

VRclimate:

Measuring the effects of climate control on presence in natural virtual environments

1. Overview



Presence:

- The subjective experience of being in one place or environment, even when physically situated in another

Simulator sickness / cybersickness:

- common concern in VR
- Symptoms include headache, sweating, disorientation, and vertigo

Climate control:

- The ability to simulate weather by varying temperature, wind, and humidity within a controlled environment

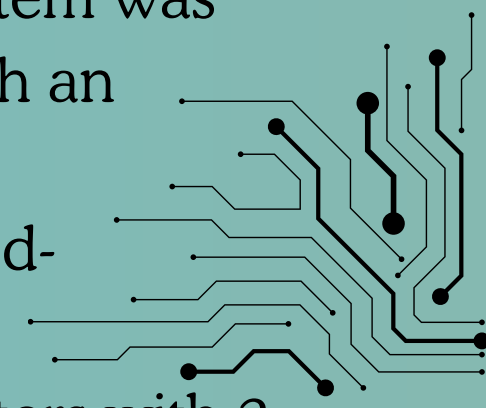
2. Aim



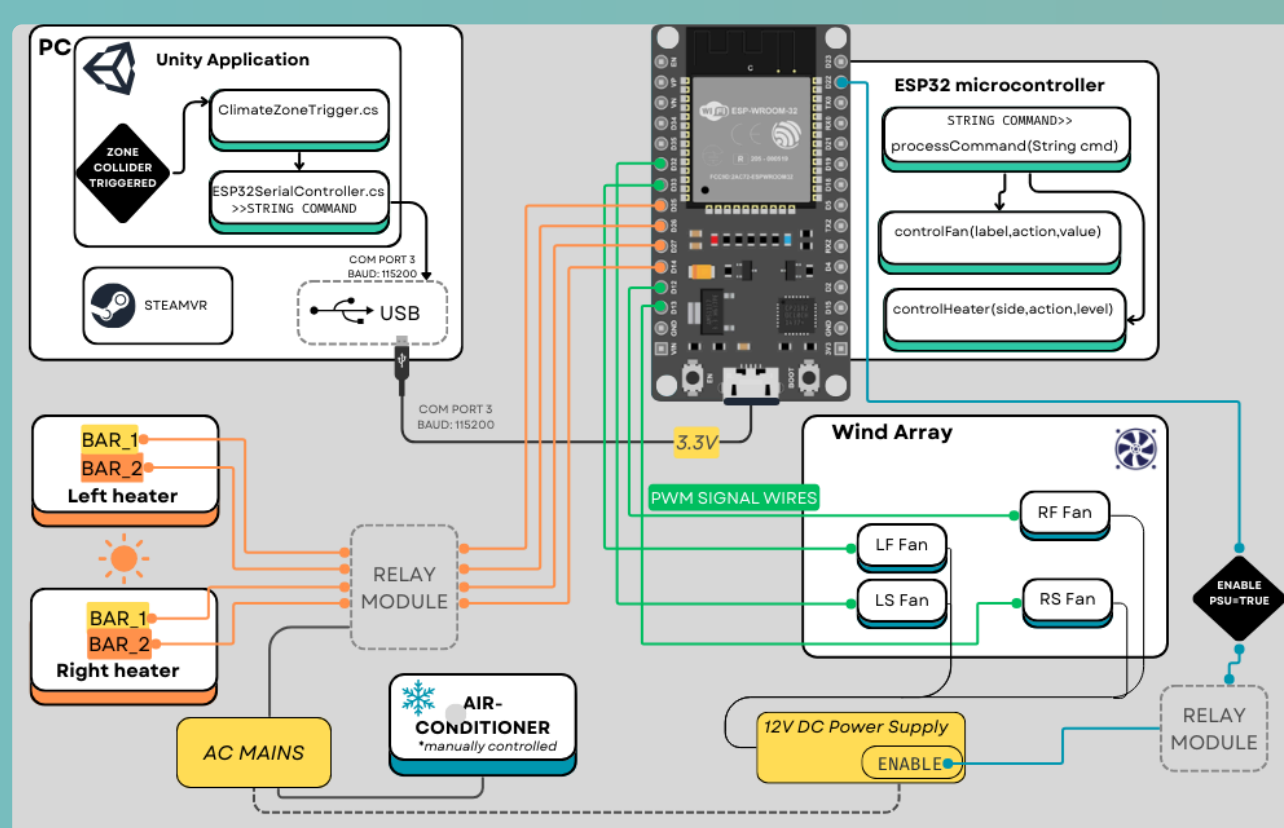
To investigate how sensory inputs, such as thermal and wind feedback, affect a user's sense of presence and occurrence of simulator sickness in VR.

3. Hardware design

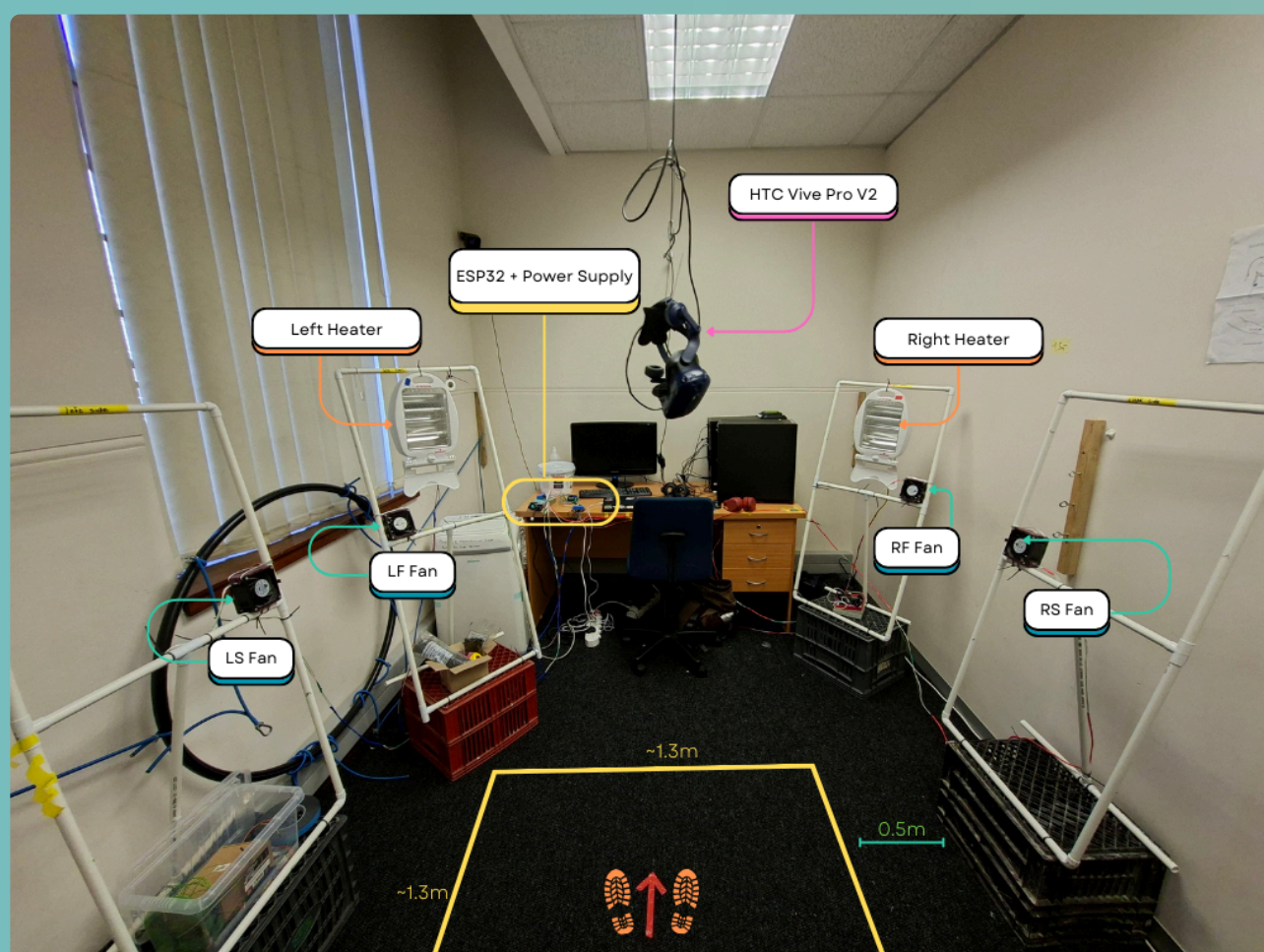
An ambient climate control system was designed and implemented with an overall environmental effect:



- Wind component:** 4 speed-controllable server fans
- Warm component:** 2 heaters with 2 temperature settings
- Cold component:** air conditioner
- The components were controlled with an **ESP32WROOM** microcontroller connected to the PC via USB.

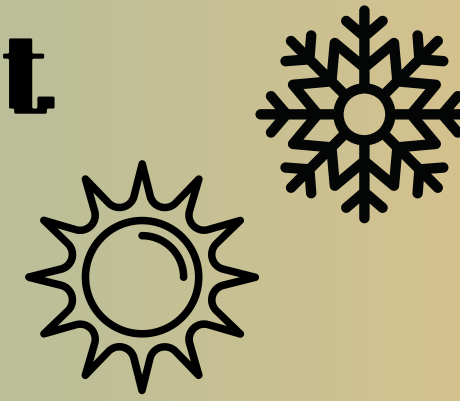


Climate control connections



Physical layout of climate control system

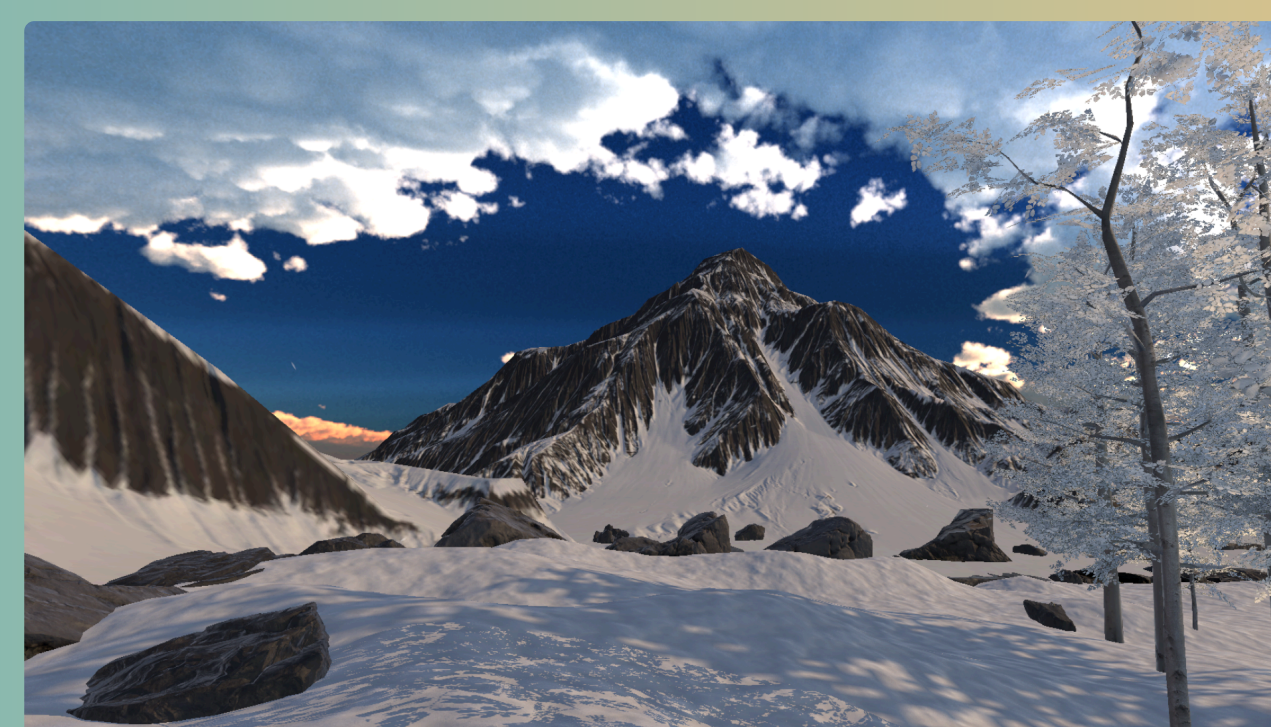
4. Environment design



Warm desert environment



Cold, snowy environment



Both environments contained tasks to encourage exploration of the environments:

Warm:

- Finding and feeding a tortoise
- Filling a water bottle by finding the oasis



Branch to be given to the tortoise



Filled bottle at the oasis

Cold:

- Building and lighting a fire
- Finding and adding the nose to the snowman

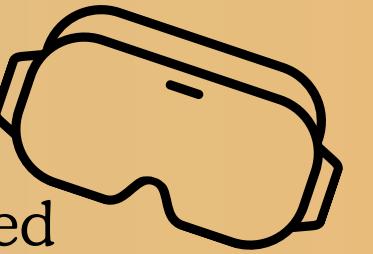


Completed fire



Completed snowman

5. Experiment



A **within-subject** design was followed where 41 participants experienced all 4 conditions which are:

- Condition A: Cold **without** climate control
- Condition B: Cold **with** climate control
- Condition C: Warm **without** climate control
- Condition D: Warm **with** climate control

The evaluations were done through the following questionnaires:

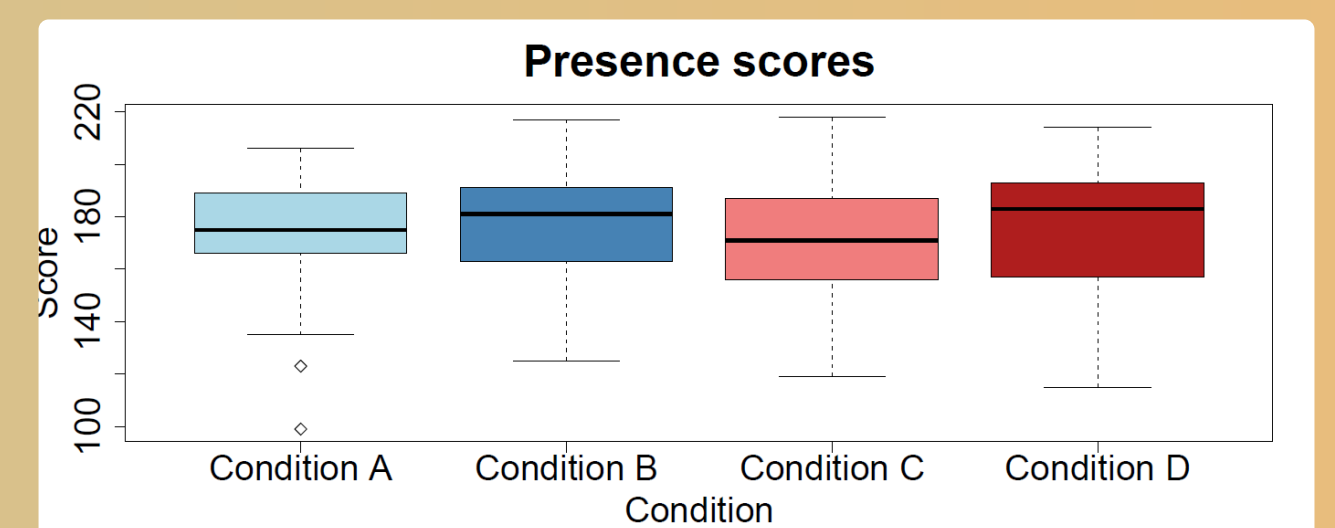
- Pre-evaluation containing questions about prior experiences
- Witmer and Singer presence questionnaire
- Simulator Sickness Questionnaire (SSQ)

6. Results



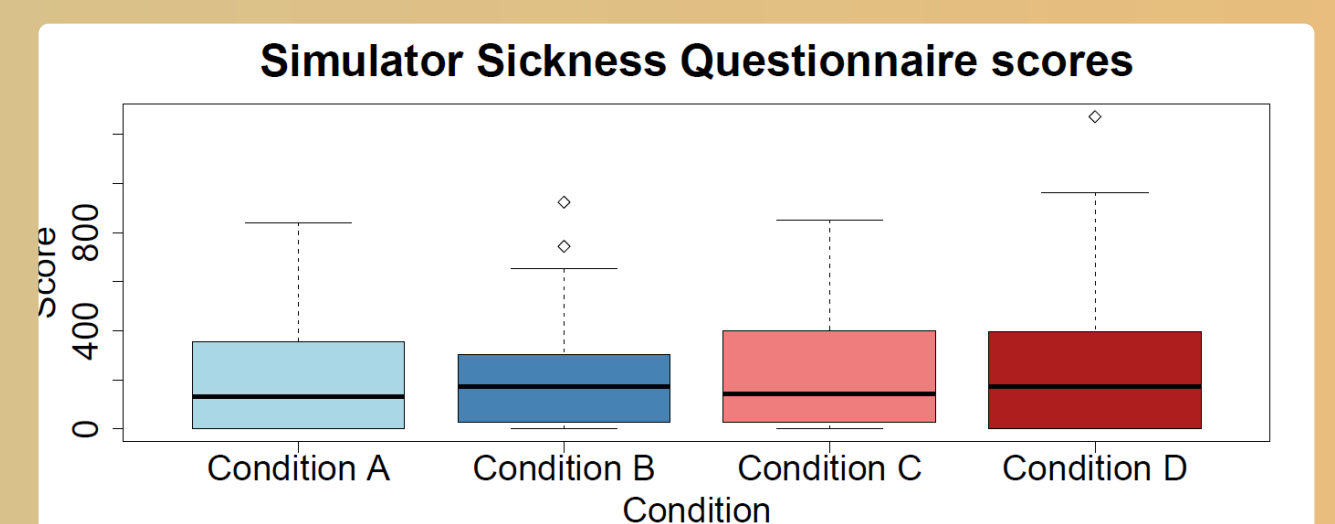
Presence:

- Shapiro-Wilk test showed normality does not hold ($p = 0.032$)
- Non-parametric Friedman test shows no significant difference between conditions ($p = 0.486$)
- Mixed-effects aligned rank transform ANOVA showed significant differences for the interaction of VR experience and conditions ($p = 0.043$)
- Post-hoc tests showed no pairwise differences between specific VR experience groups and conditions



SSQ:

- Shapiro-Wilk test showed normality does not hold ($p < 0.001$)
- Non-parametric Friedman test shows no significant difference between conditions ($p = 0.998$)



7. Conclusions



- Climate control does not have a significant effect on presence and simulator sickness in VR.
- The interaction of condition and prior VR experience does have a significant effect on presence in VR



Researchers:

- Zahra Bawa (BWZAH003@myuct.ac.za)
- Pietro Scheepers (SCHPIE019@myuct.ac.za)
- Rachel Strachan (STRAC002@myuct.ac.za)
- Supervisor: James Gain (jgain@cs.uct.ac.za)