SeGAH '17

5th IEEE International Conference on

Serious Games and Applications for Health

Perth, Western Australia, from 2 - 4 April 2017

BOOK OF ABSTRACTS

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Supporting Entities

MURDOCH UNIVERSITY
PERTH, WESTERN AUSTRALIA

WWW 2017

SUMMARIZED PROGRAM

2 April

12:00	Registration
13:00	Opening Session
13:10	Invited Lecture - David Gibson
14:00	Session 1: Healthcare Training I
15:40	Coffee Break
16:00	Session 2: Rehabilitation

3 April

8.30	Registration
9:00	Invited Lecture - Rudy McDaniel
9.50	Session 3: Games for Children
10:50	Coffee Break
11:10	Session 4: Healthcare Training II
12:30	Lunch

14:00	SPECIAL TRACK - On Augmented Reality, Virtual Reality and Wearable Technologies
17:30	Conference Dinner

4 April

8.00	Registration
8:00	Session 5: Sensors and haptics for Games
9:20	Round Table: Augmented and Virtual Reality in Health
10:10	Poster Session & Coffee Break
10:50	Session 6: Education
12:50	Closing Session

DETAILED PROGRAM

2 April

12:00 Registration

13:00 Opening Session

13:10 **Analytic and Strategic Challenges of Serious Games: How higher education learning and teaching can learn from serious game developers**
Invited Lecture - David Gibson, Director of Learning Futures, Curtin University, Australia

Session 1: Healthcare Training I

14:00 **Game-based Cultural Competence Training in Healthcare**
Simon Mayr, Sebastian Schneider, Lev Ledit, Stefan Bock, David Zahradnicek and Stefan Prochaska
Paper

14:20 **Using simulated digital role plays to teach healthcare 'soft skills'**
Stefan Schutt, Dale Linegar, David Holloway and Daan Deman
Paper

14:40 **A Virtual Online Environment for Testing the Effect of Social and Physical Context on the Effectiveness of Health Warning Messages**
David Glance, Ye'Elah Berman, Simone Pettigrew, Michelle Jongenelis, Tanya Chikritzhs, Wenbin Liang, Iain S Pratt and Terry Slevin
Paper

15:00 **Integrating Big Data Analytics, Virtual Reality, and ARAIG to Support Resilience Assessment and Development in Tactical Training**
Carolyn Mcgregor, Brendan Bonnis, Brodie Stanfield and Michael Stanfield
Paper

15:20 **Positive Design of Smart Interactive Fabric Artifacts for People with Dementia**
Graham Mann and Giles Oatley
Paper

14:40 **Coffee Break**

Session 2: Rehabilitation

16:00 **A Usability Evaluation of Neuromender's Upper Limb Game-based Rehabilitation System for Stroke Survivors**
Mohd Fairuz Shiratuddin, Shri Rai, Gowshik Murali Krishnan, Mike Newton, Xuequn Wang, Ferdous Sohel, David Blacker and Michelle Byrne
Paper

16:20 **Neuromender::FlexiBrains - A game-based remotely supervised autonomous in-home rehabilitation system for cognitive retraining of stroke survivors**
Shri Rai, Mohd Fairuz Shiratuddin, Mark Carriedo, Andrew Harrison, Khalid Saleh, Mike Newton, Robert Herne, David Blacker and Michelle Byrnes
Paper

16:40 **MPRL: Multiple-Periodic Reinforcement Learning for Difficulty Adjustment in Rehabilitation Games**
Yoones A. Sekhavat
Paper

17:00 **An Interactive Full Body Exercise Experience for Patients suffering from Ankylosing Spondylitis.**
Jayati Bandyopadhyay and Girish Dalvi
Paper

17:20 **Robotic-assisted serious game for motor and cognitive post-stroke rehabilitation**
Sophie Heins, Stéphanie Dehem, Vincenza Montedoro, François Rocca, Pierre-Henri De Deken, Martin Gareth Edwards, Bruno Dehez, Matei Mancas, Gaetan Stoquart and Thierry Lejeune
Paper

17:40 **Computational Thinking (CT) and Rebel Game Design: CT in Health Games**
Hock Chuan Lim
Paper

18:00 **A Paradigm for the Development of Serious Games for Health as Benefit Delivery Systems**
Gary Ushaw, Janet Eyre and Graham Morgan
Paper

3 April

8:30 Registration

9:00 **The ethics of serious games for health**
Invited Lecture - Rudy McDaniel, Director of the School of Visual Arts and Design, University of Central Florida, FL, USA

Session 3: Games for Children

9:50 **Designing Games to Help Train Children to Use Prosthetic Arms**
Peter Smith and Matt Dombrowski
Paper

10:10 **A Serious Game for Children with Autism Spectrum Disorder as A Tool for Play Therapy**
Alejandra Ornelas Barajas, Hussein Al Osman and Shervin Shirmohammadi
Paper

10:30   EnCity: A Serious Game for Empowering Young People with Down's Syndrome

Aikaterini Bourazeri, Tyrone Bellamy-Wood and Sylvester Arnab

Paper

10:50   Coffee Break

Session 4: Healthcare Training II

11:10   ASPIRA: Employing a Seruis Game in an mHealth App to Improve Asthma Outcomes

Jamie Thomson, Chris Hass, Ivor Horn, Elizabeth Kleine, Stephanie Mitchell, Kevin Gary, Ishrat Ahmed, Derek Hamel and Ashish Amresh

Paper

11:30   Through the Eye of the Master: The Use of Virtual Reality in the Teaching of Surgical Hand Preparation.

Ben Harrison, Raoul Oehmen, Anitra Robertson, Brett Robertson, Penny De Cruz, Riaz Khan and Daniel Fick

Paper

11:50   Piloting Mobile Mixed Reality Simulation in Paramedic Distance Education

James Birt, Emma Moore and Michael Cowling

Paper

12:10   NutritionRush - A Serious Game to Support People with the Awareness of Their Nutrition Intake

René Baranyi, Bernhard Steyrer, Lukas Lechner, Gevher Agbektas, Nadja Lederer and Thomas Grechenig

Paper

12:30   Lunch

SPECIAL TRACK: Augmented Reality, Virtual Reality and Wearable Technologies

14:00   The effect of virtual reality in reducing preoperative anxiety in patients prior to arthroscopic knee surgery: A randomised controlled trial

Anitra Robertson, Rajitha Gunaratne, Daniel Fick, Riaz Khan, Hunter Hoffman, Ramesh Rajan, Vanessa Bowden, Shanil Yapa and William B Robertson

Paper

14:20   Minimizing cyber sickness in head mounted display systems: design guidelines and applications

Thiago M. Porcino, Esteban Clua, Daniela Trevisan, Cristina N. Vasconcelos, Luis Valente

Paper

14:40 Fun-Knee™: A Novel Smart Knee Sleeve for Total-Knee-Replacement Rehabilitation with Gamification

Yang Qiu, Kun Man Li, Eng Chuan Neoh, Huiguo Zhang, Xin Yue Khaw, Xiuyi Fan and Chunyan Miao

Paper

15:00 **Developing Virtual Patients with VR/AR for a Natural User Interface in Medical Teaching**
Marjorie Zielke, Djakhangir Zakhidov, Gary Hardee, Leonard Evans, Sean Lenox, Nick Orr, Dylan Fino and Gautham Mathialagan
Paper

15:20 **The Possibilities of Embroidered Passive UHF RFID Textile Tags as Wearable Moisture Sensors**
Dawood Shuaib, Sari Merilampi, Leena Ukkonen and Johanna Virkki
Paper

15:40 **Virtually Controlled Robotic Arm using Haptics**
Kiran Kulkarni, Abhijit Murgod and Vasudev Parvati
Paper

16:00 **More Attention, Less Deficit: Wearable EEG-Based Serious Game for Focus Improvement**
Alaa Eddin Alchalabi, Amer Nour Eddin and Shervin Shirmohammadi
Paper

16:20 **Detecting and Exploiting Periodicity in Activity Classification**
Liana E. Taylor, Umran A. Abdulla, Michael G. Barlow and Ken Taylor
Paper

17:30 **Conference Dinner**

4 April

Session 5: Sensors and haptics for Games

8:00 **Playing with and without Biofeedback**
Mohammad Zafar, Beena Ahmed and Ricardo Gutierrez-Osuna
Paper

8:20 **A Virtual Environment for Breast Exams Practice with Haptics and Gamification**
André Luiz Brazil, Aura Conci, Esteban Clua, Leonardo Kayat Bittencourt and Lúcia Blondet Baruque
Paper

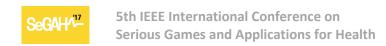**8:40** **Precision of Control as a Function of Control Scheme: Implications for Serious Exertion Games from a Flow Perspective**
Erandi Lakshika and Michael Barlow
Paper

9:00 **Effects of Reactive and Strategic Game Mechanics in Motion-based Games**
Aseel Berglund, Erik Berglund, Fabio Siliberto and Erik Prytz
Paper

9:20 Round-table: Augmented and Virtual Reality in Health
David Gibson, Director of Learning Futures, Curtin University, Australia
Rudy McDaniel, Director of the School of Visual Arts and Design, University of Central Florida, FL, USA
Marjorie Zielke, Director of the Center for Modeling and Simulation, The University of Texas at Dallas, TX, USA
Brett Robertson, Director at Surgical Realities, WA, Australia
Sara de Freitas, SEGAH 2017 General Co-Chair

Poster Session

10:10 Use of Assistive Technology to Accommodate Students with Writing Disabilities
Onintra Poobrasert, Thaphat Mupattararot and Lattapol Sae-que
Paper

Hemineglect assessment and rehabilitation using a robotic serious game
Vincenza Montedoro, Stephanie Dehem, Marie Alsamour, Thierry Lejeune, Daniel Galinski, Sophie Heins, Bruno Dehez, Gaetan Stoquart and Martin Edwards
Paper

Protection of parathyroid glands in thyroid surgery and treatment of postoperative hypocalcemia
Xue-Hai Bian and Hui Sun
Paper

Assessment of upper limb motor impairments in children with cerebral palsy using a rehabilitation robot and serious game exercise
Stephanie Dehem, Vincenza Montedoro, Martin Gareth Edwards, Sophie Heins, Daniel Galinski, Bruno Dehez, Gaetan Stoquart, Isaline Brouwers and Thierry Lejeune
Paper

Serious Game on Recognizing Categories of Waste, to Support a Zero Waste Recycling Program
Balu M Menon, Unnikrishnan R, Alexander Muir and Bhavani R Rao
Paper

The Untapped Benefit of Doing Almost Nothing: Massively Scalable Learning via Games and Exploration
Dominicus Tornqvist, Lian Wen and Jennifer Tichon
Paper

D.R.E.A.M.S. (Digital Rehabilitation Environment-Altering Medical System)
Marko Suvajdzic, Azra Bihorac and Parisa Rashidi
Paper

Playing against dengue Design and development of a serious game to help tackling dengue
Tiago Lima, Breno Barbosa, Carlos Niquini, Camila Araújo and Raquel Lana
Paper

Memori: A Serious Game for Diagnosing and Treating Visual Sequential Memory Deficit

Ayşe Rumeysa Mohammed, Ammar Rashed and Shervin Shirmohammadi

Paper

A Serious Game for Children with Speech Disorders and Hearing Problems

Nahid Nasiri, Shervin Shirmohammadi and Ammar Rashed

Paper

LA-VIE: A Serious Game for Cardio Pulmonary Resuscitation

Ajmal Rana Muhammad, Farooq Ahmad, Hamza Latif Muhammad and Junaid Alam

Paper

MyEyes- Automatic Combination System of Clothing Parts to Blind People: First insights

Daniel Rocha, Vitor Carvalho, Eva Oliveira, Joaquim Gonçalves, Filipe Azevedo

Paper

Classification algorithms for body posture

Sílvia Silva, Sandro Queirós, António Moreira, Nuno Rodrigues, Fernando Veloso, Eva Oliveira and João L. Vilaça

Paper

Brain-Function Analysis of Changes in Female Hearing Induced by Childbearing

Hiroko Kotani, Misa Kato, Aki Nishiyama, Kasumi Kuramoto, Maka Matsuno and Hidenori Nakagawa

Paper

Instrumented vest for postural reeducation

Pedro Carvalho, Sandro Queirós, António Moreira, José Henrique Brito, Fernando Veloso, Miguel Terroso, Nuno F. Rodrigues and João L. Vilaça

Paper

Serious games design considerations for people with Alzheimer's disease in developing nations

Sanda Samarasinghe, Hiran Weerasinghe, Yamaya Ekanayaka, Madawa Weerasooriya, Roshan Rajapakse and Diyunugal Wijesinghe

Paper

Session 6: Education

10:50 Predicting Math Performance of Children With Special Needs Based on Serious game

Umi Laili Yuhana, Remy Geovany Mangowal, Siti Rochimah, Eko Mulyanto Yuniarno and Mauridhi Hery Purnomo

Paper

11:10 MathBharata: A Serious Game for Motivating Difabled Students to Study Mathematics

Remy Giovanny Mangowal, Umi Laili Yuhana, Eko M. Yuniarno and Mauridhi Hery Purnomo

Paper

11:30 **Towards the development of a serious game that targets psychological stressors of the workplace**
Houssemedine Yahyaoui and Bob-Antoine Jerry Menelas
[Paper](#)

11:50 **Developing Serious Games to Promote Cognitive Abilities for the Elderly**
Hongmei Chi, Edward Agama and Zornitza Genova Prodanoff
[Paper](#)

12:10 **The Cognitive Mobile Games for Older Adults - A Chinese User Experience Study**
Sari Merilampi, Antti Koivisto, Andrew Sirkka, Xu Xiao, Yan Min, Lin Ye, Xiao Chujun, Jiani Chen, Pasi Raumonen and Johanna Virkki
[Paper](#)

12:30 **Universal Tools for Measuring Games and Learning: Dynamic Causal Nets**
Dominicus Tornqvist, Lian Wen and Jennifer Tichon
[Paper](#)

13:30 **Closing Session**
Best Paper Award
Wrap-up + Announcement of SEGAH 2018

ABSTRACTS

2 April

Session 1: Healthcare Training I

14:00 **Game-based Cultural Competence Training in Healthcare**

Simon Mayr, Sebastian Schneider, Lev Ledit, Stefan Bock, David Zahradnicek and Stefan Prochaska

Abstract - Doc and the machine can be described as a game based qualitative analysis and crowd interpretation software that provides real-time, in-game peer assessment and feedback to encourage user reflection and self-explanation in cultural competence training. The primary audience includes students and trainees in medical and nursing schools and practicing healthcare providers looking for professional development and development of new skills that support decision making in culturally sensitive context. The game content is based on real world scenarios and lessons learned from culturally diverse subject matter where experts are involved in socially ambiguous situations that do not have the one right answer.

14:20 **Using simulated digital role plays to teach healthcare 'soft skills'**

Stefan Schutt, Dale Linegar, David Holloway and Daan Deman

Abstract— Training deficits in 'soft skills' – personal or nontechnical skills – have long been lamented by educators and employers despite longstanding evidence of their importance. Virtual environments, combined with online learning management and reporting platforms, offer potential for addressing this gap through affordable and scalable simulations. This paper aims to summarise virtual 'soft skills' work undertaken to date, and to explore practical issues encountered by development teams working in this area. The first section provides historical overviews of the 'soft skills' term and related digital training initiatives. This is followed by a case study of an interdisciplinary team of Australian software developers, researchers and educators who have built a series of virtual healthcare products. The case study reports on a number of challenges encountered by the team.

14:40 **A Virtual Online Environment for Testing the Effect of Social and Physical Context on the Effectiveness of Health Warning Messages**

David Glance, Ye'Elah Berman, Simone Pettigrew, Michelle Jongenelis, Tanya Chikritzhs, Wenbin Liang, Iain S Pratt and Terry Slevin

Abstract— Testing the effectiveness of warning statements designed to encourage healthy lifestyle behaviors is largely done by showing the messages to study participants in the absence of 'real world' social and physical contexts. This approach does not factor in the impact of the medium of the message. A virtual, 360-

degree environment (Messaging360) was developed that online participants can explore and be exposed to messages in a variety of different social and physical contexts: through advertising in a newspaper, labels on products and from a small child and a doctor avatar. The platform allows for large numbers of participants to be tested in a way that models real-life contexts for the messages and so may represent a more effective way of assessing their impact in delivering the health information

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15:00 Integrating Big Data Analytics, Virtual Reality, and ARAIG to Support Resilience Assessment and Development in Tactical Training

Carolyn Mcgregor, Brendan Bonnis, Brodie Stanfield and Michael Stanfield

Abstract - Combat tactical training activities utilizing virtual reality environments are being used increasingly to create training scenarios to promote resilience against stressors and to enable standardized training scenarios to allow trainees to learn techniques for various stressors. Resilience is an important component for mental health. However, assessment of the trainees' response to these training activities has either been limited to various pre and post training assessment metrics or collected in parallel during experiments and analysed after collection rather than in real-time. New Big Data approaches have the potential to provide real-time analytics. We have created a Big Data analytics platform, Athena, that in real-time acquires data from a first person shooter military combat
simulation game, ArmA 3, as well as the data ArmA 3 sends to the muscle stimulation component of a multisensory garment, ARAIG that provides on the body feedback to the wearer for communications, weapon fire and being hit and integrates that

data with physiological response data such as heart rate, breathing behaviour and blood oxygen saturation. We present results from our initial pilot study from an ethics approved equipment integration study. Our approach is equally applicable for Virtual Reality Graded Exposure Therapy with physiological monitoring.

15:20 Positive Design of Smart Interactive Fabric Artifacts for People with Dementia

Graham Mann and Giles Oatley

Abstract—Confronting the expected rise of dementia as a major health care problem raises many questions about the best ways to adapt the health system to deal with it. To the extent that intelligent assistive technologies can help, there seems to be value in comforting fabric artifacts enhanced by electronic games and activities designed to support, engage and entertain people with dementia. Local cottage industries which now support the creation of textile crafts should be empowered to scale up to meet the growing demand for such products. New design concepts are required to accomplish this in the face of rising costs and limited resources. This paper proposes a four-step design process that meets this need, and provides practical suggestions about how it could be applied in this context. A number of examples are included.

Session 2: Rehabilitation

16:00 A Usability Evaluation of Neuromender's Upper Limb Game-based Rehabilitation System for Stroke Survivors

Mohd Fairuz Shiratuddin, Shri Rai, Gowshik Murali Krishnan, Mike Newton, Xuequn Wang, Ferdous Sohel, David Blacker and Michelle Byrne

Abstract—Game-based technologies have been widely used as part of stroke rehabilitation. The Neuromender system utilizes game-based technologies and consists of serious games that are designed and developed for the purpose of rehabilitation of stroke survivors. In this paper, one of the modules in the Neuromender system which is the "upper limb" module is described and tested for its usability. The upper limb module primarily focuses on the rehabilitation of the upper body extremities of stroke survivors. An experimental study is designed to test the usability of the upper limb module. Various metrics including the optimal distance between the 3D depth sensor device and the survivor, the optimal position of the 3D depth sensor with respect to the survivor, and the response time of the gestures made by the survivors based on their distance to the sensor are evaluated. At the end of the experiments, the optimal distance and optimal position for the survivors to utilize the upper limb module is determined.

16:20 Neuromender::FlexiBrains - A game-based remotely supervised autonomous in-home rehabilitation system for cognitive retraining of stroke survivors

Shri Rai, Mohd Fairuz Shiratuddin, Mark Carriedo, Andrew Harrison, Khalid Saleh, Mike Newton, Robert Herne, David Blacker and Michelle Byrnes

Abstract—Stroke is a very debilitating disease that a stroke survivor can suffer. It can result in both physical and cognitive deficits in the survivor. Without regular rehabilitation, a survivor will reach a chronic condition resulting in a huge burden. Rehabilitation is expansive, and a major issue is access as care givers are needed to take survivors to rehabilitation centres. This paper presents Neuromender::FlexiBrains, a novel game-based rehabilitation system with autonomous adjustment capabilities that can be used in a stroke survivor's home. The system was developed in collaboration with clinicians, neuroscientists and stroke survivors. Stroke clinicians can customise their rehabilitation to cater for each stroke survivor's deficits. The system enables clinicians to remotely monitor and track their clients' progress. Rehabilitation regimes can also be adjusted remotely. The system enables prescribed monitored rehabilitation to be carried out, and it permits clinicians to take care of more survivors without sacrificing the quality of care.

16:40 MPRL: Multiple-Periodic Reinforcement Learning for Difficulty Adjustment in Rehabilitation Games

Yoones A. Sekhavat

Abstract—Generally, the difficulty level of a therapeutic game is regulated manually by a therapist. However, home-based rehabilitation games require a technique for automatic difficulty adjustment. This paper proposes a personalized difficulty adjustment technique for a rehabilitation game that automatically regulates difficulty settings based on a patient's skills in real-time. To this end, ideas from reinforcement learning are used to dynamically adjust the difficulty of a game. We show that difficulty adjustment is a multiple-objective problem, in which some objectives might be evaluated at different periods. To address this problem, we propose and use Multiple-Periodic Reinforcement Learning (MPRL) that makes it possible to evaluate different objectives of difficulty adjustment in separate periods. The results of experiments show that MPRL outperforms traditional Multiple-Objective Reinforcement Learning (MORL) in terms of user satisfaction parameters as well as improving the movement skills of patients.

17:00 An. An Interactive Full Body Exercise Experience for Patients suffering from Ankylosing Spondylitis.
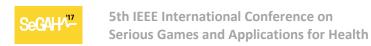
Jayati Bandyopadhyay and Girish Dalvi

Abstract— Accessibility, affordability and lack of knowledge are major concerns for patients suffering from chronic diseases like rheumatism. In India, access to an exhaustive set of exercises involving both affected and active joints is still limited for patients residing in tier-two cities, suburbs, villages or belonging to lower socio-economic strata. Patients who could access and afford to consult physiotherapists, at times lack motivation and flexibility in exercise timings. Unadjustable appointments and time spent in travelling to such facilities are barriers to a regular exercise regime. The aim of this project was to design an interactive full body exercise experience platform while addressing issues such as accessibility, affordability and motivation issues for patients affected with Ankylosing Spondylitis. Our project had two dimensions: An exercise regime with a virtual instructor and games based on exercises. These methods were tested with patients and evaluated qualitatively. Results suggest that the system has potential to cater to the needs of both motivated and unmotivated patients.

17:20 Robotic-assisted serious game for motor and cognitive post-stroke rehabilitation

Sophie Heins, Stéphanie Dehem, Vincenza Montedoro, François Rocca, Pierre-Henri De Deken, Martin Gareth Edwards, Bruno Dehez, Matei Mancas, Gaetan Stoquart and Thierry Lejeune

Abstract—Stroke is a major cause of long-term disability that can cause motor and cognitive impairments. New technologies such as robotic devices and serious games are increasingly being developed to improve post-stroke rehabilitation. The aim of the present project was to develop a ROBiGAME serious game to simultaneously improve motor and cognitive deficits (in particular hemiparesis and hemineglect). In this context, the difficulty level of the game was adapted to each patient's performance, and this individualized adaptation was addressed as the main challenge of the game development. The game was implemented on the REAplan end-effector rehabilitation robot, which was used in continuous interaction with the game. A preliminary feasibility study of a target pointing game was run in order to validate the

game features and parameters. Results showed that the game was perceived as enjoyable, and that patients reported a desire to play the game again. Most of the targets included in the game design were realistic, and they were well perceived by the patients. Results also suggested that the cognitive help strategy could include one visual prompting cue, possibly combined with an auditory cue. It was observed that the motor assistance provided by the robot was well adapted for each patient's impairments, but the study results led to a suggestion that the triggering conditions should be reviewed. Patients and therapists reported the desire to receive more feedback on the patient's performances. Nevertheless, more patients and therapists are needed to play the game in order to give further and more comprehensive feedback that will allow for improvements of the serious game. Future steps also include the validation of the motivation assessment module that is currently under development.

17:40 **Computational Thinking (CT) and Rebel Game Design: CT in Health Games**
Hock Chuan Lim

Abstract—Game-based learning (GBL) is a popular innovative pedagogical framework for developing Computational Thinking (CT) skills. The base idea is to use games to help create awareness and generated needed CT skills and abilities; in short, it is "games for CT" approach. This is however, one part of the equation for understanding and developing CT in our modern digital age. The other part of the equation lies in using "CT for games". This paper addresses this perspective to aid in the understanding and framing of the elusive CT concept. In "CT for games", this paper highlights and draws attention to using CT for developing games instead of using games to develop CT. The core contributions of the paper are a "CT for games" proposed framework; selected variants of health games and observations of "Rebel Design". Readers can benefit from a perspective with a different focus and increase awareness and understanding of CT with the hope of grooming future leaders with required CT problem-solving skills and abilities and applying "Rebel Design" for games.

18:00 **A Paradigm for the Development of Serious Games for Health as Benefit Delivery Systems**
Gary Ushaw, Janet Eyre and Graham Morgan

Abstract—Serious games are developed with the purpose of bestowing a benefit on the user. That benefit could be related to the user's health, education, safety or efficiency. We propose that the mechanism that the game employs to achieve such a benefit should be identified as the key to the development of a successful serious game. We introduce a paradigm for the design and development of serious games as benefit delivery systems. We suggest that the paradigm can apply to all applications and genres of serious game. Three serious games for health are employed as case studies of developing a serious game as a benefit delivery system. Recommendations are then made for the adoption of the paradigm for serious gaming in general.

3 April

Session 3: Games for Children

9:50 Designing Games to Help Train Children to Use Prosthetic Arms

Peter Smith and Matt Dombrowski

Abstract— Prosthetic Arms are often financially out of reach for children. A single prosthetic can cost upwards of $40,000 USD and as children grow they may need multiple new arms throughout a single year. Further, high end prosthetics can be incredibly complicated allowing for articulated wrists and individual finger movements, leading to a complex learning curve that leaves many adults frustrated leading to lack of use of the prosthetics. Limbitless Solutions, however, has applied low cost 3D printing to the task and has developed a simple to control prosthetic arm for kids and the emerging world. This work explores the use of video games combined with a custom controller to train kids to use their new prosthetic arms before they get them.

10:10 A Serious Game for Children with Autism Spectrum Disorder as A Tool for Play Therapy

Alejandra Ornelas Barajas, Hussein Al Osman and Shervin Shirmohammadi

Abstract—We propose a Serious Game (SG) for children on the Autism Spectrum Disorder (ASD) composed of a Tangible User Interface (TUI) and a Graphical User Interface (GUI). The TUI is built from physical Lego-like building blocks augmented with electronic modules. The proposed SG is envisaged as a play therapy tool aimed at improving autistic children's social and cognitive skills. We investigate the effects of using our SG in a play therapy exercise, by running an empirical study that compares conventional clinical non-computer block-games with the proposed SG. In our preliminary experimental study, the proposed system showed an improvement in social interaction, collaborative play and exercise performance, and a decrease in solitary play. Our results suggest that the proposed system can be a useful tool for play therapy aimed for young children with ASD.

10:30 EnCity: A Serious Game for Empowering Young People with Down's Syndrome

Aikaterini Bourazeri, Tyrone Bellamy-Wood and Sylvester Arnab

Abstract—Down's syndrome (also known as trisomy 21) is a genetic disorder caused by the presence of a third copy of chromosome 21 in a baby's cell. With education and proper care the quality of life of these people can be improved, and with the right support people with Down's syndrome can have an active role in the community. In this paper we examine how a virtual reality serious game, the EnCity game, could engage and encourage young people with Down's syndrome to have a more active involvement in the community. Players should complete mini games related to everyday tasks (e.g. preparing a meal, shopping in the supermarket, paying a bill, buying a ticket to visit a museum or gallery), and through these mini-games players will gain the appropriate training and encouragement for leading their lives without requiring help from their families or social services.

Session 4: Healthcare Training II

11:10 ASPIRA: Employing a Seruis Game in an mHealth App to Improve Asthma Outcomes

Jamie Thomson, Chris Hass, Ivor Horn, Elizabeth Kleine, Stephanie Mitchell, Kevin Gary, Ishrat Ahmed, Derek Hamel and Ashish Amresh

Abstract—This paper presents the design, implementation and evaluation of a home based intervention targeting economically disadvantaged children to improve asthma clinical outcomes. The monitoring and intervention activities were delivered within an embedded astronaut-themed game to promote user acceptance and compliance to the clinical protocol. An iterative, user-centered design process was used to prototype the asthma home monitoring system (Aspira) involving a tablet application, digital spirometer and a particulate monitor linked to a data management server. Children of low socio-economic demographic populations were the main target group for this study as they have significantly high asthma rates and lack of condition awareness. Aspira is the first intervention of its kind that provides the target audience an easy to use and low-cost inhome monitoring application. Aspira's design is grounded in the principles of social cognitive theory and aims to increase use, participation and efficacy in the target population. We present the results of a pilot study to determine feasibility and preliminary efficacy of the resulting high-fidelity Aspira prototype among four families with asthmatic children living in the Seattle metropolitan area.

11:30 Through the Eye of the Master: The Use of Virtual Reality in the Teaching of Surgical Hand Preparation.

Ben Harrison, Raoul Oehmen, Anitra Robertson, Brett Robertson, Penny De Cruz, Riaz Khan and Daniel Fick

Abstract— Virtual Reality (VR) demonstrates unique educational benefits over other teaching mediums including enhanced engagement and learner motivation. Such benefits could be exploited to improve teaching of surgical hand preparation (SHP), a practice crucial in preventing post-surgical infection. This study hypothesizes that the utilization of VR technology to demonstrate SHP technique will produce superior skill acquisition and longer skill retention than the standard practice of video demonstration. 40 healthcare students unfamiliar with SHP were recruited from a tertiary university and randomized into two groups. The control group (n=21) viewed a video demonstration of SHP while the VR group (n=19) viewed a VR demonstration of the same technique. Participants were assessed immediately after demonstration (acquisition score), and again one week later (retention score), using a 20-point assessment scale. Scores were compared between the groups. Groups were equal in age, prior education, handedness and gender distribution. Neither skill acquisition (Control mean: 12.29, VR mean: 12.84; p = 0.57) nor retention (Control mean: 12.29, VR mean: 12.74; p = 0.52) differed significantly between groups however a non-significant trend toward better performance in the VR group was observed. Parallel scoring of 35% of participants showed very high inter-rater reliability (intra-class correlation coefficient = 0.92). Utilization of VR technology did not demonstrate a perceivable acquisition or retention benefit in the teaching of SHP. Future studies could investigate the value of more immersive features including 360-degree point of view or

haptic feedback which were not features of the technology used in the present study.

11:50 Piloting Mobile Mixed Reality Simulation in Paramedic Distance Education

James Birt, Emma Moore and Michael Cowling

Abstract— New pedagogical methods delivered through mobile mixed reality (via a user-supplied mobile phone incorporating 3d printing and augmented reality) are becoming possible in distance education, shifting pedagogy from 2D images, words and videos to interactive simulations and immersive mobile skill training environments. This paper presents insights from the implementation and testing of a mobile mixed reality intervention in an Australian distance paramedic science classroom. The context of this mobile simulation study is skills acquisition in airways management focusing on direct laryngoscopy with foreign body removal. The intervention aims to assist distance education learners in practicing skills prior to attending mandatory residential schools and helps build a baseline equality between those students that study face to face and those at a distance. Outcomes from the pilot study showed improvements in several key performance indicators in the distance learners, but also demonstrated problems to overcome in the pedagogical method.

12:10 NutritionRush - A Serious Game to Support People with the Awareness of Their Nutrition Intake

René Baranyi, Bernhard Steyrer, Lukas Lechner, Gevher Agbektas, Nadja Lederer and Thomas Grechenig

Abstract—Malnutrition poses a threat to our physical healt hand to our well-being. Among the effects of malnutrition are stunting, wasting, overweight, obesity or micronutrient deficiencies. All of which foster the onset of noncommunicable diseases, which grow at alarming rates, especially in the European Region, according to the World Health Organization. This problem can be found across all age groups. In order to raise awareness on that matter and educate about healthy nutrition the authors designed a serious game which was entitled "NutritionRush" together with a nutritionist. It offers a nutrition library to look up nutrition details regarding nutrients, nutritional values, daily energy intake and encourages users to actively employ their knowledge while trying to accomplish specific missions during the game part. The authors also evaluated the initial prototype of NutritionRush with 14 participants in terms of gameplay satisfaction, user experience, quality of nutritional content and the potential to educate or foster healthy eating behaviors. The feedback showed that there is a lot of potential for such serious games and that the prototype is a good initial starting point for different identified requirements.

SPECIAL TRACK: Augmented Reality, Virtual Reality and Wearable Technologies

14:00 **The effect of virtual reality in reducing preoperative anxiety in patients prior to arthroscopic knee surgery: A randomised controlled trial**

Anitra Robertson, Rajitha Gunaratne, Daniel Fick, Riaz Khan, Hunter Hoffman, Ramesh Rajan, Vanessa Bowden, Shanil Yapa and William B Robertson

Abstract Preoperative anxiety positively correlates with postoperative levels of pain, analgesic use and length of hospital stay. This preliminary study aimed to determine if the principle of distraction, using a relaxing Virtual Reality (VR) immersion, would reduce preoperative anxiety in patients undergoing arthroscopic knee surgery. Sixty patients were randomised into three groups (Standard care group, Virtual Reality group and iPad group). Anxiety scores (Hospital Anxiety and Depression Scale), Galvanic Skin Response (GSR), heart rate and blood pressure were measured pre and post intervention. The Standard care group received no intervention. The iPad group watched a video slideshow of beaches around the world and the VR group experienced a virtual beach immersion. Guided relaxation audio content (via headphones) was replicated across VR and iPad groups. Planned comparisons showed a significant difference between the average GSR measures at Time 1 and Time 2 between the Standard group and VR group. GSR measures for the Standard care group increased by 54 per cent from time 1 to time 2 and the VR and iPad groups reduced slightly, demonstrating an ameliorating effect on anxiety levels. A marginal difference between the Standard care group and VR group in anxiety change scores was reported. Whilst the VR condition reduced anxiety more than Standard care in both GSR and Anxiety change score measures, it provided no significant advantage over iPad condition. In conclusion, distraction using VR and iPad temporarily reduces selfreported anxiety levels and GSR measures compared to standard care in patients prior to knee arthroscopy. Further study is required to determine how long-lasting these benefits are in a clinical setting. The continuing advancements in VR technology, including immersion quality, present an opportunity to investigate the application of VR as a 'digital pre-med'.

14:20 **Minimizing cyber sickness in head mounted display systems: design guidelines and applications**

Thiago M. Porcino, Esteban Clua, Daniela Trevisan, Cristina N. Vasconcelos, Luis Valente

Abstract—We are experiencing an upcoming trend of using head mounted display systems in games and serious games, which is likely to become an established practice in the near future. While these systems provide highly immersive experiences, many users have been reporting discomfort symptoms, such as nausea, sickness, and headaches, among others. When using VR for health applications, this is more critical, since the discomfort may interfere a lot in treatments. In this work we discuss possible causes of these issues, and present possible solutions as design guidelines that may mitigate them. In this context, we go deeper within a dynamic focus solution to reduce discomfort in immersive virtual environments, when using first-person navigation. This solution applies an heuristic model of visual attention that works in real time. This work also discusses a case study (as a first-person spatial shooter demo) that applies this solution and the proposed design guidelines.

14:40 Fun-Knee™: A Novel Smart Knee Sleeve for Total-Knee-Replacement Rehabilitation with Gamification

Yang Qiu, Kun Man Li, Eng Chuan Neoh, Huiguo Zhang, Xin Yue Khaw, Xiuyi Fan and Chunyan Miao

Abstract—Total Knee Replacement (TKR) is an increasingly common surgery worldwide. A significant contributor to TKR success is post-surgical rehabilitation. In this work, we present Fun-Knee™, a novel sensor-equipped knee support complemented by mobile device-supported games, specifically designed for "gamified" TKR rehabilitation. Two inclinometers are used to measure the knee angle, which is used as the main input to the developed game. Human-Centered Design theory is applied throughout the game design to ensure a customized, dynamic gaming experience to maximize the pain distraction effect and to increase the exercise compliance and improve the rehabilitation outcome. Preliminary survey results collected from practicing physiotherapists show promising outcomes of the developed prototype, in terms of hardware and software characteristics, usability, clinical utility and overall effectiveness.

15:00 Developing Virtual Patients with VR/AR for a Natural User Interface in Medical Teaching

Marjorie Zielke, Djakhangir Zakhidov, Gary Hardee, Leonard Evans, Sean Lenox, Nick Orr, Dylan Fino and Gautham Mathialagan

Abstract— Professionalism and communication skills are important aspects of medical training, and virtual patient applications can offer cost effective, easily accessible platforms for communication practice which complement flexible, student-driven medical school curriculum design. Further, numerous virtual and augmented reality platforms have been introduced recently. This paper explores potential advantages and disadvantages Virtual and Augmented Reality (VR/AR) technologies offer to the development of a virtual patient application specifically for communication practice– the Emotive Virtual Patients – with a natural user interface. VR/AR technologies may offer highly interactive, immersive virtual patient experiences that tie to our research goals, improve presence and create a more fertile environment to practice empathy, however they may also present platform-specific challenges. A potential virtual patient design framework is discussed, and the unique benefits and limitations of VR/AR devices are analyzed. We put our research in the context of other virtual patient research, and hypothesize what benefits in terms of presence and natural user interfaces VR/AR may provide.

15:20 The Possibilities of Embroidered Passive UHF RFID Textile Tags as Wearable Moisture Sensors

Dawood Shuaib, Sari Merilampi, Leena Ukkonen and Johanna Virkki

Abstract— Moisture measurements of the body can be used for healthcare purposes as well as for helping in exercising. In this paper, the suitability of passive UHF RFID technology for moisture sensing is investigated. The technology has a great potential in wearable, comfortable, and wireless moisture sensing systems, although it is not originally used for sensing purposes. In our study, the tag antenna outlines are embroidered on a fabric substrate, the tag ICs are attached by embroidery or with conductive glue, and the tag performance as a moisture sensor is evaluated by wireless measurements. All tags attained peak read ranges of about 7-8 meters, which is well enough for wireless moisture sensors. The effects of moisture on the tag

response were noticeable through a frequency range of 900-980 MHz and the tag performance was excellent also when wet. Thus, the achieved results indicate high potential of passive UHF RFID textile tags in moisture sensing and embroidery as a textile tag antenna and antenna-IC interconnection fabrication method.

15:40   Virtually Controlled Robotic Arm using Haptics

Kiran Kulkarni, Abhijit Murgod and Vasudev Parvati

Abstract—Haptics and robotics are widely growing technologies of 21 century. Robots of present days are being used in the fields which are secluded from the human society; they face major short comings because of their limited abilities to interact with humans, to fill this void the proposed system uses haptics technology which provides a tactile feedback to give the feel of touch, sense and force. The main objective of this project is to design and develop the robotic arm that is controlled by haptics glove for virtual environment capable of haptic interaction. Without risking human limbs. The proposed system has applications in many areas including robotic medical surgery, rehabilitation, and exploration of harmful or remote environments, enabling technologies, defense application and education.

16:00   More Attention, Less Deficit: Wearable EEG-Based Serious Game for Focus Improvement

Alaa Eddin Alchalabi, Amer Nour Eddin and Shervin Shirmohammadi

Abstract— Attention Deficit Hyperactivity Disorder (ADHD) and Attention Deficit Disorders (ADD) are two of the most spread mental disorders characterized by the lack of attention and focus. One way to measure focus is through Electroencephalogram (EEG) signals that can be read using the new wireless EEG reading devices often used by Brain-computer Interface (BCI) researchers. In parallel, serious games have been recently providing opportunities for the rehabilitation of various cognitive and emotional deficiencies. In this paper, we put the two things together, and we design a virtual reality serious game using a wireless wearable EEG device to improve the focusing ability of people with ADHD and ADD. Our preliminary experiments with healthy subjects show an average improvement of 10% in engagement and 8% in focus for people using our EEG-controlled game compared to using the same game but keyboard-controlled.

16:20   Detecting and Exploiting Periodicity in Activity Classification

Liana E. Taylor, Umran A. Abdulla, Michael G. Barlow and Ken Taylor

Abstract—The technology for activity classification presents new opportunities for control and monitoring of serious games players. Other than for step detection, human activity classification is normally undertaken by calculating features from a fixed interval length of sensor data and comparing them to values expected from a range of activities. It was observed that many human activities, especially vigorous activities, are cyclic. This paper tested the hypothesis that, if features are calculated over an integer number of cycles of a cyclic activity, more accurate activity classifications will be achieved. An algorithm was developed that determines whether an activity is cyclic and if so, identifies the cycles and calculates the feature set over an integer multiple of cycles. If the activity is determined to be noncyclic, the features are calculated over a fixed time window. The hypothesis that more accurate activity classifications will be

achieved was confirmed with a pairwise t-test at the 99% significance level. Knowledge that a cyclic activity is taking place is already informative and can enable generation of features from individual cycles. One of these, cycle length, was added to the feature set which improved recognition rates for activities where the cycle length varied greatly from other activities. For example, brushing teeth improved from 39% with a fixed window to 54% for an adaptive window and 74% for an adaptive window with cycle length. An overall improvement in activity classification success rate was found for this adaptive windowing method compared to a fixed window approach with overall success rates of 54% for a fixed window, 62% for an adaptive window and 64% for an adaptive window with the additional feature.

4 April

Session 5: Sensors and haptics for Games

8:00   Playing with and without Biofeedback

Mohammad Zafar, Beena Ahmed and Ricardo Gutierrez-Osuna

Abstract—Casual mobile games enhanced with biofeedback provide a more engaging alternative to traditional stress self-regulation therapies. Previous studies have shown to help players acquire breathing control skills that carry-over into a subsequent cognitively stressful task. We replicated these results with higher power (42 users), and with a more challenging game. We used a Pac-Man style game enhanced with Respiratory Biofeedback, Pac-Man Zen, to compare 1) breathing control during play, 2) the carry-over of said control into a subsequent stressful task and 3) cognitive improvement in a subsequent stressful task against a non-biofeedback version of the game. Results showed that onetime training with the biofeedback version of the game was not only more effective, but also led to improved performance in a later stressful task, both in terms of lowered breathing and improved test scores, compared to the non-biofeedback version. The result is important because it suggests that stimulating, casual biofeedback games can be effective at teaching breathing control, and thus arousal regulation, in a stressful setting.

8:20 **A Virtual Environment for Breast Exams Practice with Haptics and Gamification**

André Luiz Brazil, Aura Conci, Esteban Clua, Leonardo Kayat Bittencourt and Lúcia Blondet Baruque

Abstract - Breast cancer is the second most frequent cancer in the world, with 250 thousands of deaths each year. Early detection of tumors by breast exams and procedures can help to reduce these numbers. More medical practice is required. Professional training for medical procedures in real environments is costly and risky both for the student and the patient. A way to reduce costs and risks of training is by the use of a virtual simulator. An environment closer to the real world in medical simulations can provide a better quality experience of to the trainee. The use of haptic devices can emulate tactile sensations and feedback forces that correspond to body structures and density of tissues. The used device has six degrees of freedom (DOF): movement on three axes (x, y, and z), rotations, and horizontal and vertical inclinations. This work presents a virtual environment for breast exams practice and sentinel nodes detection procedures that employ the use of a haptic device and a gamified interface for feedbacks. The objective is to improve early breast cancer diagnosis chances. A model for tissue deformation calculations on tridimensional patient body mesh is proposed, to add visual realism to the interactions in the virtual environment. Needle depth and its tridimensional position data are updated at real-time on needle insertion. Tumor nodes size and position are dynamically generated upon each simulation, increasing training possibilities for the student. The gamification strategy improves the practice on environment, with elements to engage the player on activity. User progress is tracked by subdivision of breast exams and procedures into smaller challenges, for better performance evaluation on the virtual environment. A gamified interface, with player score and achievements mapping is included. These gamification features have not been employed on breast simulators from previously investigated works.

8:40 **Precision of Control as a Function of Control Scheme: Implications for Serious Exertion Games from a Flow Perspective**

Erandi Lakshika and Michael Barlow

Abstract—Exertion based games have shown significant potential to influence health and well-being positively. Natural locomotion systems have been developed towards this end, however designing appropriate control schemes for such systems are particularly challenging as performance degradation might occur in terms of response time, precision and dexterity in consequence. This could affect the player's sense of control and thereby the gameplay experience negatively. This paper primarily focuses upon - taking objective measures of the precision of control a player experiences as the interface for a game is changed as a consequence of incorporating an exertion based control scheme. Four standard tests used in the psychology literature have been employed to understand the performance differences in terms of detection and speed of response, combined with precise 'pixel accurate' motion and tracking of objects. Finally the implication of any potential degradation in control will also be discussed by framing the discussion within Csikszentmih´alyi's Flow model and a discussion of player skill/ability.

9:00   **Effects of Reactive and Strategic Game Mechanics in Motion-based Games**

Aseel Berglund, Erik Berglund, Fabio Siliberto and Erik Prytz

Abstract — Motion-based games offer positive effects on physical, social, and mental health for the players and have been common during the past decade, enabled by commercial motion tracking devices. However, little is known about the impact of game mechanics on the player experience, movement, and performance in motion-based games. In this paper we present results from a study with 35 participants comparing two different game mechanics, one reactive and one strategic, for a casual motion-based game. The assumption was that a more strategic mechanic would lead to less movement but more enjoyment. However, there was no significant difference in player experience, performance, or movement between the two game mechanics. In addition, a key aspect for the players' preferred game mechanics was the perceived amount of thinking the game mechanic required.

Poster Session

10:10   **Use of Assistive Technology to Accommodate Students with Writing Disabilities**

Onintra Poobrasert, Thaphat Mupattararot and Lattapol Sae-que

Abstract—At present, there are various kinds of assistive technology tools in the market to help students who struggle in writing. Hence, those tools are not suitable for students with learning disabilities in Thailand, we then need to design and develop our own assistive technology. Similar to other disabilities, students with learning disabilities will also need suitable assistive technology tools for them. However, for students with learning disabilities in writing, it is important to note that assistive technology cannot cure but will assist them in their writing. It does not replace good teaching, but it can be used in addition to well-designed instruction. It can help the students be more self-confident and work more independently. Therefore in this study we also review the work from previous researchers and conclude with the recommendation for the path to develop suitable assistive technology for students with writing disabilities.

Hemineglect assessment and rehabilitation using a robotic serious game

Vincenza Montedoro, Stephanie Dehem, Marie Alsamour, Thierry Lejeune, Daniel Galinski, Sophie Heins, Bruno Dehez, Gaetan Stoquart and Martin Edwards

Abstract— Hemineglect is a condition where brain-damaged patients are impaired at perceiving and responding to the contralesional part of objects (allocentric hemineglect) and/or the contralesional part of space (egocentric hemineglect). The condition can also be accompanied by motor impairments. Although treatments exist, none are completely effective. The pipeline objective of our research is to develop a serious game that evaluates and rehabilitates the different forms of hemineglect according to the patient's impairment severity. The first step towards this objective is the development and validation of a robotic assessment for egocentric hemineglect. We tested 12 stroke patients and 40 healthy control participants with the robotic hemineglect assessment. Patients were also assessed with two hemineglect standardized tests. Significant correlations between the robotic and standardized tests demonstrated a good validity for the assessment of egocentric hemineglect. Moreover, the robotic assessment showed a good sensitivity and specificity. Based on these results, we can identify the captures / components necessary for the serious game rehabilitation to adapt difficulty level in correspondence to the patient's egocentric hemineglect impairment. Future steps in development will focus on the validation of the allocentric and motor hemineglect assessment.

Protection of parathyroid glands in thyroid surgery and treatment of postoperative hypocalcemia

Xue-Hai Bian and Hui Sun

Abstract— Background: Hypoparathyroidism is one of the most frequent and serious complications of the thyroid surgery. Preservation of parathyroid glands (PGs) and treatment of postoperative hypocalcemia are key factors. The aim of this review is to evaluate the relevant literature and provide the clinician guidance for preservation of PGs and the formulation of individualized therapeutic strategies for patients with postoperative hypocalcemia. Methods: This was a review of preservation of PGs in thyroidectomy procedures and treatment strategies for postoperative hypocalcemia. Results: In-depth knowledge of the anatomy of PGs along with relations and an adequate preoperative assessment are the cornerstone for surgeons performing safe thyroid parathyroid surgeries. The "capsular dissection" of the thyroid lobe is the key technique to protect PGs and their supply blood vessels; the intraoperative parathyroid auto-transplantation if the occasion should arise is an effective method to prevent definitive hypoparathyroidism. The patients after thyroidectomy are given monitoring of the serum calcium and parathyroid hormone (PTH); the early combinational supplement treatment of calcium and calcitriol effectively prevent postoperative hypocalcemia. Conclusion: To master the anatomic regularity of PGs, intraoperative in-situ conservation and auto-transplantation of PGs, and postoperative individualized therapeutic strategies of hypoparathyroidism are effective methods to avoid hypocalcemia in thyroid surgery.

Assessment of upper limb motor impairments in children with cerebral palsy using a rehabilitation robot and serious game exercise

Stephanie Dehem, Vincenza Montedoro, Martin Gareth Edwards, Sophie Heins, Daniel Galinski, Bruno Dehez, Gaetan Stoquart, Isaline Brouwers and Thierry Lejeune

Abstract—Brain damaged patients require long and intensive rehabilitation. Recent advances in robotic devices and serious games provide two interesting innovations that together, intensify the therapy, and increase the patient motivation to engage in the therapy. In our project, we implemented a serious game on a rehabilitation robot in order to adapt the rehabilitation to the individual impairments of each patient. In the first phase of development, we assessed the patient impairments. Here, we report the validation and reproducibility of the robotic upper limb motor assessment. The protocol assessed four variables: passive range of motion, elbow flexor and extensor, isometric and isokinetic strength, and upper limb kinematics. The results showed that the protocol had good validity and reproducibility. In the second phase of development, the robotic motor assessment will be integrated to the serious game to provide a continuous measure of motor performance. This allow a continuous adaptation of the rehabilitation in function of each patient's impairments severity.

Serious Game on Recognizing Categories of Waste, to Support a Zero Waste Recycling Program

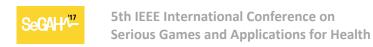Balu M Menon, Unnikrishnan R, Alexander Muir and Bhavani R Rao

Abstract—Picking up and sorting garbage is a tedious task, and the health effects of garbage on the streets of India is grave. Recycling trash into categories (e.g. hard plastic, soft plastic, organic, paper) requires training to do correctly at speed. Major national clean up campaigns as well as neighborhood level initiatives require trained trainees who can quickly place each piece into the appropriate place. For this reason, we investigated using a serious game to train people in how to recycle trash quickly. Serious games and virtual reality applications expand opportunities in the field of skill development and training, by creating an environment which can be frequently and safely accessed in which one can practice the skills in question. Also, low cost technology like Microsoft Kinect enables gesture recognition which in turn allows for more physical aspects of skills training like the means of embodied cognition Through this paper, we are presenting a prototype of the a serious game on how to sort depending on the various categories of waste, as well as the results of a nine person user study. We offer recommendations on how to create an effective serious game for training people to sort waste.

The Untapped Benefit of Doing Almost Nothing: Massively Scalable Learning via Games and Exploration

Dominicus Tornqvist, Lian Wen and Jennifer Tichon

Abstract— An application for which serious games are almost uniquely suited, and yet rarely mentioned, is Massively Scalable Learning (MSL): the design of an educational object that is effective at delivering its value in virtually any conditions, minimizing any dependencies or requirements such as external guidance. This allows it to be shared and spread, maximizing its reach to the human population. Games (particularly exploratory games) can be well suited to this educational goal. The reasons

for this are discussed in this paper, along with the advantages of designing inherently learnable systems, which domains of knowledge would benefit from MSL, and some of the design implications in making games for MSL.

D.R.E.A.M.S. (Digital Rehabilitation Environment-Altering Medical System)

Marko Suvajdzic, Azra Bihorac and Parisa Rashidi

Abstract— In project D.R.E.A.M.S., we propose to develop and assess the feasibility of a novel and intelligent delirium prevention system to address depression, pain, sleep, activity patterns and emotional states using the Emotiv Epoc+ | 14 Channel EEG", and HTC Vive VR set.

Playing against dengue Design and development of a serious game to help tackling dengue

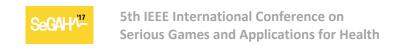Tiago Lima, Breno Barbosa, Carlos Niquini, Camila Araújo and Raquel Lana

Abstract—Dengue is a global public health challenge. The dengue virus is transmitted mainly by the Aedes aegypti mosquito, which is also a vector of other diseases such as zika, chikungunya and urban yellow fever. Its transmission dynamics is complex, involving several actors, factors and processes. Acting against vectors is still an important strategy, mainly due to limitations in efficacy and accessibility of vaccines. We believe that including and awareness of population is an important factor to address the problem. This project aims to design and develop a serious game to support actions and strategies based on prevention and epidemiological surveillance. In order to raise awareness about vector ecology and disease transmission dynamics, the game design presents information and seeks to encourage behavior changes in a playful environment. Moreover, gamification strategies are being used to stimulate concrete actions in real world. A mix of 2D-based game, augmented reality, virtual reality and the real world itself, will provide the proper environment to offer fun with the purpose of helping to deal with this complex problem. This paper presents the game design and current development stage. The artifacts are being developed in an iterative and incremental way, involving activities of conception, design, construction/prototyping and evaluation. Results include the game design, prototypes and the release of a demo version.

Memori: A Serious Game for Diagnosing and Treating Visual Sequential Memory Deficit

Ayşe Rumeysa Mohammed, Ammar Rashed and Shervin Shirmohammadi

Abstract—Visual Sequential Memory (VSM) allows a person to perform tasks such as remembering letters, numbers, objects or shapes in the correct order. Its deficit can lead to challenges in one's personal life, including dyslexia and dyscalculia. Detecting Visual Sequential Memory Deficit (VSMD) is essential for those who suffer from its related consequences. But current clinical methods don't have a high rate of diagnosis, and also for treatment are limited to the few hours the person spends in the clinic. In this paper, we propose an Origami based Serious Game, called Memori, for the diagnosis and treatment of children with VSMD. We illustrate the rationale behind using Origami, the design process of our game, and its implementation.

A Serious Game for Children with Speech Disorders and Hearing Problems

Nahid Nasiri, Shervin Shirmohammadi and Ammar Rashed

Abstract—Speech impediment affecting children with hearing difficulties and speech disorders requires speech therapy and much practice to overcome. To motivate the children to practice more, serious games can be used because children are more inclined to play games. In this paper, we have designed and implemented a serious game in which children can learn to speak specific words that they are expected to know before the age of 7. The game consists of an avatar controlled by the child through speech, with the objective of moving the avatar around the environment to earn coins. The avatar is controlled by voice commands such as Jump, Ahead, Back, Left, Right. Children will be guided by an arrow during the game instead of a getting help from a therapist or a teacher to guide the child to the next coin. This allows the child to practice longer hours, compared to clinical approaches under the supervision of a therapist, which are time-limited.

LA-VIE: A Serious Game for Cardio Pulmonary Resuscitation

Ajmal Rana Muhammad, Farooq Ahmad, Hamza Latif Muhammad and Junaid Alam

Abstract-Every year a number of people involved in a cardiac arrest (a condition in which the heart of a person stops working) die before the arrival of paramedics. Therefore, a timely cardiopulmonary resuscitation (CPR) is a necessary act to save somebody's life. Now a days gamming has become a common trend in both children and adults, so it should be used as a key to learning. In this paper, we discuss the use of a purposely made serious game to make a layman learn basics of CPR i.e. Chest Compressions and Mouth to Mouth Ventilation. In addition, the game also resembles the daily routine of a person and consists of a proper storyline to make it attractive to play. Evaluation results of LA-VIE game show that it's an effective tool to train general people about CPR.

MyEyes- Automatic Combination System of Clothing Parts to Blind People: First insights

Daniel Rocha, Vitor Carvalho, Eva Oliveira, Joaquim Gonçalves, Filipe Azevedo

Abstract— The technology world for visually impaired people has evolved over the past few years, making their day-to-day life more functional. However, there are still gaps such as in the area of aesthetics and visual image that need to be more explored. Thus, this article describes the first validation in the development of a Web platform in aid of the combination of clothing for blindness people. This project uses NFC (Near Field Communication) technology for the identification of the clothes. At the moment the clothes characteristics of the blind people are inserted manually but in the future one intends to use algorithms of automatic insertion, resorting to the image processing andmachine learning. The first perceptions about the project were promising.

Classification algorithms for body posture

Sílvia Silva, Sandro Queirós, António Moreira, Nuno Rodrigues, Fernando Veloso, Eva Oliveira and João L. Vilaça

Abstract— Bad posture while working or playing videogames can affect our life quality and impose negative economic consequences over time. There's raising concern in companies regarding worker's wellness, many adopting preventive measures. Specialized training in posture is important to prevent occupational activities risks and to foster health promotion. In this paper, we present a study of different classifiers to detect good and bad body postures in workplaces. A set classifiers, namely artificial neural networks, support vector machine, decision trees, discriminant analysis, logistic regression, treebagger and naïve Bayes, were tested in three-dimensional acquisitions of 100 people for automatic determination of the type of body posture. The best classifier was the treebagger with a rating of True Positive and True Negative of 93.3% and 96.2%, respectively.

Brain-Function Analysis of Changes in Female Hearing Induced by Childbearing

Hiroko Kotani, Misa Kato, Aki Nishiyama, Kasumi Kuramoto, Maka Matsuno and Hidenori Nakagawa

Abstract—We strongly suggest the idea that the simple card games "CogHealth" can be a powerful diagnostic tool adaptable for women with gestational dementia and/or postnatal depression. As a proof-of-concept of the suggestion, we examined the relationship between cognitive functions and prefrontal hemodynamics in a women's brain during a time of pregnancy and child raising.

Instrumented vest for postural reeducation

Pedro Carvalho, Sandro Queirós, António Moreira, José Henrique Brito, Fernando Veloso, Miguel Terroso, Nuno F. Rodrigues and João L. Vilaça

Abstract—According to the World Health Organization, 85% of the world population suffers from back pain, which accounts for over 50% of physical incapacity, permanent or temporary, among individuals in working age. In most situations, this is caused by an incorrect posture, which causes changes in the spine structure. This paper proposes an instrumented vest for postural reeducation to address this issue. The vest has a set of inertial measurement unit (IMU) sensors strategically placed to provide an accurate characterization of the spine profile. The sensor readings are classified by a central processing unit. In case of an incorrect posture, users are alerted by an audio signal and through vibration. The wearable system works in stand-alone mode, but can also communicate with external systems through an API. Two applications were developed to communicate with the device through this API, one intended to run on a desktop computer and the other one for Android devices. These applications monitor spine profiles in real time and notify the user of incorrect postures, among other functionalities. The device prototype and the applications have been tested by 10 individuals in two different settings, first without any kind of feedback and then with feedback enabled. The tests demonstrate the usability, accuracy and robustness of the system, proving its high level of reliability in classifying postures and effectiveness for postural reeducation. In the future, the system is expected to be used as a platform for a serious game, to promote posture reeducation in a real world scenario.

Serious games design considerations for people with Alzheimer's disease in developing nations

Sanda Samarasinghe, Hiran Weerasinghe, Yamaya Ekanayaka, Madawa Weerasooriya, Roshan Rajapakse and Diyunugal Wijesinghe

Abstract— There is a wide range of serious games all over the world which are used as a Cognitive Stimulation Therapy to treat Alzheimer's patients. But the utilization of these applications in the developing countries is very low due to low literacy in English and ICT. The aim of the study is to identify basic design considerations for making games more accessible, utilizable and stimulating for people with Alzheimer's disease who lack IT literacy skills as well as English knowledge. This research utilizes qualitative data in the research design which comprised of two stages: Scoping stage and Prototype development stage. Scoping stage consisted of an observation conducted with a sample of 6 patients with mild to moderate Alzheimer's disease giving a prevailing serious game to identify the issues in them. Participatory design was followed in the Prototype development stage, conducted with a sample of 12 patients with mild to moderate Alzheimer's disease which consisted of 2 observations: one during the developing stage and the other after the development. Through the study we have found some design considerations that can be used to overcome low utilization of serious games. Some of our findings were games are more accurate when developed based on MOCA test and relating on their day to day lives, simple and easy games with short duration, using real images in the games, bigger buttons with more space between them, instructions in their native language etc. The findings suggest that developing serious games following these design considerations would make these games more accessible, utilizable and stimulating for people with Alzheimer's disease who lack English knowledge and IT literacy skills, especially in Sri Lankan context.

Session 6: Education

10:50 Predicting Math Performance of Children With Special Needs Based on Serious game

Umi Laili Yuhana, Remy Geovany Mangowal, Siti Rochimah, Eko Mulyanto Yuniarno and Mauridhi Hery Purnomo

Abstract — Predicting and classifying student's performance using data mining techniques have been gaining an enormous amount of attention from researchers and practitioners. However, the use of games for the classification of student's ability level is still slightly. This study focuses on identification of important factors for determining student level performance on Math. The best classification algorithm is observed as part of intelligent game development research for assessment of children with special needs. The real dataset from randomly selected of elementary school is taken to construct a dataset. About 135 normal students and 25 children with special needs played the game and did a manual test. Our study shows that the age, gender, grade, and mark of each level became important factors in determining the level of math skill for the normal student. However age, gender, and grade don't have a correlation with math level of children with special needs. Six classification methods, Naive Bayes, Multilayer Perceptron (MLP), SMO, Decision Table, JRip, and J48, were performed to predict math

skill performance level of normal students and children with special needs. JRip with 10 fold cross validation gives the highest percentage of accuracy of 64.12.

11:10 MathBharata: A Serious Game for Motivating Difabled Students to Study Mathematics

Remy Giovanny Mangowal, Umi Laili Yuhana, Eko M. Yuniarno and Mauridhi Hery Purnomo

Abstract—Game addiction is a serious issue. A lot of children play games too much that it hinders their academic prowess. This further makes hard subjects like mathematics to be more difficult for the student. This paper proposes a method to motivate students to study mathematics using a serious game to utilize that gaming addiction to help students instead. Serious game is a game which conveys serious content. MathBharata is a serious quiz game where players can try to answer multiple choice questions with incrementing difficulty. It uses various aspects to entice students to learn mathematics. MathBharata was tested on 85 students of both regular and disabled school. Every student who tested the MathBharata game, including both disabled students and regular students, responded that playing the game boosted their motivation to study more to beat the game, with 29.4% of students responding with "Strongly Agree" and 70.6% students responding with "Agree".

11:30 Towards the development of a serious game that targets psychological stressors of the workplace

Houssemedine Yahyaoui and Bob-Antoine Jerry Menelas

Abstract—In addition to managerial parameters, various factors, which are related to the evolution of modern societies, generate many changes in the world of work. Although they represent great opportunities in themselves, when mishandled, these changes may represent significant stressors in the workplace. As a result, a large proportion of workers in industrialized countries have to cope with psychological distress episodes. Considering that some observations suggest that the first step in targeting stress should be in identifying the stressors that negatively affect the person. Moreover, since serious games have been proved effective for the transfer of knowledge, our work aims at designing a serious game that may help people at identifying stressors of the workplace. As a first step, we report the main elements required for such a game. For this, we use two frameworks that allow us to target the two main aspects of this serious game. This systematic approach offers two main advantages. First, it insures that the designed software solution has the principal elements of a game. Secondly, it supports the implementation of the pedagogical objectives throughout the game mechanics.

11:50 **Developing Serious Games to Promote Cognitive Abilities for the Elderly**

Hongmei Chi, Edward Agama and Zornitza Genova Prodanoff

Abstract—This paper presents the design of a computerized serious game suite called the "Smart Thinker", which is used to enhance core cognitive skills. The focus is specifically on memory and attention skills. Smart Thinker empowers older adults to exercise their brains and achieve their maximum cognitive performance. To achieve this objective, a thorough study was completed on 59 older adults who were randomly separated as participants of a controlled group or an intervention group. The 20 participants within the controlled group did not play Smart Thinker and were not surveyed. The Mini Mental State Examination (MMSE) was administered to both groups at the beginning and ending of the six week period. The measuring tool was administered under the guidance of licensed clinical social workers of the Alzheimer's Project and was used to determine whether Smart Thinker had an effect on the participants' cognitive functioning. This game research revealed a significant improvement in the cognitive skills of the intervention group who used Smart Thinker Game compared to the controlled group who did not play Smart Thinker.

12:10 **The Cognitive Mobile Games for Older Adults - A Chinese User Experience Study**

Sari Merilampi, Antti Koivisto, Andrew Sirkka, Xu Xiao, Yan Min, Lin Ye, Xiao Chujun, Jiani Chen, Pasi Raumonen and Johanna Virkki

Abstract— Cognitive self-rehabilitation lacks updated means and tools. This paper provides a synopsis of novel cognitive recreation game tools, an analysis of their user feedback, as well as potential new ideas for game developers. The purpose of this study was to evaluate the attitudes and user experiences of Chinese elderly people on mobile memory rehabilitation games originally developed in Finland, Europe. Mobile games that require cognitive skills were tested with a test group in a Chinese elderly care home. User feedback was collected by interviews and observations in the game event. The most noteworthy finding was the positive user experience both of the elderly and the nursing staff and the experience of the games being cognitively stimulating. Games also seemed to provide potential for self rehabilitation and to support social interaction. Also some special characteristics related to the Chinese culture were found in the game trial, although the experiences were surprisingly similar compared to original Finnish trials despite the cultural differences of Finland and China. The results are an encouragement for conducting further testing (on a larger test group, over a longer time) and continuing with the game development for cognitively impaired older adults. These results also encourage further development and testing of welfare technology applications in different cultural environments.

**12:30 Universal Tools for Measuring Games and Learning:
Dynamic Causal Nets**

Dominicus Tornqvist, Lian Wen and Jennifer Tichon

Abstract— How can one measure the learning outcome of playing a serious game? We need an objective measure of the learning contents included in a game. The research is diverse, utilizing vastly different games to teach various different kinds of knowledge and skills. This makes it difficult to compare and generalize studies, lacking any established formal tool of analysis. This problem requires the design of an abstract and objective measurement of the quantity of learning material independent of the learning domain. Based on cognitive research on causal Bayes nets (CBNs), this paper proposes using dynamic causal nets (DCNs) to model an abstract knowledge base, which could be mapped to many different domains of learning. We also apply Kolmogorov Complexity (KC) as an approach to measure the content of the abstract knowledge base. This work will establish a theoretical foundation for future research of serious games.