

Evaluation of Virtual Reality for Usability Studies in Occupational Safety and Health

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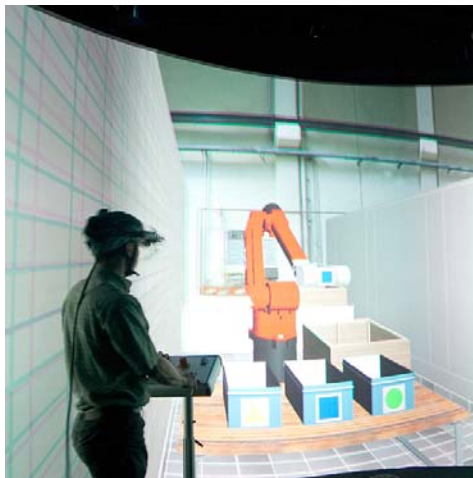
Safety and usability through applications in Virtual Reality



Virtual Reality (VR) is a simulated 3D environment for close to reality Human-Machine Interaction

- Simulation technique and methodology
- Systems design and training
- Industrial and services sectors
- Applications in occupational safety and health context
- Human information processing in human-machine interaction

Evaluation of VR in human-robot interaction application



VR for analysis, design, and evaluation of human-machine interfaces

Research topics

- **Simulator sickness**
- Ergonomics assessment of VR design
- Information presentation quality
- **Immersion, presence experience**
- Perception, decision making, action implementation in VR
- **Operator behaviour monitoring**
- VR versus Reality comparisons
- Distance, velocity, movement assessments
- Generalisability of VR results

Concerns about simulator sickness in VR application

- Simulator sickness (SimSick) is a condition caused by viewing visual stimuli with compelling **ego-motion inappropriate to body movements** and resulting in **symptoms of nausea** and eye fatigue
- SimSick causes **performance decrements**
 - risk of contaminated human performance in VR applications
- SimSick has longer **lasting effects**
 - VR participation may lead to impaired safety at work
- **Does VR design result in simulator sickness?**
Testing environment: Human-Robot Interaction application

VR enables hazardous work without putting operator at risk

- Even if working with obviously **dangerous machinery** in VR it **will not harm** or injure the participant
- However, operator behaviour in VR is of relevance only if **operator behaves as in reality**
 - VR should be immersive
 - VR should result in experience of presence

• Is VR design immersive?

Does operator experience presence?




Testing environment: Human-Robot Interaction application

VR for human-centred system design

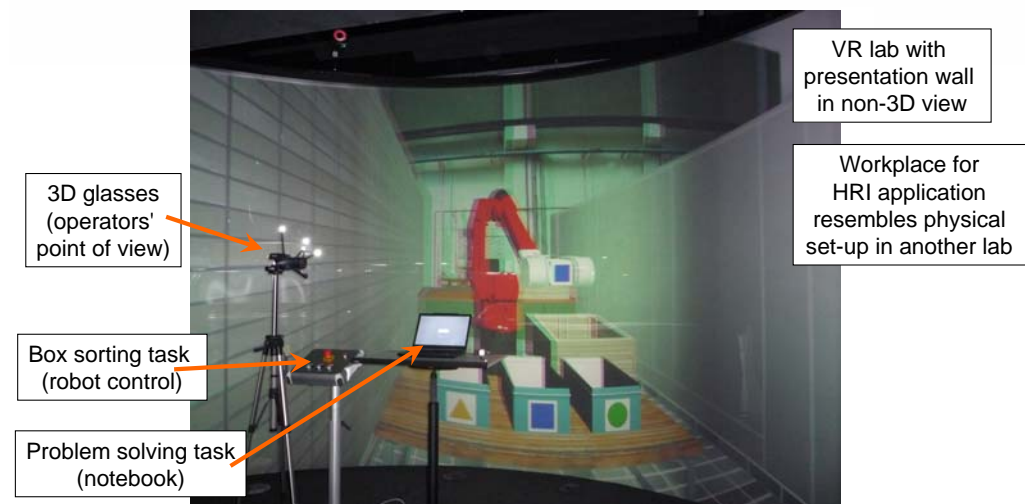
- VR should enable real world investigations and should include advantages of simulation
 - **workplace set-up** that enables human-robot interaction
 - systematic variation of experimental/ working conditions
- Suitability of human performance measures in VR
 - **human performance as criteria** for technical systems design
 - application of **measures as used in laboratory/field studies**
- **Does VR result in close to reality human behaviour** (performance, self-assessment, psychophysiology)?
Testing environment: Human-Robot Interaction application

Evaluation pilot study on human-robot interaction

- Variation of level of intensity of human robot interaction (HRI)
- All participants performed all task scenarios 1 to 3
- Study design

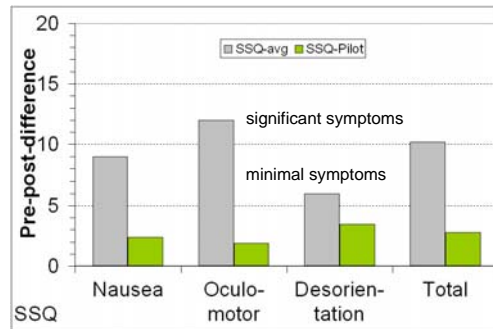
Preparation	Testing (operator task scenarios)			Debriefing
	Task scenario 1:	Task scenario 2:	Task scenario 3:	
				
	Problem solving task HRI low intensity	Problem solving task HRI high intensity	Problem solving task HRI low intensity	
SSQ, ITQ	performance, PSAM, ECG, NASA TLX	performance, PSAM, ECG, NASA TLX	performance, PSAM, ECG, NASA TLX	PQ, SSQ

Workplace with human-robot interaction application



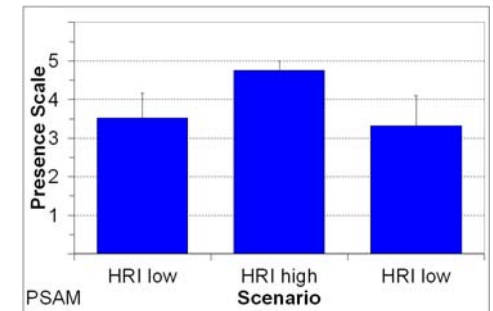
Evaluation pilot study human-robot interaction

- Does VR design result in simulator sickness?
 - Simulator Sickness Questionnaire (Stanney et al. 1997)
- Average across simulator studies (Kennedy et al. 2010): significant symptoms (10-15)
- Pilot study: negligible symptoms (0-5)
- SSQ score and categorisation:
 - > 20: bad simulator
 - 15-20: symptoms are a concern
 - 10-15: significant symptoms
 - 5-10: minimal symptoms
 - <5: negligible symptoms
 - 0: no symptoms



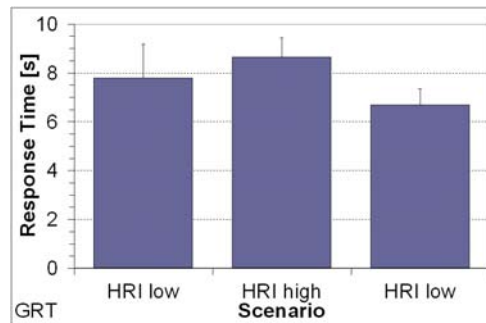
Evaluation pilot study human-robot interaction

- Is VR design immersive? Does operator experience presence?
 - Presence Self-Assessment Manikin (Wissmath et al. 2010)
- Immersion levels similar to average in other studies in other studies (Witmer & Singer 1998)
- Operator experience of presence
 - Low and high intensity of HRI yields high presence experience
 - High intensity of HRI results in highest presence experience



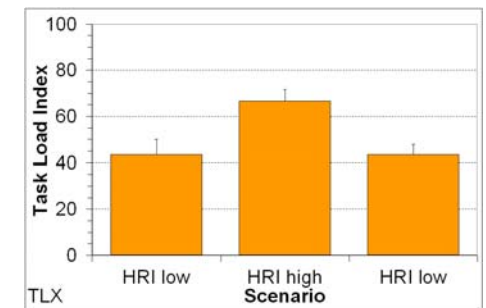
Evaluation pilot study human-robot interaction

- Does VR result in close to reality human behaviour (performance, self-assessment, psychophysiology)?
 - Problem solving and decision making task (notebook) (AGARD-STRES 1989):
- High intensity of HRI results in performance decrements in problem solving task (notebook)



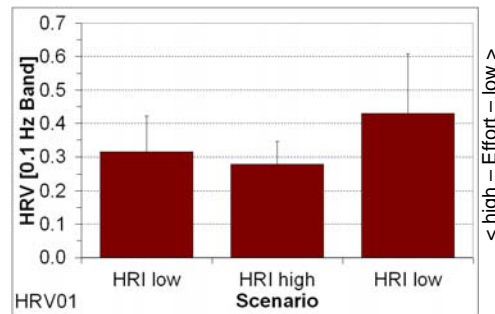
Evaluation pilot study human-robot interaction

- Does VR result in close to reality human behaviour (performance, self-assessment, psychophysiology)?
 - Task Load Index (NASA-TLX: Hart & Staveland 1988)
- High intensity of HRI results in higher ratings for task load



Evaluation pilot study human-robot interaction

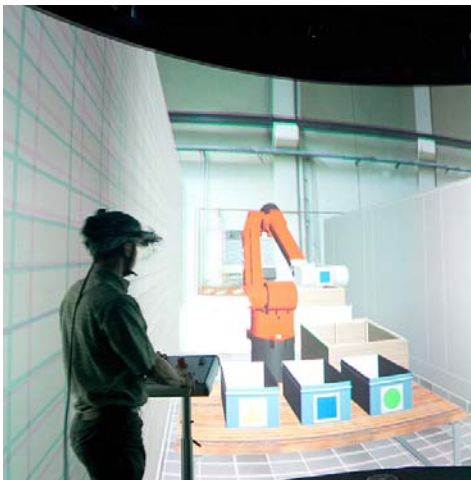
- Does VR result in close to reality human behaviour (performance, self-assessment, psychophysiology)?
- High intensity of HRI results in higher effort investment
- Mental effort investment (0.1 Hz component of HRV: Mulder et al. 1987, Nickel & Nachreiner 2003)



VR-Evaluation for usability studies in OSH

- Pilot study results suggest:
 - Does VR design result in simulator sickness? **NO**
 - Is VR immersive? Does operator experience presence? **YES**
 - Does VR result in close to reality human behaviour? **YES**
- Fundamental requirements for future VR research and promising basis for ongoing VR evaluation studies

Evaluation of VR in human-robot interaction application

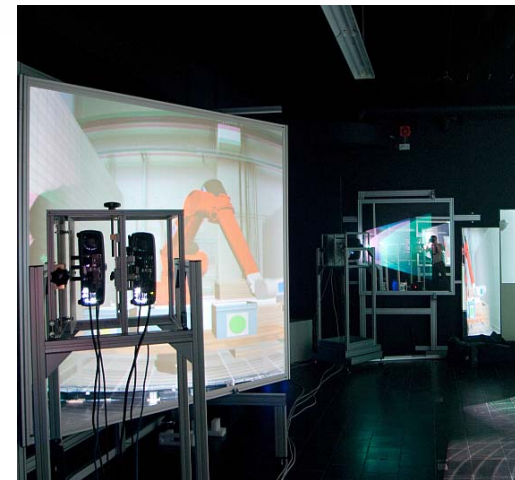


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Thank you very much for your attention!



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