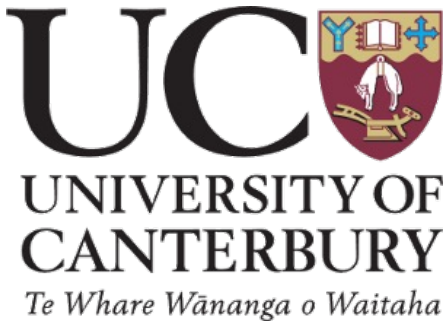


HIT Lab NZ:
Putting People before Technology

Rob Lindeman
Professor/Director
Human Interface Technology Lab
University of Canterbury
gogo@hitlabnz.org

Human Interface Technology Lab NZ

- At University of Canterbury
  - Christchurch, NZ
  - Faculty of Engineering
- Founded in 2002
  - VR/AR Pioneers Tom Furness & Mark Billinghurst
- Largest interaction lab in NZ
  - 50-66 Researchers at any given time
- Multidisciplinary
- Research and Teaching
  - Masters & PhD Programmes

HIT Lab NZ Staff

Prof Rob Lindeman

A/Prof Heide Lukosch

Prof Stephan Lukosch

Dr Susanne Schmidt

Dr Donald Degraen

Chris Buyarski
Centre Manager

Ryan McKee
Game Dev/IT

Shun Fukuden
Artist/Designer

Karen Anderson
Admin

HIT Lab NZ Philosophy

- We Put People Before Technology
  - *Hangarau Tangata, Tangata Hangarau*
- Start with the ***person***...
- ...look at the ***tasks*** they are trying to perform...
- ...look at the ***environment*** they are in...
- ...apply appropriate ***technologies*** to support them in their work, learning, etc.

Master of Human Interface Technology (MHIT)

- Multidisciplinary, HIT focused research, 12-months
- Students learn
  - Key HIT design principles
  - To build and evaluate interface hardware and software
  - Research and development skills
- Engagement with industry through dynamic projects and scholarships
- Preparation for job market or further research (PhD)
- Currently: 15 MHIT students

Doctorate of Human Interface Technology (PhD HIT)

- Multidisciplinary, HIT focused research
- ~3 years of independent research
- Many topics around HIT, VR/AR, games
- Rolling admissions (can start any time)
- Currently: 19 PhD students

HIT Lab NZ Research Themes

- Virtual Reality (VR)
- Augmented Reality (AR)
- Applied Immersive Gaming (AIG)
- Artificial Intelligence (AI)
- Haptics & Fabrication

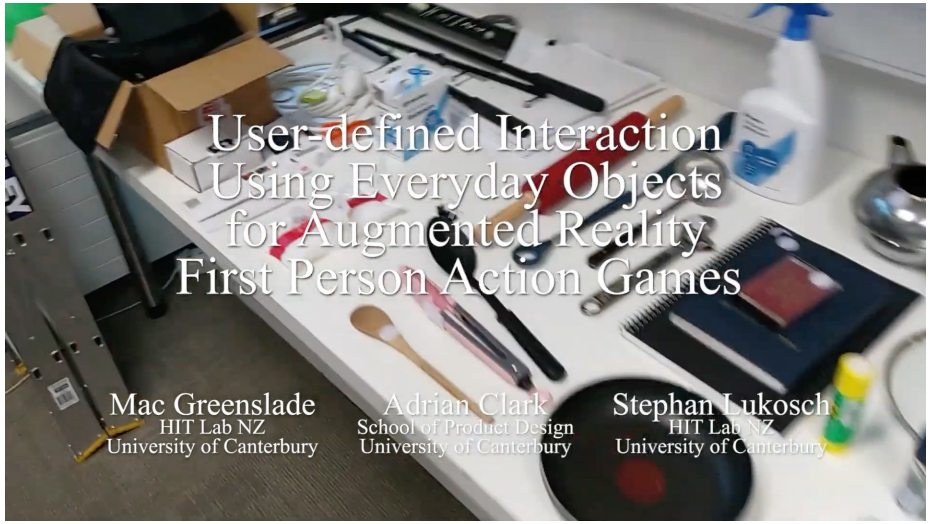
Virtual Reality (VR)

- Replace the real world with the virtual world
- Sample uses:
  - Training: Cheaper, less hazardous, more frequent
  - Education: Explore knowledge in engaging ways
  - Behaviour change: See things from a different POV
- Problems: Expressiveness, fatigue, cybersickness

(SnowSportsNZ: Start-gate desensitisation)

Augmented Reality (AR)

- Mix virtual content with the real world
- Sample uses:
  - Terrestrial data overlays: e.g., digging in safe areas
  - Wearable info display: e.g., tour guides
  - Remote collaboration: Expert/novice interaction
  - Leisure: Games & super-human sports
- Technically hard to match real & virtual content



(Mac Greenslade & Stephan Lukosch)

Applied Immersive Gaming (AIG)

- Using games for non-entertainment applications
- Improve realism of experience over desktops
  - Training/education: Increase time on task/effectiveness
- Difficulty: Transfer of skills from VR to real-world performance
- Difficulty: Games must be both ***fun*** and ***effective***
- We use a co-design approach

Recent Developments:

Applied Immersive Gaming Initiative (AIGI)

- Five year, NZ$7.7m matching grant
  - NZ$3.2m from NZ Tertiary Education Commission
  - NZ$4.5m from University of Canterbury
- Bring non-NZ-based entrepreneurial academics to NZ
- Focused around AIGI

Recent Developments: Digital Screen Campus (DSC)

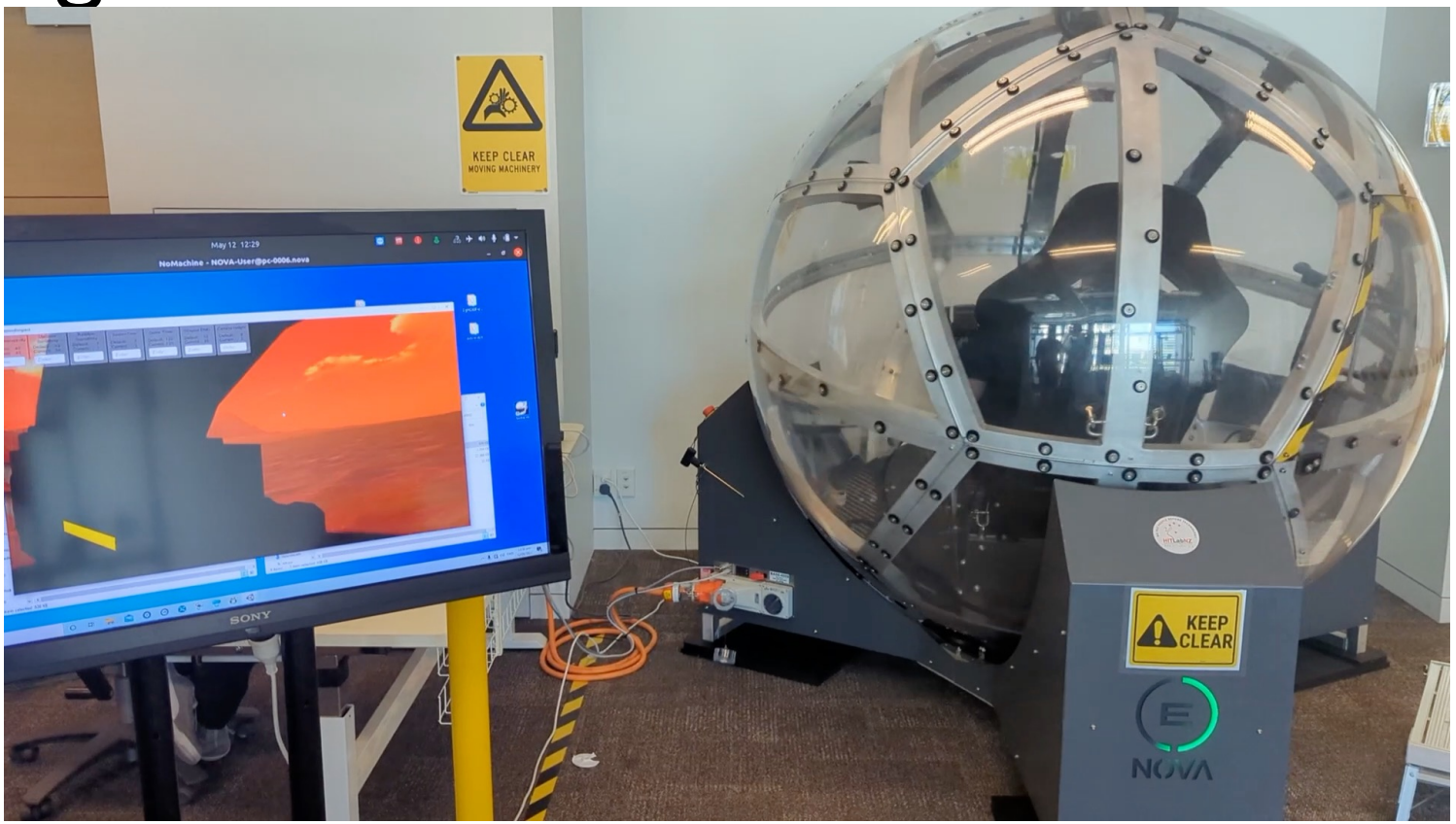
- NZ$130m investment from University of Canterbury
- Convergence of film, games, immersive technologies
- Facilities (e.g., Virtual production sets, audio mixing, editing)
- Existing physical infrastructure
- Educational Programmes
  - First students arrived Feb. 2023
- Workforce development
- Commercial incubation

Photo: John Kirk-Anderson/Stuff

HIT Lab NZ Facilities (cont.)

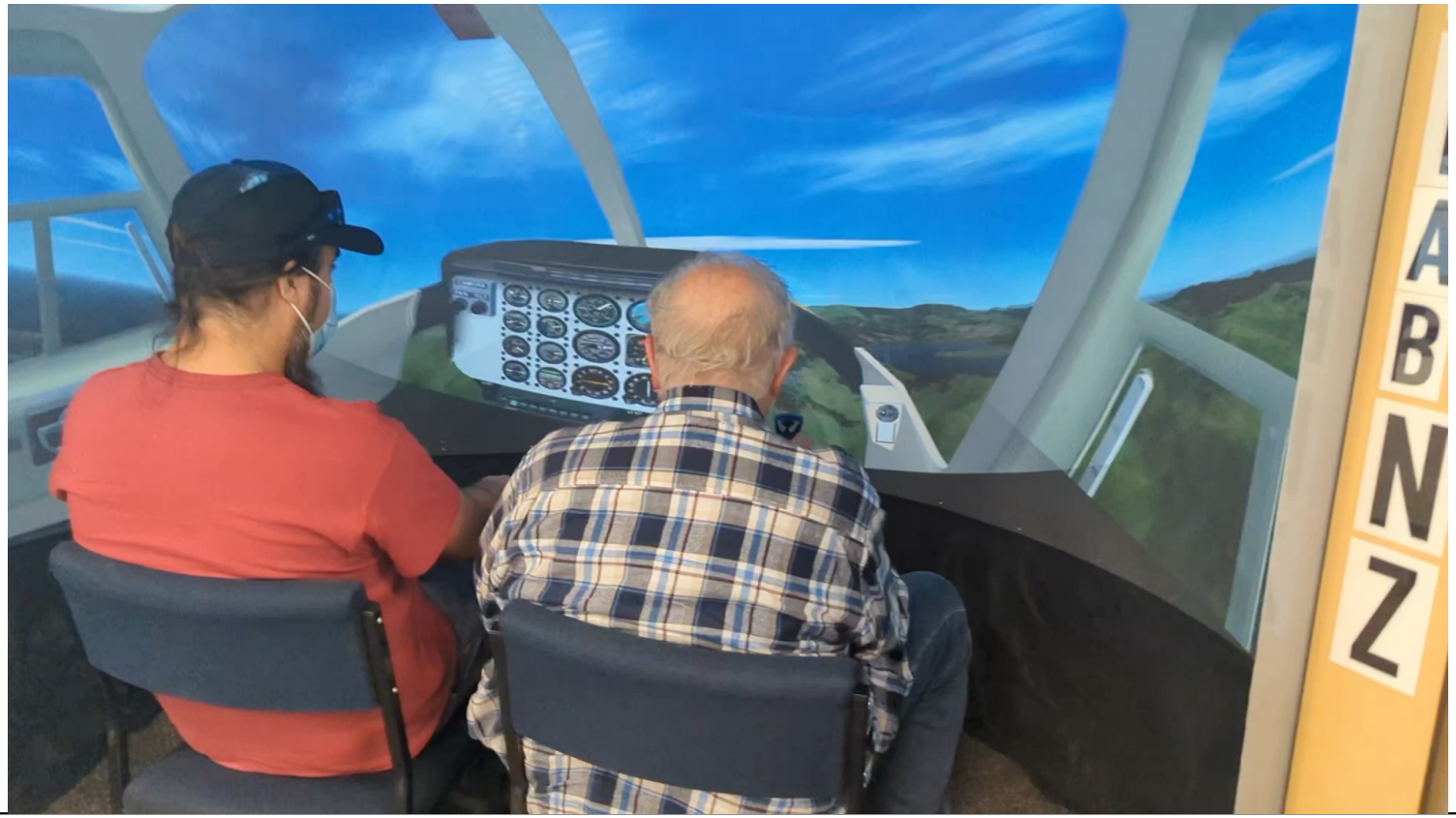
- 50+ VR/AR headsets
- Multi-sensory custom VR pods
- 360-degree motion platform
- 270-degree cylindrical display
- In-house fab lab
- Virtuix Omni
- Full-body motion capture studio
- Lots more!

Eight360 Nova Ball:
360-degree Motion Platform



TactaCage:
Multi-sensory Surround System

SimPit:
270-degree Projection VR System



Recent HIT Lab NZ Work

- VR imagery training for Snow Sports NZ
- VR Baby Training Tool for caregiver training
- Effective locomotion in VR
- Applied Immersive Games for students with ADHD/ASD
- Multi-sensory VR for improving experiential realism
- VR fire service training, decision making under stress
- Intimate VR (e.g., doctor/patient, prisoner/lawyer)
- Teacher training for disruptive student behaviour

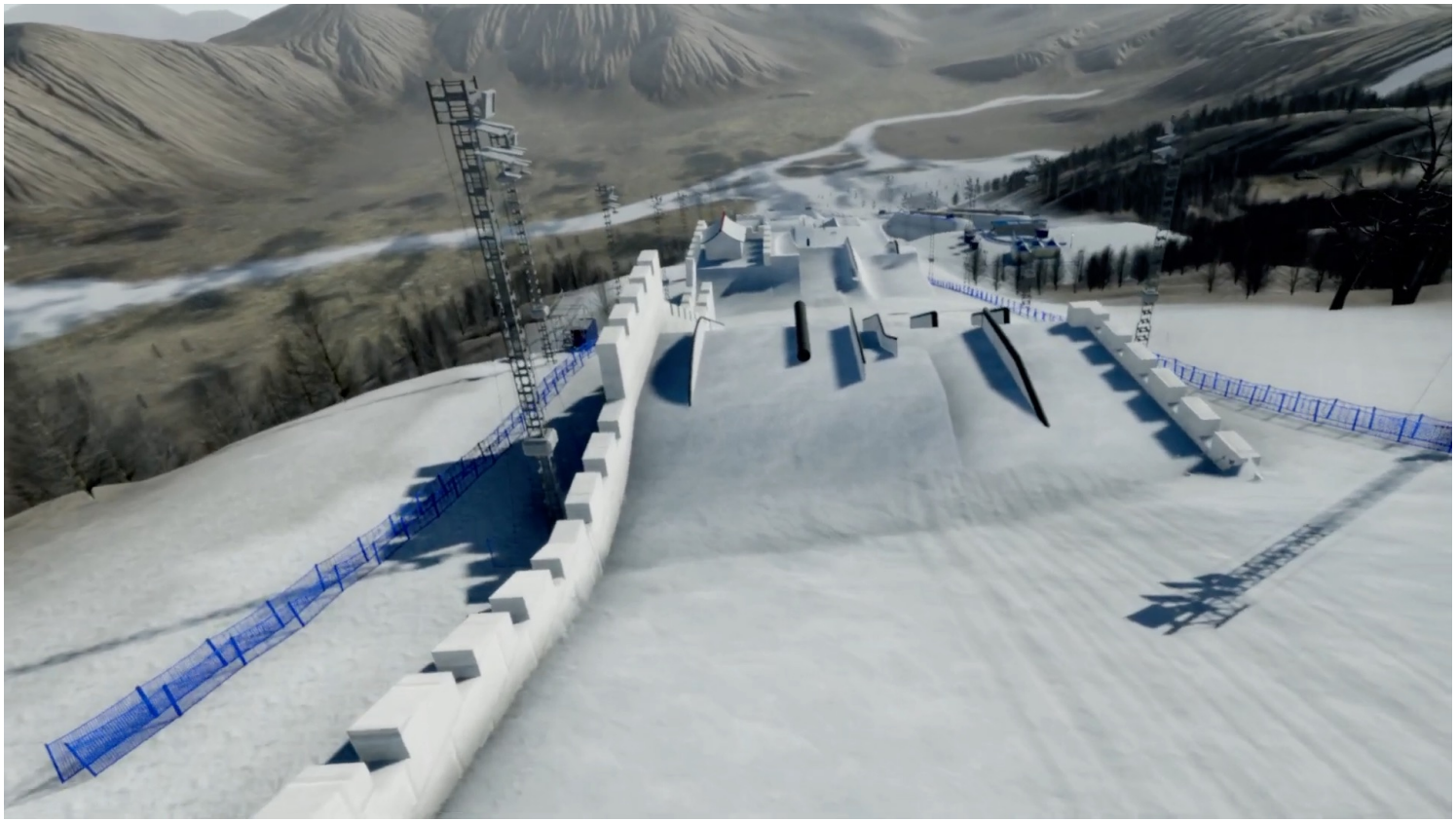
Recent HIT Lab NZ Work (cont.)

- Preparedness training for volcano hazards
- Lighting pre-visualisation for built environments
- Improved UX for immersed users in office spaces
- Highly expressive avatars without mocap suits
- Improved text entry for VR and AR
- Effective Virtual Labs, field trips and art studios
- Super-human sports using AR/VR
- Effective use of 360-video with “Swivel-chair VR”

Co-design of Start-gate Simulator for Elite Athletes

- Case-study research with a small number of people
- Use qualitative data, pictures, stories
- Useful for exploration of technology

Course Familiarisation for Slope Style Athletes



Zoi Sadowski-Synnott (stuff.co.nz)

“VR Baby” Simulator for Caregiver Training

Masters Project: Broomstick Sim

VR Headsets (1995-2005)

VictorMaxx CyberMaxx
Rel: **1994**
Res: 263x225/eye
FOV: 56(H)x42(V)
Tracking: Orientation
Weight: 390g
Price: NZ$1,150
(US$1200 in 2018$)
Controllers: None

Virtual IO i-glasses
Rel: **1995**
Res: 640x480/eye
FOV: 30(H)x25(V)
Tracking: Orientation
Weight: ~220g
Price: NZ$1,315
Controllers: None

Forte VFX-1
Rel: **1995**
Res: 263x230/eye
FOV: 36(H)x26(V)
Tracking: Orientation
Weight: ?? g
Price: NZ$1,150
Controllers: None

Sony Glasstron
Rel: **1998**
Res: 832x624/eye
FOV: 30(H)x22.5(V)
Tracking: None
Weight: ~120g
Price: NZ$4,500
(US$4200 in 2018$)
Controllers: None

eMagin z800
Rel: **2005**
Res: 800x600/eye
FOV: 32(H)x24(V)
Tracking: Orientation
Weight: ~220g
Price: NZ$1,500
Controllers: None

VR Headsets (2015-2019)

Razer OSVR
Rel: **2015**
Res: 960x1080/eye
FOV: 90(H)x90(V)
Tracking: 6-DOF
Weight: ?? g
Price: NZ$500
Controllers: None

Oculus Rift
Rel: **Mar 2016**
Res: 1080x1200/eye
FOV: 110
Tracking: 6-DOF
Weight: 470g
Price: NZ$1,000
Controllers: Extra

HTC Vive (pro)
Rel: **Apr 2016**
(Apr 2018)
Res: 1080x1200/eye
(1440x1600/eye)
FOV: 110
Tracking: 6-DOF
Weight: 555g
Price: NZ$1,315
Controllers: 2x6-DOF

Sony PSVR
Rel: **Oct 2016**
Res: 960x1080/eye
FOV: ~100
Tracking: 6-DOF
Weight: 610 grams
Price: NZ$660
Controllers: Extra

Oculus Rift S
Rel: **May 2019**
Res: 1280x1440/eye
FOV: 115
Tracking: Inside-out
6-DOF
Weight: 500g
Price: NZ$500
Controllers: 2x6-DOF

Valve Index
Rel: **Jun 2019**
Res: 1440x1600/eye
FOV: ~125
Tracking: 6-DOF
Weight: 809g
Price: NZ$1,650
Controllers: Extra

VR Headsets (2020-)

Varjo VR-3/XR-3
Rel: **Dec 2020**
Res: Focus: 1920x1920/eye
Periphery: 2880x2720/eye
FOV: 115
Hand Tracking: Ultraleap Gemini
Weight: 944g/980g
Price: NZ$6.6k/$11.7k+$1.5k/yr
Controllers: Optional from Vive
XR-3 adds:

- Depth Tracking: LiDAR+RGB
- Eye Tracking
- Video pass-through: 2x12MP

Meta Quest Pro
Rel: **Oct 2022**
Res: 1800x1920/eye
FOV: 106x96 (HxV)
Pass-through: 2x9PPD
Face+Eye+Hand Tracking
Weight: 722g
Price: NZ$1,650
Controllers: 6-DOF

Meta Quest 3
Rel: **Oct 2023**
Res: 2064x2208/eye
FOV: 110x96 (HxV)
Pass-through: 2x18PPD
Tracking: Inside-out
Hand tracking
Weight: 515g
Price: NZ$928 (128GB)
Controllers: 2x6-DOF

Apple Vision Pro
Rel: **Feb 2024**
Res: 3660x3200/eye
FOV: ~100
Pass-through/Tracking:
12 cameras+LiDAR
Hand+Eye tracking
Weight: ~625g+Battery
Price: US$3,499 (256GB)
Controllers: None

Mobile-phone Based VR

Google Cardboard
Rel: **2014**
Res: phone
FOV: ~90deg
Tracking: phone
Price: NZ$30
Controller: Phone

Google Daydream
(Gen 2.)
Rel: **Nov. 2016**
(Oct 2017)
Res: phone
FOV: ~100deg
Tracking: phone
Price: NZ$150
Controller: Phone

Samsung Gear VR
(Gen 2, Gen3)
Rel: **Nov. 2015**
(…2017)
Res: phone
FOV: ~101deg
Tracking: phone
Price: NZ$200
Controller: 3-DOF

Standalone VR

Lenovo Mirage
Rel: **2018**
Res: 2560x1440
FOV: ~110deg
Tracking: 3-DOF
Weight: 645g
Price: NZ$575
Controller: 3-DOF

Oculus Go
Rel: **May 2018**
Res: 2560x1440
Tracking: 3-DOF
Weight: 467g
Price: US$200
Controller: 3-DOF

Meta/Oculus Quest (2)
Rel: **May 2019 (Oct 2020)**
Res: 1600x1440/eye
(1832x1920/eye)
FOV: 110
Tracking: Inside-out
6-DOF
Weight: 555 (503g)
Price: NZ$700 (NZ$500)
Controllers: 2x6-DOF

Pico neo 2
Rel: **May 2020**
Res: 1920x2160/eye
FOV: 101
Tracking: Inside-out
6-DOF
Weight: 690g
Price: US$700
Controllers: 2x6-DOF

Microsoft's Mixed Reality Platform

- Produced by HP, Acer, Dell, Lenovo, Samsung, Asus…

Idea is to provide a more affordable and more compatible solution

- Resolution: 1440x1440 (1600) per eye
- FoV: 95(up to 110) degrees
- Tracking: 6DoF ("inside out")
- Weight: 400g (up to 800g)
- Price: NZ$500 – NZ$800

www.wikipedia.org/wiki/Comparison_of_virtual_reality_headsets

So Why Has VR Not Taken Off?

- Lack of killer app?
  - Entertainment games
  - Training/simulation
  - Education
  - Immersive analytics
- Cost?
  - Pretty affordable
- Content creation?
  - Tools: Same as games/film
  - Skills: Same as games/film
- Content portals?
  - Steam VR
  - Meta Store
  - Apple Store
- Public awerness
  - COVID
  - Pokémon Go
- Discomfort
  - This is my current focus!

My Current Research Focus: "Comfortable VR"

- Support people to use VR for long durations and/or on a regular basis
  - Allow people to ***meet comfortably***
  - Allow workers to ***get real work done*** (e.g., surgeons, therapy sessions)
  - Allow gamers to ***play for long periods***
- Interaction
  - ***Support expressive, efficient, low-fatigue user interaction***
  - ***Reduce encumbrances*** (stuff people have to wear/hold)
  - ***Provide "automated" support***

Comfortable VR

- Types of discomfort
  - Fatigue
  - Cybersickness
  - Worry
- Aims of this research
  - ***Identify sources*** of discomfort
  - ***Measure levels*** of discomfort
  - ***Predict occurrences*** of discomfort
  - ***Mitigate effects*** of discomfort

Comfortable VR: Fatigue

- Sources
  - Can affect many body parts: Neck, arms, legs, eyes, brain (cognition), etc.
  - Can be caused by: Repetition, complexity, sustained interaction, required precision
- Measurement
  - Post-exposure (e.g., Borg CR10)
  - Run-time collection (e.g., using Microsoft Dial)
- Prediction
  - Consumed endurance
- Mitigation
  - Developer guidelines (e.g., careful design/use of interaction techniques)
  - Run-time intervention (e.g., rest breaks, eye exercises)

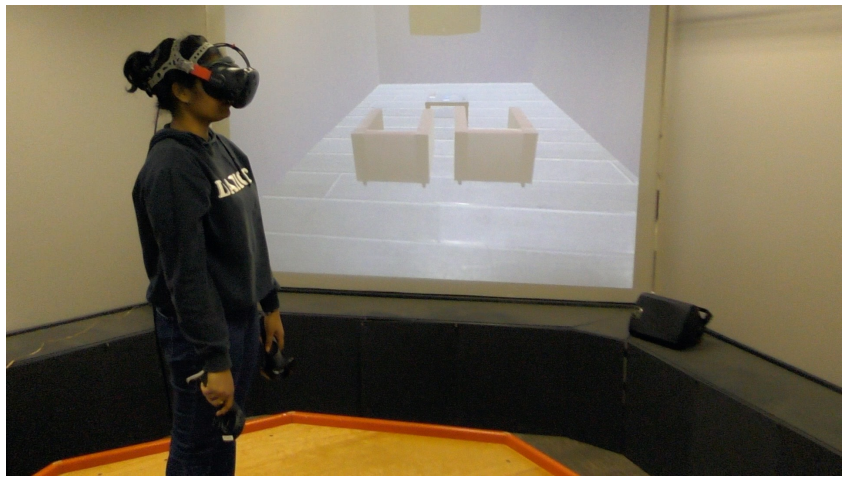
My Work to Date: See my online list!

- My University of Canterbury profile lists all of my publications:

tinyurl.com/gogoucnz

My Work to Date: Fatigue Mitigation (1/2)

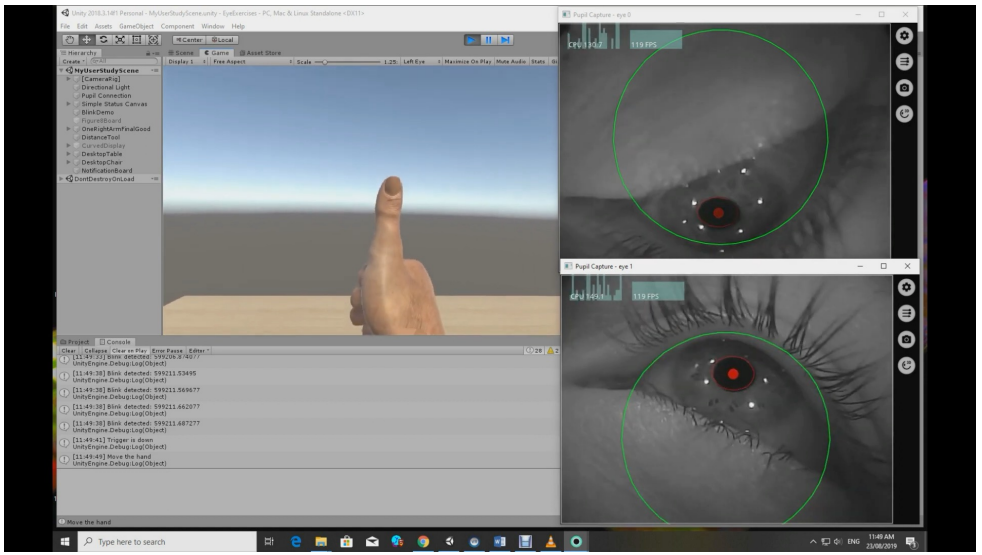
- Forearm-mounted interaction panel (Past PhD student)
- Multiple multi-touch wearable touch pads (Past Masters student)
- Haptic ChairIO (Past PhD student)
- TriggerWalking (Past PhD student)
- FingerWalking (Past Masters student)
- Swivel-chair VR (Past PhD student)
- Active Breaks (Past PhD student)



Papers: **tinyurl.com/gogoucnz**

My Work to Date: Fatigue Mitigation (2/2)

- Active Breaks: Vergence-Accommodation Conflict (VAC) visual fatigue mitigation



Comfortable VR: Cybersickness

- Sources - Can be caused by:
  - Sensory mismatch, technical limitations, content
  - Lunar phases may influence performance/susceptibility (Māori perspective)
- Measurement
  - Run-time collection (e.g., physiological, verbal reporting, or Microsoft Dial) + Machine Learning
  - Post-exposure (e.g., SSQ)
- Prediction
  - Personal user tendencies (e.g., motion sickness history)
  - Current user state (e.g., tired, hungover)
  - App characteristics (e.g., high motion)
- Mitigation
  - Developer guidelines (e.g., careful design of experience)
  - User recommendations (e.g., don't use it if you are tired, hungover)
  - Run-time intervention (e.g., reduced FOV, reference frames)

My Work to Date: Cybersickness

- Measurement
  - Microsoft Dial (Past Masters student)
- Prediction
  - Head-bob evaluation for movement in VR (Past PhD student)
  - Analysis of motion data from game sessions (Current Postdoc)
- Mitigation
  - Dynamic Immersion (Past PhD student)
  - Floor vibration (Many past & present students and postdocs)
    - Off-road truck (Past Postdoc)
    - Broom-stick simulator (Past Masters student)

Papers: **tinyurl.com/gogoucnz**

Comfortable VR: Worry

- Sources
  - Physical safety: Tripping/bumping into objects
  - Social concerns: Interactions with others
  - Sense of embodiment: My feeling that I, myself, am in the environment
- Measurement
  - Run-time collection: Physiological measures, behavioural measures (eye-movements, posture)
  - Post-exposure: Self report
- Prediction
  - Individual differences/personality (Big-Five Personality Factors [1])
  - Demographics (age, gender, race, ethnicity)
  - VR environmental factors
  - Roles and relationships of participants
- Mitigation
  - User guidelines/room clearance
  - Virtual guardian/chaperone system
  - Non-immersive HMD (with peripheral vision)
  - Minimap/WIM
  - Sidekick
  - Time
  - Careful transitions from the real to the virtual environment (onboarding)
  - New technology for facial-feature capture/eye gaze

1. *Roccas, Sonia; Sagiv, Lilach; Schwartz, Shalom H.; Knafo, Ariel (2002). "The Big Five Personality Factors and Personal Values". Personality and Social Psychology Bulletin. **28** (6): 789–801. doi:10.1177/0146167202289008*

My Work to Date: Worry Mitigation

- Physical safety
  - Depth-coloured Guardian system (Past Masters student)
  - Dynamic Immersion (Past PhD student)
  - Swivel-chair VR (Recent PhD student)
- Virtual worries
  - Spatialised audio cues to help with guidance (Past PhD student)
  - Directional wearable vibrotactile cues to help guidance (Past students)
- Social concerns
  - Modelled lab room as first virtual room (Past Masters student)

Papers: **tinyurl.com/gogoucnz**

Generally Helpful Ideas: Familiarity

- Avatars
  - Consistent avatar
  - Predictable avatar traits/movements
- Natural interaction
  - Multi-modal input
  - Familiar tools/interfaces/defaults
- Predictable feedback
  - Multi-sensory cues

My Work to Date: Familiarity (1/2)

- Avatars
  - Unencumbered skeletal & hand capture (Past PhD student)
  - Embodiment (Past PhD student and Postdoc)
- Natural interaction
  - Unified direct+indirect user interaction (Past PhD student)
  - Survey of commercial game interaction to inform VR techniques (with Anthony Steed)
- On-boarding (with Anthony Steed)
  - Standard tutorial/lobby (current intern)
  - Directed familiarization tasks (current intern)

Papers: **tinyurl.com/gogoucnz**

My Work to Date: Familiarity (2/2)

- Predictable feedback
  - **LOTS** of work on vibrotactile and passive haptics
  - **LOTS** of work on coordinated multi-sensory feedback
    - Visual, auditory, floor & wearable vibration, smell
  - Smell+taste (Past Masters student)
  - Symmetric vs. Asymmetric (traditional vs. multi-sensory)

Papers: **tinyurl.com/gogoucnz**

Generally Helpful Ideas:

Transitioning Between Worlds

- Smooth transitions between real and virtual worlds
- Reduce the "Wow!" effect
- Reduce context-switch penalties
- Reduce the need to transition often
- Reduce the amount of "stuff" that needs to be donned and doffed
- Māori perspective:
  - Haere pai atu, Hoki pai mai ("Go well, return well")

M

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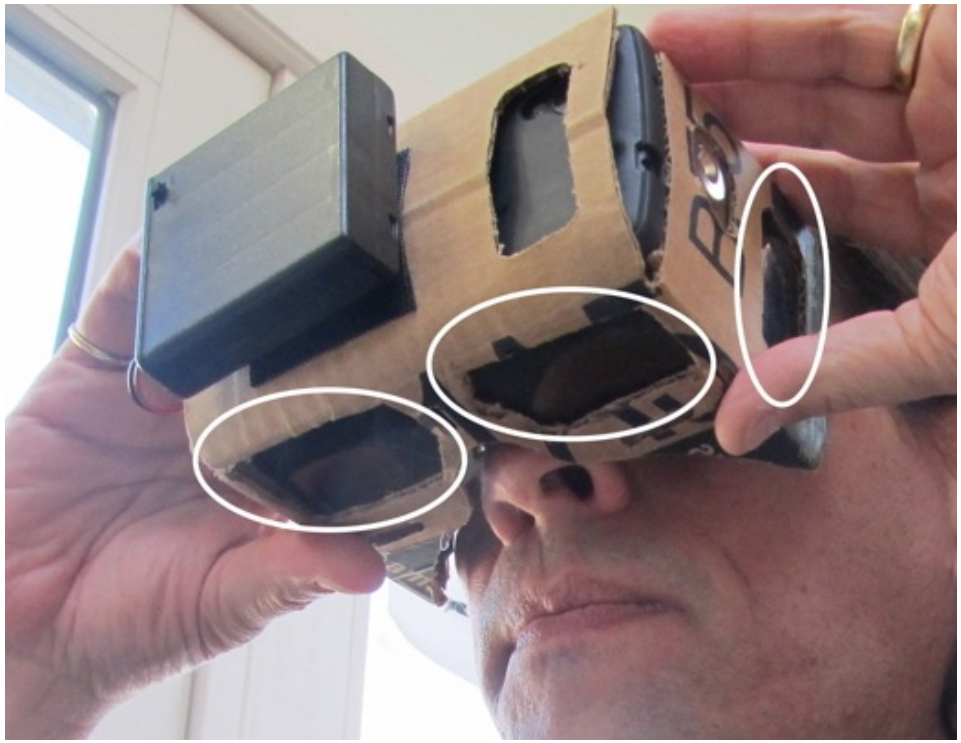
My Work to Date: Transitioning

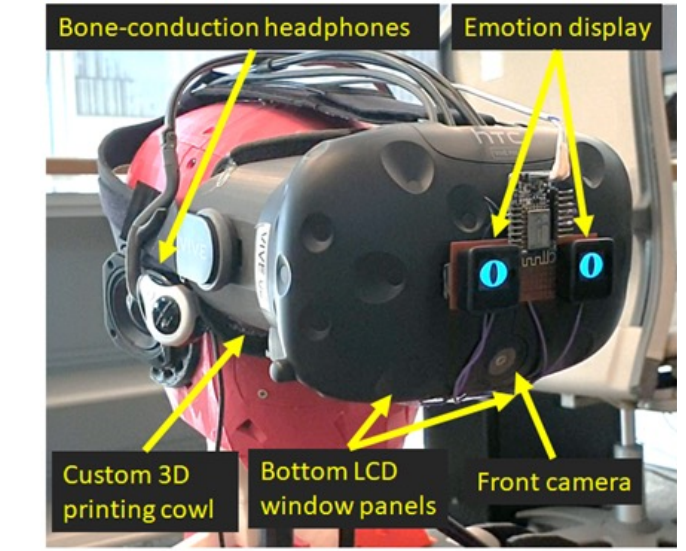
- Control with:
  - Software
  - Sensors
  - Buttons/slider
- Lots of comfort ideas:
  - Reduce cybersickness
  - Drink your tea
  - Answer phone
  - Be a better office worker
  - Use your keyboard and mouse

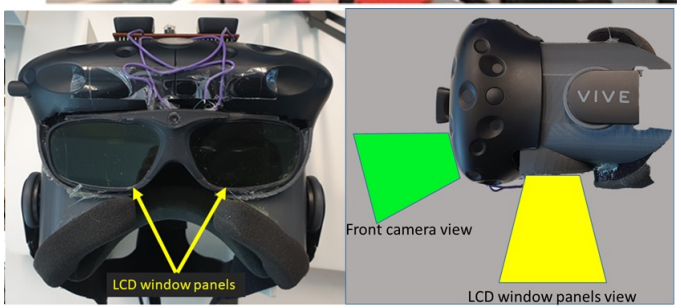
Dynamic Immersion (Lindeman, IEEE VR 2016)



My Work to Date: Transitioning

- Reduce the "Wow!" effect
  - Modelled physical room in VR to ease transitions (Past Masters student)
- Reduce context-switch penalties
  - Dynamic immersion (Past PhD student)
- Reduce the need to transition often
  - Dynamic immersion (Past PhD student)
- Reduce the amount of "stuff" that needs to be donned and doffed
  - Unencumbered skeletal & hand capture (Past PhD student)





Papers: **tinyurl.com/gogoucnz**

Generally Helpful Ideas: Interaction

- Need to balance *expressiveness* and *discomfort*
  - Required precision should match interface support
    - Provide help, like "smart snapping" and intent prediction
  - Combine direct and indirect techniques
    - Select using pointing
    - Manipulate using panel
- Don't require ***everything*** to be done in VR
    - Choose appropriate tasks/interfaces (e.g., desktop vs. VR)

My Work to Date: Interaction

- Forearm-mounted interaction panel (Past PhD student)
- Multiple multi-touch wearable touch pads (Past Masters student)
- Eye-gaze-based interaction (Past Postdoc)
- Effects of avatar expressiveness on collaboration (Past PhD student)

Papers: **tinyurl.com/gogoucnz**

Some Easy-to-Use Guidelines (1/2)

- Have the user *sit*, preferably in a swivel chair
- Provide "*no-look*" interfaces
- Encourage "*bursty*" interaction
- Separate *Indication* from *Confirmation*
- Use more *voice* input
- Use *direct techniques* for things with physical analogues, and *indirect techniques* for everything else

Some Easy-to-Use Guidelines (2/2)

- Use *body-centric* approaches (bi-manual, forearm)
- Use *multi-sensory* cues (natural bandwidth)
- Offer multiple ways of doing common things
  - Supports diverse users
  - Supports user maturation
- Let users *train* to get up to speed
- Provide ways for users to *predict* comfort

How to Engage with Us

- Masters Students
- PhD Students
- Interns
- Exchanges
- Visiting Researchers (e.g., sabbatical)
- Corporate project sponsorship
- Consultancy (buy some staff time, work for hire)

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha

HITLabNZ
Human Interface Technology Lab New Zealand
Hangarau Tangata, Tangata Hangarau
www.hitlabnz.org

Questions?

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- Website: www.hitlabnz.org
- LinkedIn: https://www.linkedin.com/company/hit-lab-nz/
- Facebook: https://www.facebook.com/HITLabNZ/