform is also fully integrated into the overall patient management platform developed by the same project (see Paper 5, page 8). Such integration allows to correlate information obtained during the physical therapy sessions, performed with the rehabilitation games, with the remaining of the clinical patient file such as anamnesis and clinical history, clinical testing (spasticity, mobility etc), functional information (e.g., gait analysis, task assessment).The underlying paradigm is to obtain clinically-relevant information when the patient is performing his/her physical therapy "when playing" and add it to the patient clinical file.

The ICT4Rehab project is now in the process to evaluate the entire platform in several hospitals in Belgium and abroad.