

Training Powered Wheelchair Manoeuvres in Virtual Reality

THOMAS W DAY, CHRISTOPHER J HEADLEAND, PANAGIOTIS D RITSOS, SERBAN R POP, NIGEL W JOHN

UNIVERSITY OF CHESTER, BANGOR UNIVERSITY



Motivation

2016 has seen the release of multiple cost effective Head Mounted Displays

- Oculus Rift, HTC Vive, Gear VR

Possible medical applications that can benefit from a HMD?

- Full immersion
- Head tracking so you can look around the virtual environment
- Interaction with joystick or other intuitive peripheral
 - E.g. Leap Motion for hand tracking

One possibility is training powered wheelchair manoeuvres in a safe environment



Wheelchair-Rift Hardware

Oculus Rift DK2

Microsoft Xbox One Controller for a convenient joystick

- A joystick adapter has been 3D printed to resemble the joystick on an actual powered wheelchair

Standard “Gaming” Desktop PC or Laptop



Wheelchair-Rift Software

Unity 3D

- Cross platform games engine with advanced physics and rendering
- Offers built-in VR support for most head mounted display
 - E.g. Oculus Rift, HTC Vive
 - Plugins Available for different input devices.



Wheelchair Physics

Real Wheelchairs

- Two wheel drive, free motion of front pivoting front caster wheels
- Direction changes are made by variable speeds on each individual powered wheel

Hand-operated joysticks with proportional control are now the *de facto* interface for most wheelchair users

Virtual Wheelchair

- Two models were developed for the purposes of this simulator
 - A physics based model
 - A non-physics based model
- The latter was chosen because of its adaptability to different chair specifications
- The virtual wheelchair was limited to a max speed of 5 mph, as per the regulations on indoor powered wheelchair usage.



Training Environment

Any desired training environment can be modelled

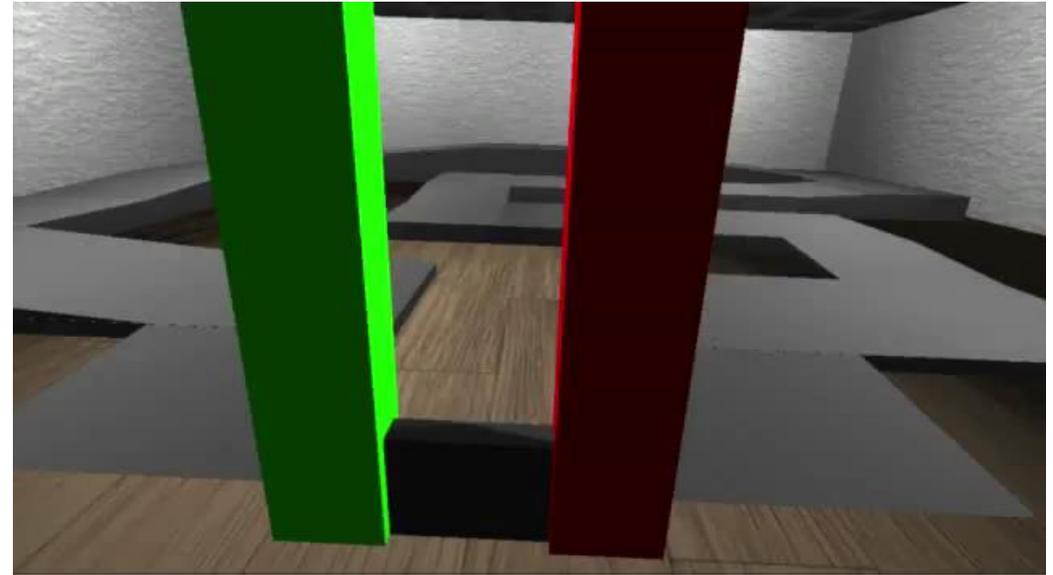
For our prototype, we designed a virtual building with a different challenge on each level:

- Collecting objects by driving up to them
- Avoiding static and moving obstacles
- A maze of doorways

Metrics such as time taken and obstacles hit can be recorded by the software



Simulator in Use



Does it work?

No standard method of training or assessment.

- Four different PMG Centres were visited
- All used different methods of training and assessment

Some examples of good practice identified

Our first validation study using able bodied participants was recently completed...



Validation Study

A validation study was carried out using 33 able bodied participants

- Age range 20-55, Male and Female

All participants navigated an obstacle course in a real chair to establish their driving competence at the beginning of the study.

- A Spectra XTR2 powered wheelchair was loaned to us by Invacare.

The participants were then randomly divided into three groups of eleven:

- **Desktop** - trained with the simulator using a standard desktop monitor
- **VR** - trained with the simulator using an Virtual Reality Head Mounted Display
- **Control Group** - no training given, they just read a guide to using an electric wheelchair safely

All participants repeated the obstacle course after the training period



Validation Study – Reaction Times

Reaction times were accessed for each participant using a mobile reaction time app.

Each participant did the reaction test 3 times and the average reaction time was calculated.

All reaction times were within an acceptable range and no-one was excluded from the study.

Response Test
0.42
0.32
0.49
0.56
0.32
0.32
0.32
0.34
0.29
0.32
0.26
0.55
0.34
0.42



Validation Study – Obstacle Course

The obstacle course for the Spectra consisted of 4 sections

- Doorway
- Arches
- Slalom
- Reverse Parking

The time taken to traverse each section, together with the number of cones hit was recorded.

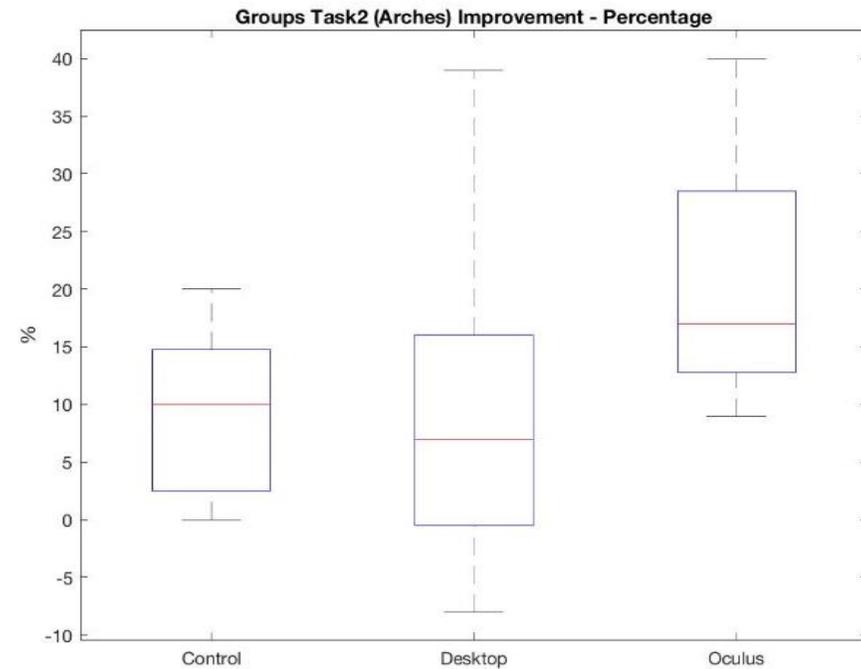
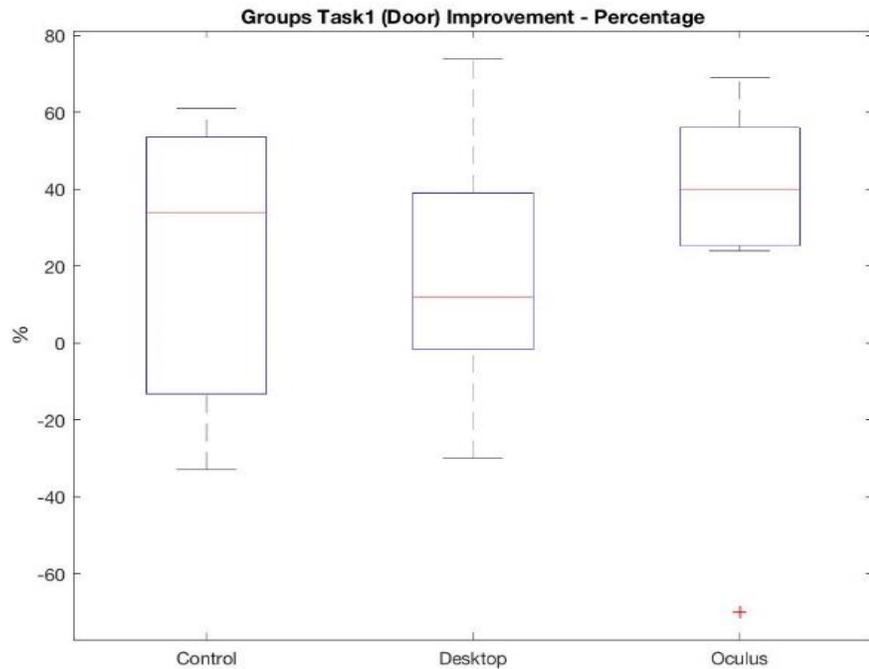


Slalom and Reverse Parking Tasks

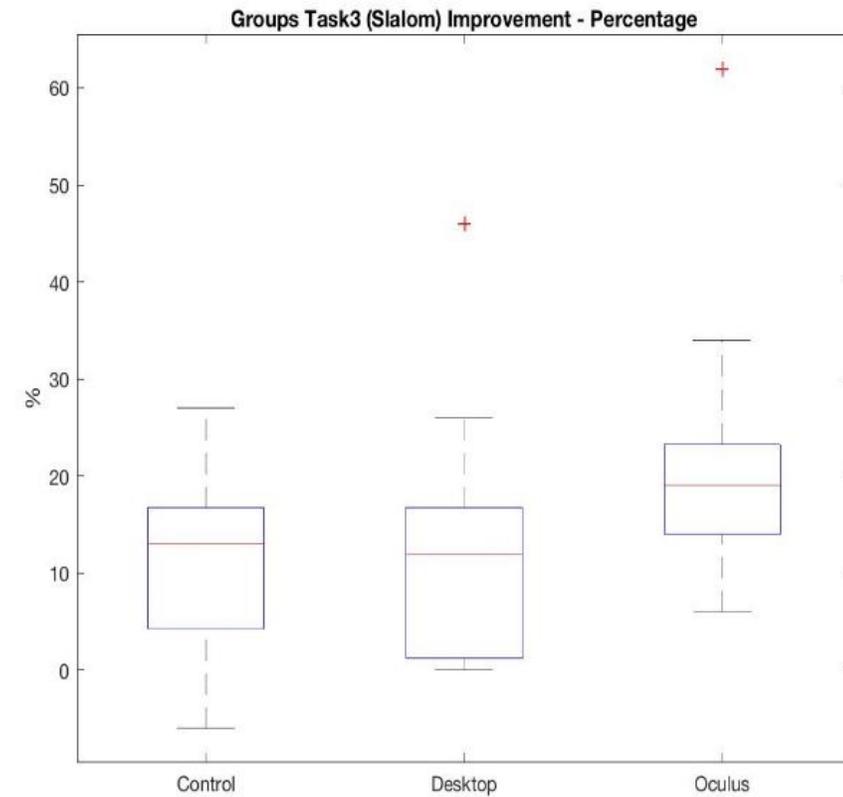
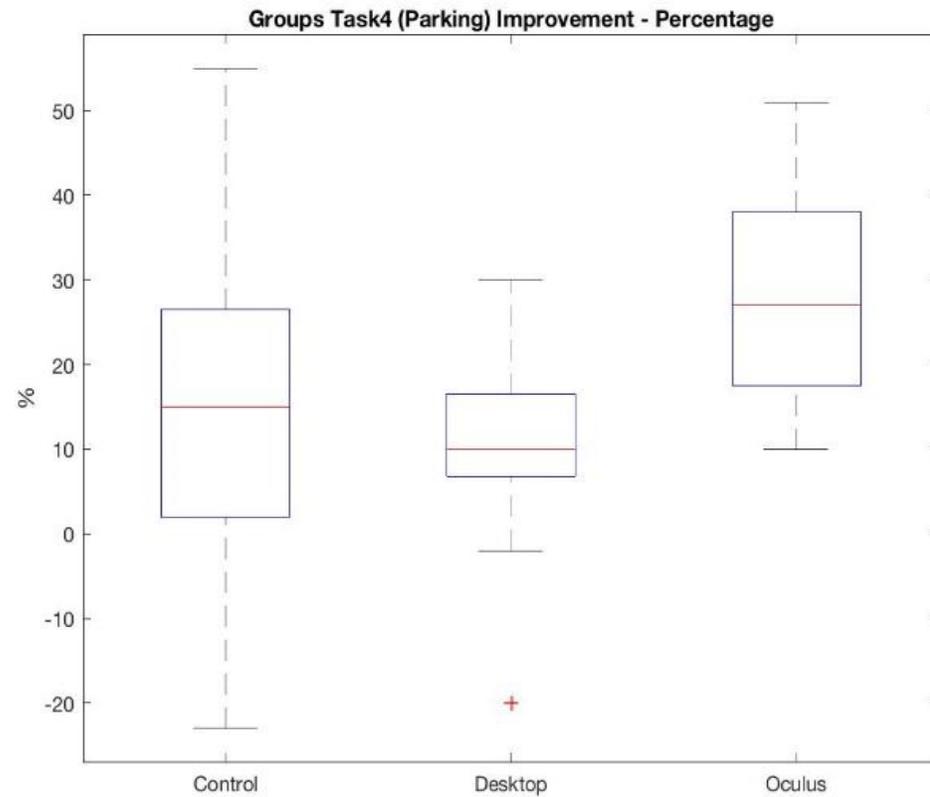


Validation Study - Results

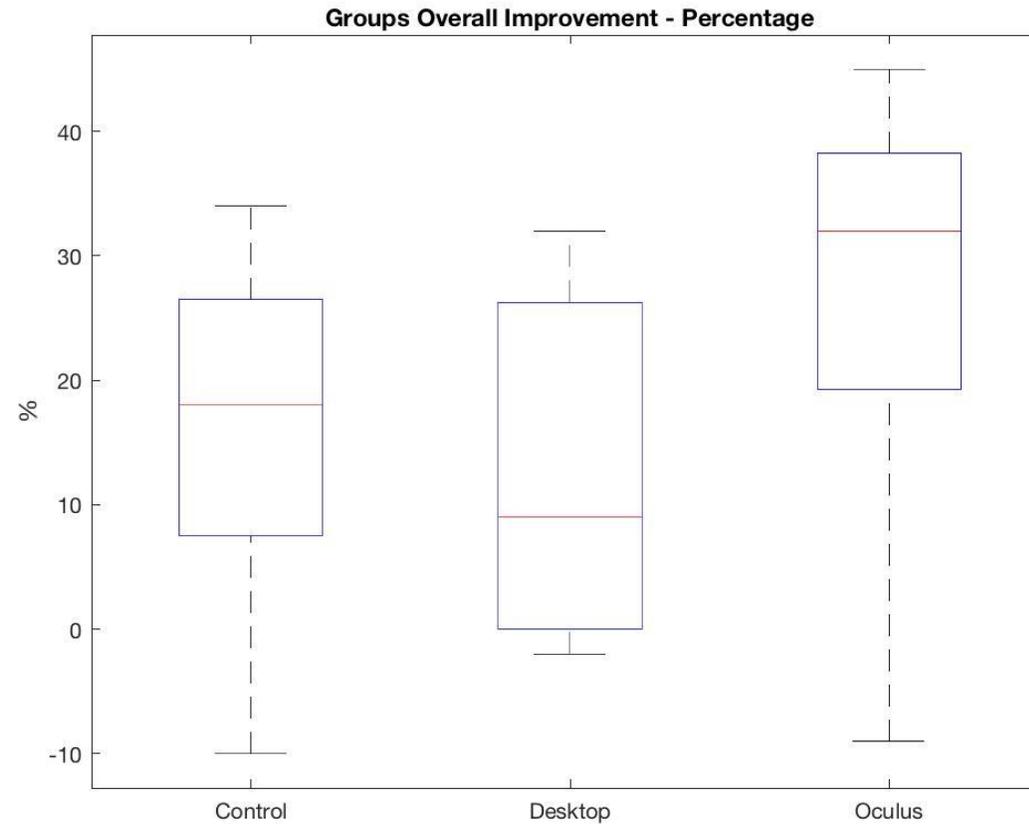
Results from the validation showed greater improvement (i.e. less time taken to successfully navigate the obstacle course) for those who used the oculus.



Validation Study - Results



Overall Improvement per Group



Cyber-sickness

The feeling of motion sickness when in virtual reality using a head mounted display.

Each participant in the VR group filled out a SSQ (Simulator Sickness Questionnaire) before and after training

Most of the participants did feel some effects of cyber-sickness.

Caused by a neuro conflict, for example, seeing motion but not feeling it.



Validation Study - Feedback

DESKTOP

Training without worry of hitting real object

Simulator felt like a computer game

Unable to look around

Lack of depth or perspective

VIRTUAL REALITY

Realistic Feeling / Control

Sense of spatial awareness

Nausea / Cyber-sickness after period of use



Future Work

Improved hardware

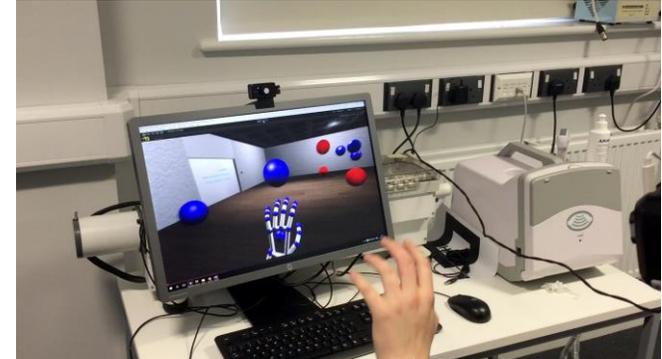
- New Oculus Rift, Wheelchair Joystick
- Haptic Feedback
- Hand Tracking

Augmented Reality Training

- Use a real powered wheelchair but with virtual objects to manoeuvre around
- Possible use of the HTC Vive or Microsoft HoloLens

Planning to apply for EU funding

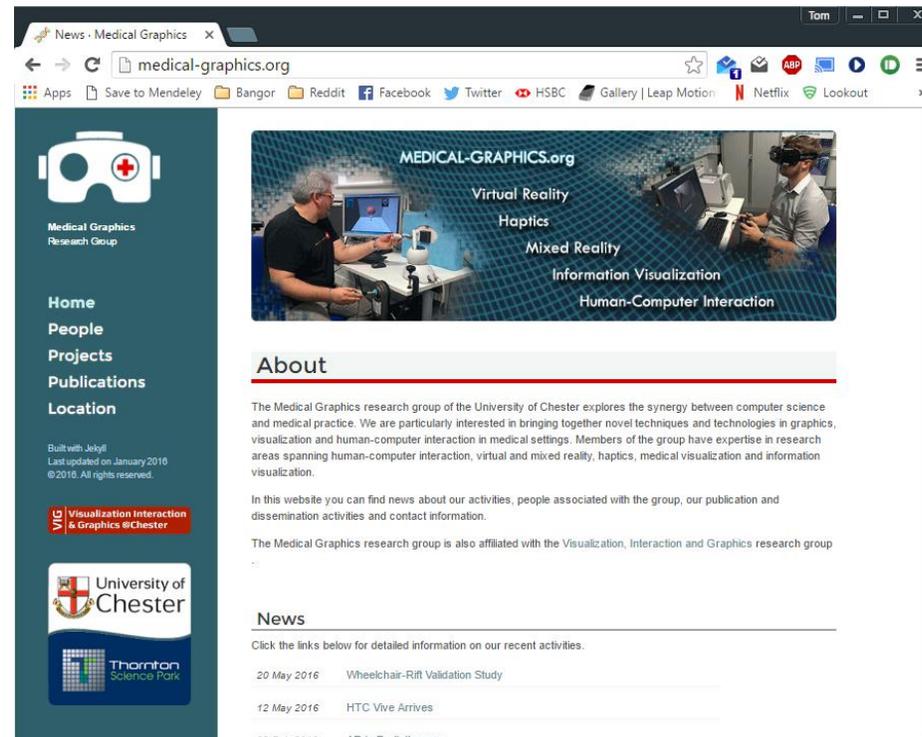
- Let me know if you are interested in partnering with us



Questions

Visit our web site for more information on this and other medical simulations projects

- <http://medical-graphics.org>



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Invacare Ltd

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