BBC

VR | BARRIERS RESEARCH

Switch Based navigation in Virtual Reality Environments

Some experiments and approaches

Overview

This purpose of this document is too details some of our experiments developing a virtual reality environment with a focus on reducing barriers for mobility impaired users;.

These barriers where large and obscuring smaller barriers so we sough to address them so we could further explore.

1. **Barriers Observed** - a description of the barriers we have observed relating to controllers and movement.
2. **Hardware & Software** - the technical approach taken and the hardware chosen.
3. **Switch control schemes** - different control scheme which have we have tried.
4. **Findings** - what we found during out experiments

About Us

The purpose of the BBC UX&D Accessibility team is to understand barriers present within BBC apps and services and to support teams to include the whole audience.

Our Approach

Initial Sessions

Initial explorations to observe and capture the barriers, develop our test methodology and process. These sessions where held in a special education setting.

Prototype Session

After the need for switch control was apparent we developed a lightweight learning prototype and ran a pair of sessions to test our approach with participants and learn about control scheme needs.

Main Session

Once the learning prototype was working well, we then integrated what we had learnt into our main environment and expanded the control schemes available.

BARRIERS OBSERVED

Barrier 1: Holding controllers

This barrier occurs when an experience *requires the user to hold a controller for an extended period* in a consistent location and orientation,

For example, holding the controller while observing the environment or when holding a virtual object.

Barrier 2: Controller orientation

This barrier occurs when an *experience requires the user to finely and precisely control a motion controllers* orientation and *accurately point the controller* at a target.

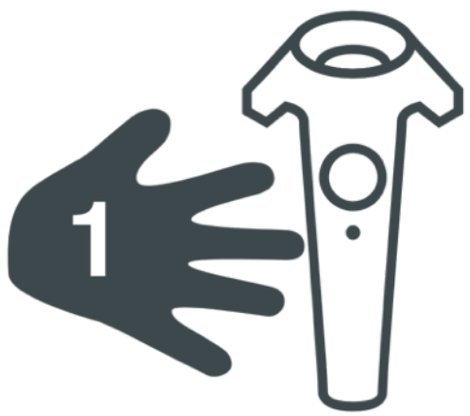
For example, When choosing a teleportation target or aiming a virtual weapon.

BARRIERS OBSERVED

Barrier 3: Holding down buttons

This barrier occurs when an experienced requires the user to hold a button down for an extended period. This barrier is *amplified* if the experience requires the user to hold a button while also moving precisely

For example: when picking a teleport target



Barrier 4: Single Handed Use

This barrier occurs when an experience requires concurrent use of multiple inputs across multiple input devices.

For example, when holding an object and teleporting or anytime when controls cannot be mapped to a single input device.

Controller Base

We used a Microsoft Xbox Adaptive Controller as our switch base. This was connected wirelessly to a windows 10 laptop and feeding data into the Unreal engine via a mapped controller config.

The controller was held in a backpack or zip tied to a wheelchair depending on the users mobility.

Ping Pong Switch

We used a ping pong switch for situations where a low activation force from any direction would be beneficial.

The switch was mounted to a wheelchair, held in the participants hand, placed in a a pocket or placed under the users chin.

Big Lib & Mini Lib Switch

These flat button switches come in two sizes. They provide a large area switch which requires low force to activate. We used multiple colours and the buttons also support affixing labels.

The buttons where mounted to participants wheelchairs.

Head Mounted Controller

While the standard HTC Vive controller could not be held by all participants. Some control schemes still used the controller as a head mounted tool. This allowed the controller to track the users head movement or wheelchair rotation.

The controller was mounted via zip ties to the HMD

Using Switches Within VR

The switch hardware and software mapping is very flexible. It provided us with a toolkit of options for participants to explore.

We developed a range of “off the shelf” control schemes for participants to start with and then adapted as needed.

Across the participants we did not observe any strong patterns for which control scheme was “best”. Flexibility and control where more important to participants than any specific solution.

Additionally, participants had varying needs over the course of a session. A third of participants changed the control scheme during the sessions. It was important we could change control schemes quickly. This was a feature we built into our test environment.

Control scheme used based on factors such as:

Fatigue - Becoming fatigued in a specific movement.

Different environmental needs - Some participants preferred one control scheme for navigating and a different scheme shooting / interacting

Learning - As participants gained confidence and experience with a specific option we could adapt the control shame to use that option more

How we approached user testing in VR using switches

Our initial explorations of the VR environment didn't support anything other than the default vive controllers. We worked with 3 user with the unmodified environment in order to understand the initial barriers.

Our approach quickly moved to overcoming some of the larger barriers so we could understand the smaller barriers. We prioritised navigation as we felt it was most foundational to the VR experience.

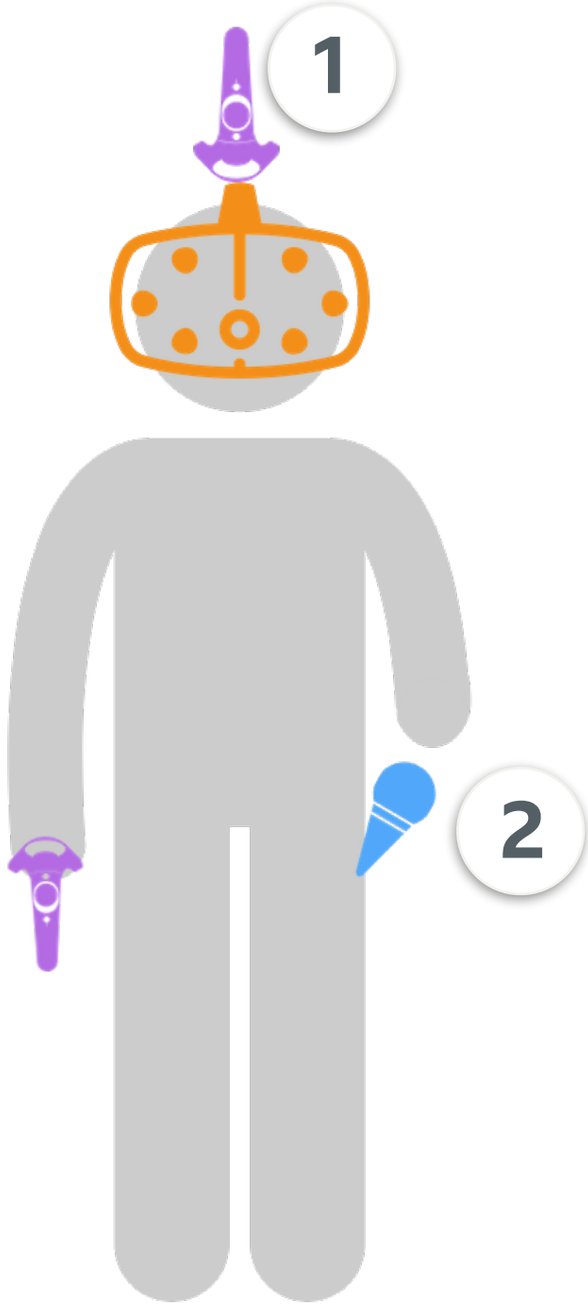
Working with the participants we then designed the the control schemes in this document.

Along the way we made a few discoveries which effected our methodology for running the sessions.

Disabling unused buttons - The large easy to press buttons on the front of the XAC are easy to accidentally press if the XAC is in a bag. We disabled any inputs we where not using during user testing sessions to prevent unexpected interactions.

Zip ties & Velcro can cause sensory issues - We avoided having velcro or zip ties touch the users skin as this can cause discomfort and hasten fatigue.

SWITCH CONTROL SCHEMES FOR NAVIGATION



Head & Neck based navigation

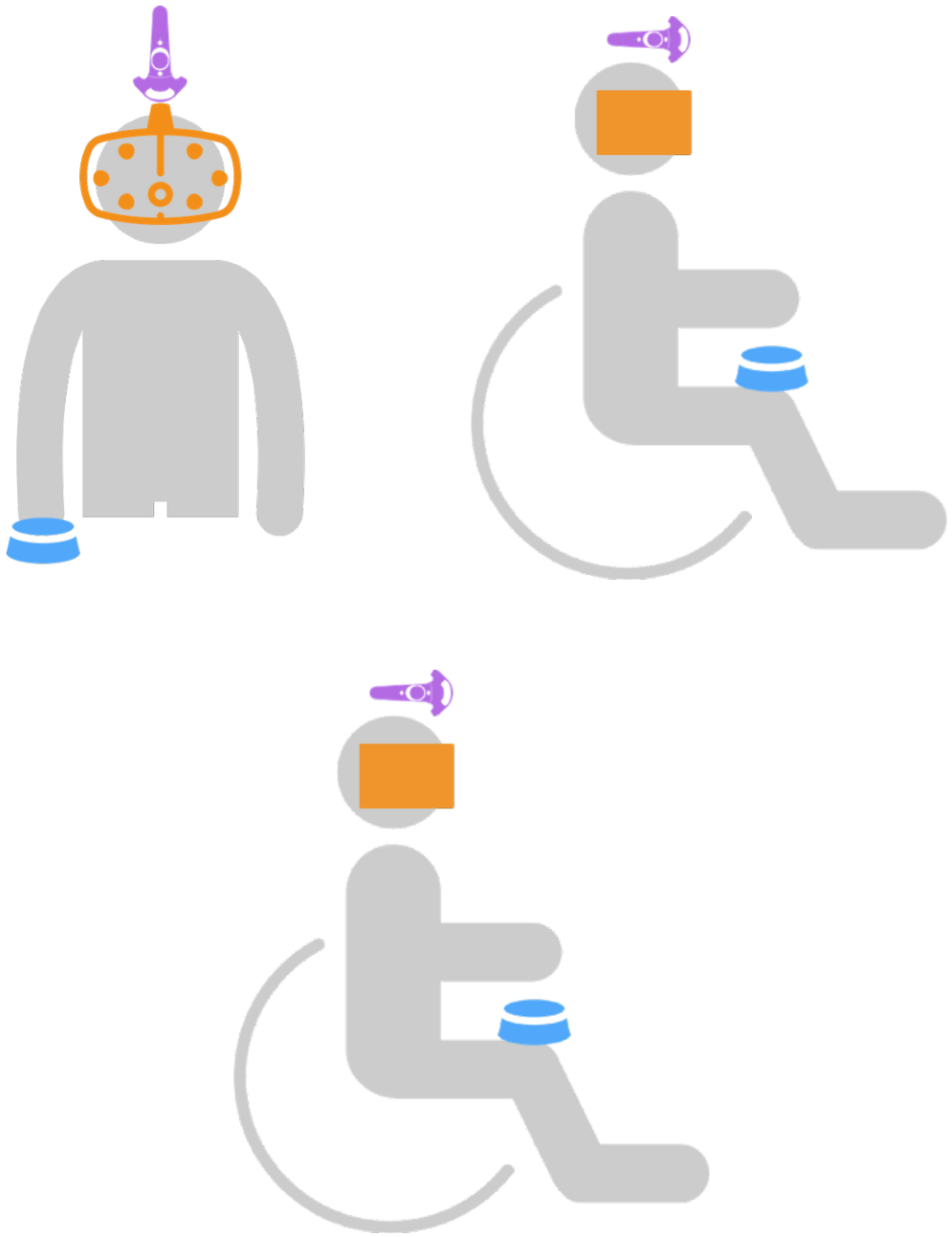
This control scheme was developed for participants who could not hold and orientate the vive motion controller but had good head and neck control

The motion controller was fixed to the headset (1) and a ping pin or lib switch was placed within the users reach (2)

To teleport the participant would first depress and hold the switch, then select a place to teleport too using a blue line projected from the head mounted controller, then release the switch to initiate the teleport.

This method was used by participants either standing, standing with aids, or sitting in a wheelchair.

SWITCH CONTROL SCHEMES FOR NAVIGATION



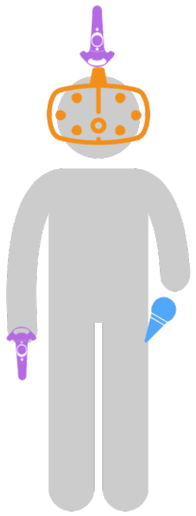
Fixed Position Navigation

This control scheme was developed for participants who could not hold and orientate the vive motion controller using any part of their body.

To track orientation a motion controller was fixed to the participant, their wheelchair or a standing aid (1). A ping pin or lib switch was placed within the users reach (2).

To teleport the participant would first depress and hold the switch, then choose a teleport target using a blue line projected from the fixed controller. Once a target was chose the participant would release the switch too initiate the teleport.

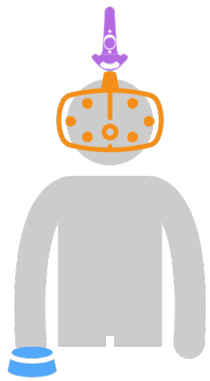
SWITCH CONTROL SCHEMES FOR NAVIGATION



Standing Head Controller

Purple - A head mounted Vive controller for setting direction / aiming

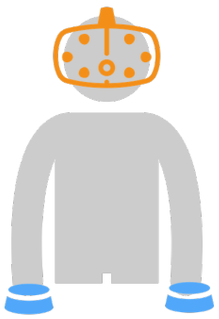
Blue - Ping ping switch placed in the placed in the users pocket / clothing used to trigger teleportation



Wheelchair Teleport

Purple - A fixed position head or chair mounted Vive controller. Tracks chair rotation.

Blue - Button switch attach to wheelchair. Leaving one hand free for controlling the wheelchair



Rotate & Move Forward

Blue left - Button switch which rotates the user left within the virtual environment at 10° per second.

Blue Right - Button switch which moves the user forward at a rate of 25cm per second.

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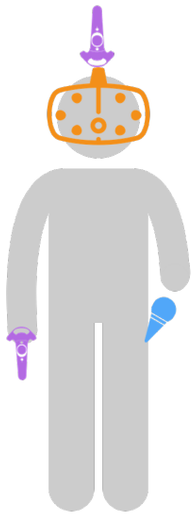

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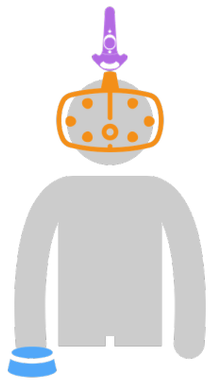

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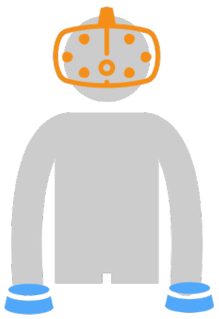

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