BBC

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VR | BARRIERS RESEARCH

Motor Barriers Deep Dive

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“Our goals is to make sure our websites, apps and services **don't disable people.**”

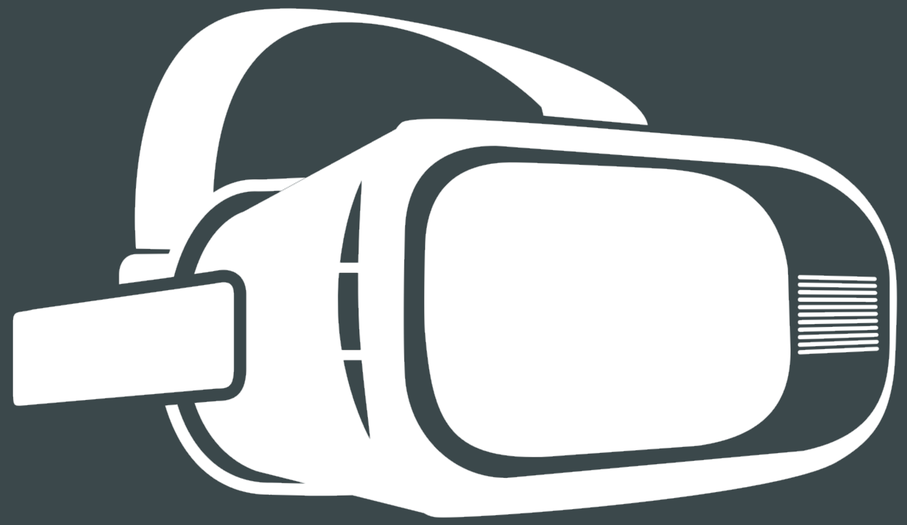
“Our goals is to make sure our websites, apps and services **don't disable people.**”

Disability has many **lenses**

Impairment
+ Environment

Disability

We **disable** people when we create barriers in environments



VR is the creation of new **environments**

& the creation of new **barriers**

BBC

VR | BARRIERS RESEARCH

Started in late 2017

Project Goals

1. To build a **dataset** of observed **barriers** faced by a wide range of users within VR environments

2. To consider if the current **inclusive design principles** encompass all observed barriers

3. To develop a **methodology** and **environment** for user testing VR with a diverse user group.

Project Goals

1. To build a **dataset** of observed **barriers** faced by a wide range of users within VR environments

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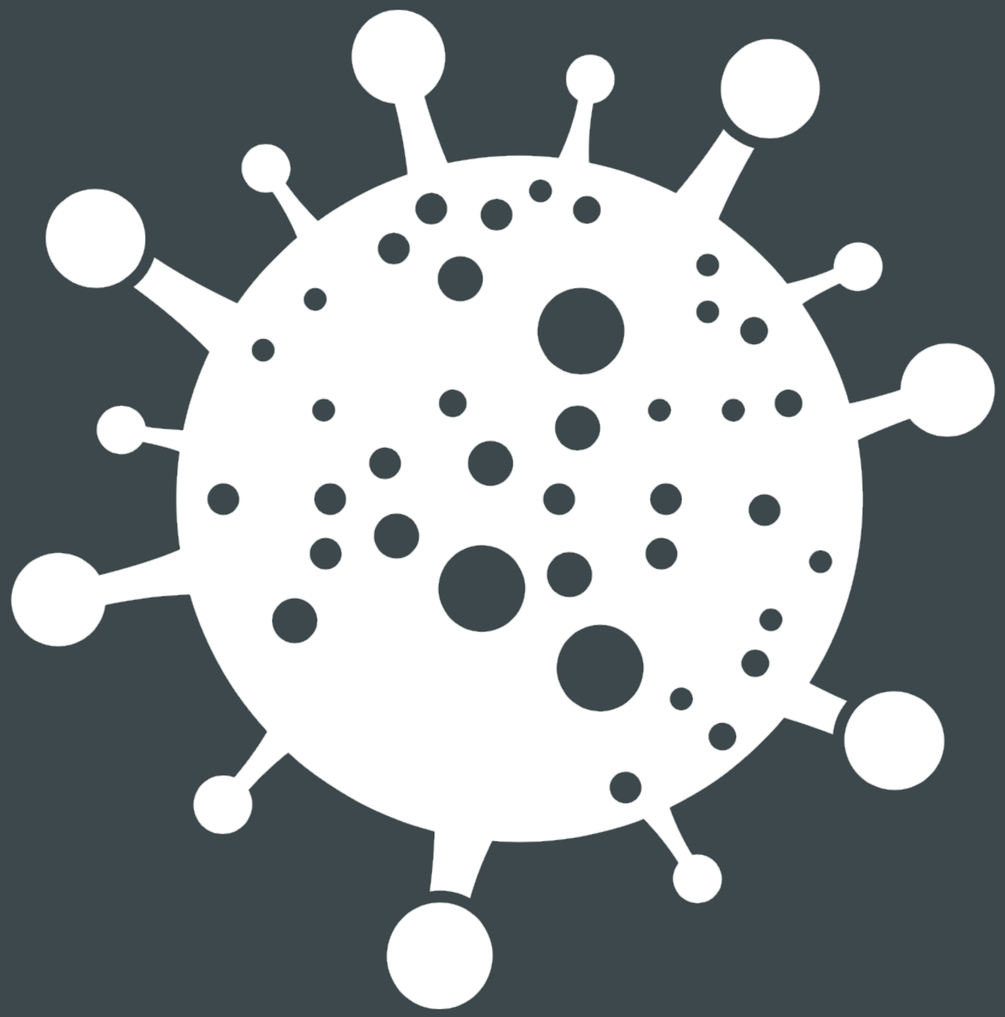
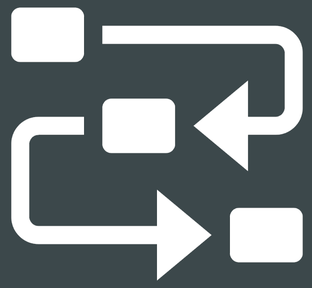


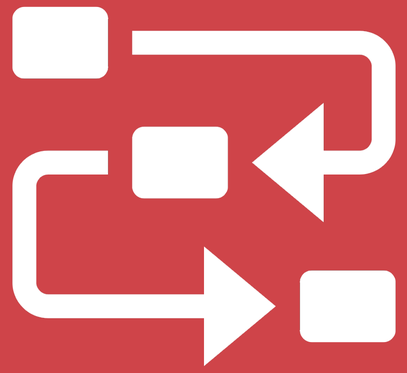
Motor Barriers Deep Dive



Collecting the Data

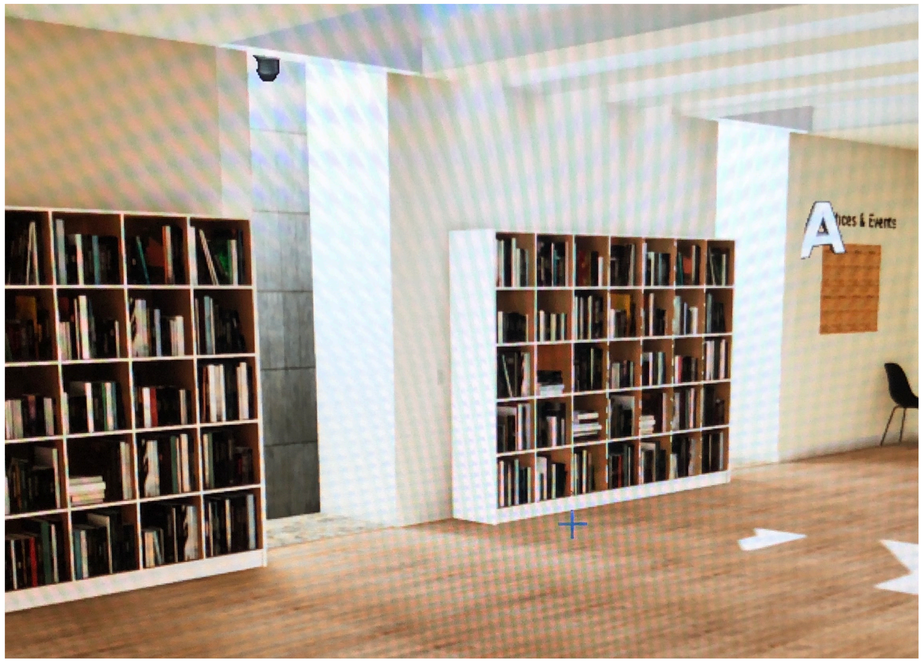
Common Motor Barriers

Switch Control Schemes



Collecting the Data

Methodology + Data pipeline



Methodology

1. **Invite participants** to explore our **test enviroment**.
2. Ask them to complete tasks relating to **navigation**, **interaction** & **information gathering**
3. **Observe** what happens and note down any **barriers** which occur

Data pipeline

Observations - The barriers we observed the participate experience

Barriers List - All the observations deduplicated, annotated & sorted

Barrier Groups - Barriers grouped by impairment & described

Data pipeline

~1700 Observations over ~100 sessions

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Data pipeline

~1700 Observations over ~100 sessions

~70 Barriers

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Data pipeline

~1700 Observations over ~100 sessions

~70 Barriers

Barrier Groups - Barriers grouped by impairment & described

Data pipeline

~1700 Observations over ~100 sessions

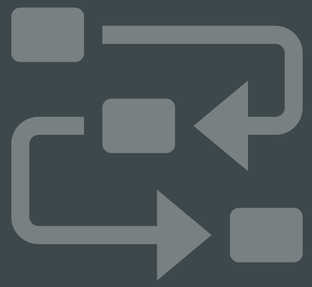
~70 Barriers

~20-30 Barriers across ~5 groups

Barrier groups so far

- **Motor Barriers**
- Cognitive barriers
- Low vision barrier
- Research barriers
- …

Motor Barriers Deep Dive



~~Collecting the Data~~

Common Motor Barriers

Switch Control Schemes

Common Motor Barriers

How environments disable users

Common **Motor Barriers**

1

2

3

4

5

Common **Motor Barriers**

1

Holding

2

3

4

5

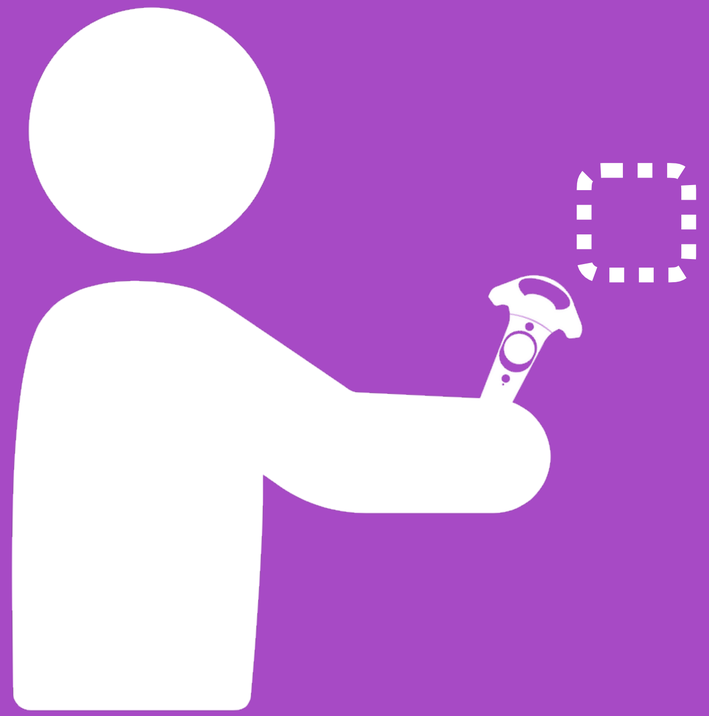
1

Holding

This barrier occurs when an experience requires the user to **grasp** a controller and then **hold** it:

- For an **extended period**
- In a **consistent location**
- In a **consistent orientation**

Example



For example, holding the controller while **observing the environment** or when **holding a virtual object,** in one **place** and **orientation.**

Common **Motor Barriers**

1

Holding

2

3

4

5

Common **Motor Barriers**

1

Holding

2

Orientation

3

4

5

2

Orientation

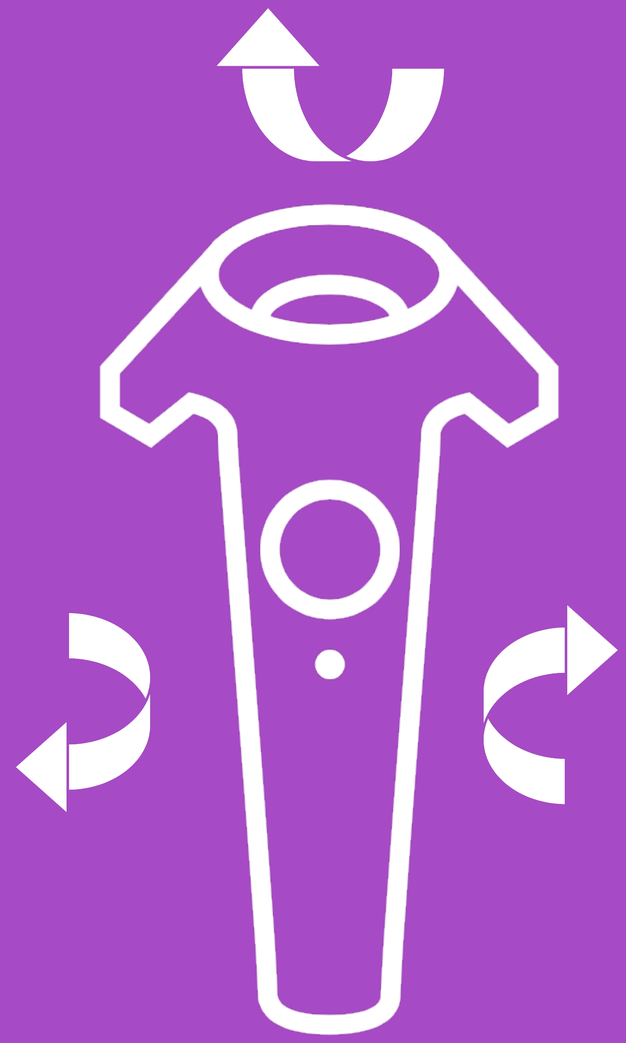
This barrier occurs when an experience requires the user to:

- **Orientate** a controller **accurately**
- **Orientate** a controller **repeatedly**
- **Point** a controller at a target

Orientation

"the position of **something** *in* **relation** *to its* **surroundings"**

Cambridge Dictionary



Accuracy and **Repeatedly** have overlapping but **distinctive barriers**

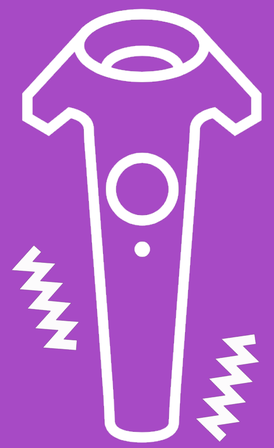
Example

Repeatable but not Accurate

A controller mounted in a fixed position to a user's wheelchair:

- **Repeatable -** every attempt very close together
- **Low Accuracy -** can only move on one axis in large increments

Example



Accurate but not Repeatable

A controller held by a user experiencing a tremor associated with Parkinson’s:

- **Not Repeatable** - multiple attempts are not grouped together
- **High Accuracy -** each shot is close to the target

2

Orientation

This barrier occurs when an experience requires the user to:

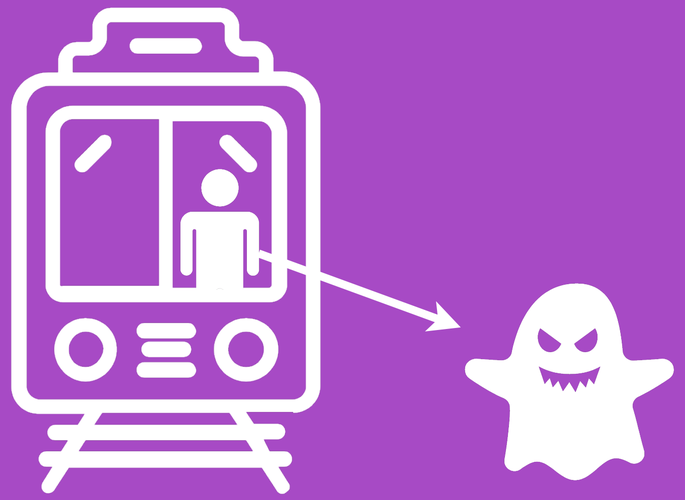
- **Orientate** a motion controller **accurately** and **precisely**
- **Point** the controller at a target

Pointing

"to **hold something** *out in the direction of* **someone** *or* **something***"*

Cambridge Dictionary

Example



A user aiming a virtual weapon while moving in multiple contexts:

- **Real world** movement of hands
- **Virtual movement** such as shooting from a moving train
- **Moving targets** to aim at

Common **Motor Barriers**

1

Holding

2

Orientation

3

4

5

Common **Motor Barriers**

1

Holding

2

Orientation

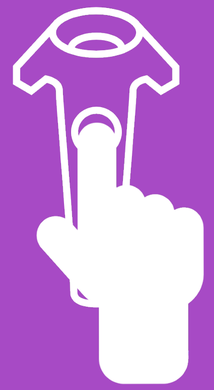
3

Press & Hold

4

5

3



Press & Hold

This barrier occurs when an experience requires the user to **hold a button down** for **an extended period.**

This barrier is **amplified** when combined with **movement.**

Example

Holding a trigger while **orientating** a **controller** in order to **point at a target** to start a teleport

Common **Motor Barriers**

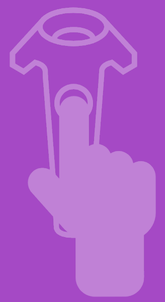
1

Holding

2

Orientation

3



Press & Hold

4

5

Common **Motor Barriers**

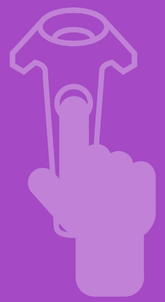
1

Holding

2

Orientation

3



Press & Hold

4

Multiple Input

5

4

x2+

Multiple Input

This barrier occurs when an experience requires:

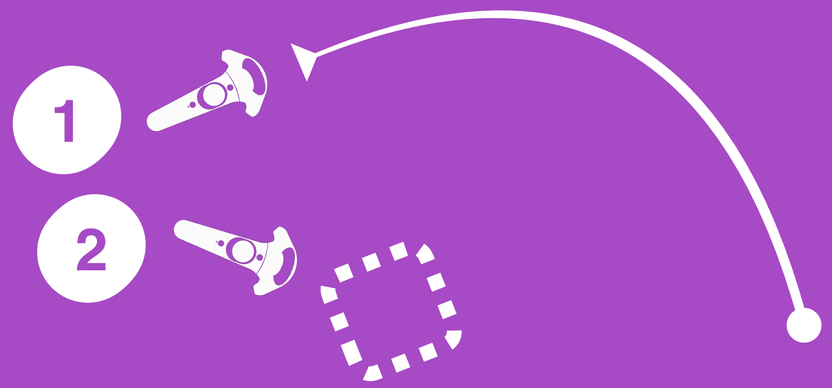
- **Concurrent** use of **multiple inputs**
  eg: pressing multiple buttons at the same time
- **Concurrent** use of **multiple controllers**
- **Coordinated** use of **multiple controllers**

Concurrent

“two or more actions happening **at the same time**”

Cambridge Dictionary

Example



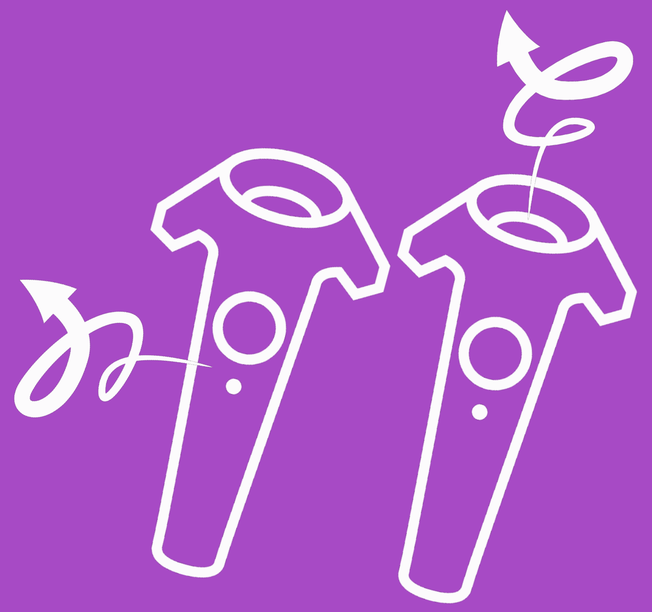
Concurrent use of multiple controllers.
A user teleporting with one hand, whilst holding a virtual object:

- **Controller 1:** Teleporting
- **Controller 2:** Holding the object

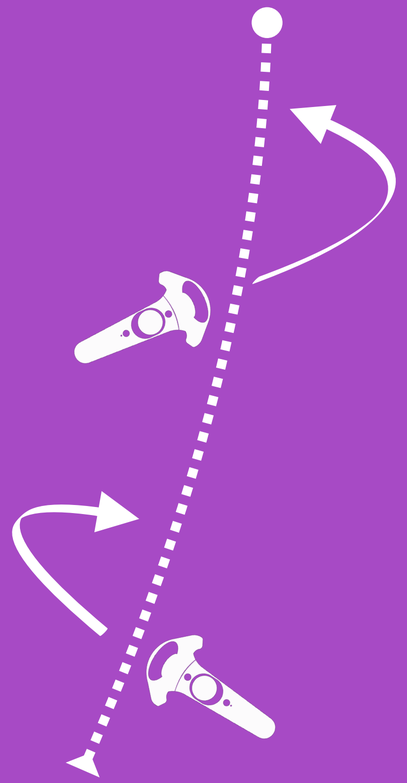
Coordinated

"*effectively* **organised** *so that* **all the parts work** *well* **together**"

Cambridge Dictionary



Example



A **coordinated** use of multiple controllers, such as:

- **Climbing** a virtual rope
- **Throwing** a virtual object from one hand to the other

Common **Motor Barriers**

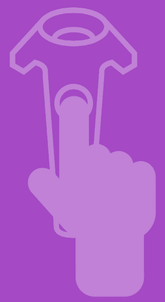
1

Holding

2

Orientation

3



Press & Hold

4

Multiple Input

Common **Motor Barriers**

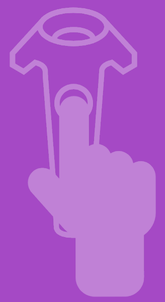
1

Holding

2

Orientation

3



Press & Hold

4

x2+

Multiple Input

5

Reach & Balance

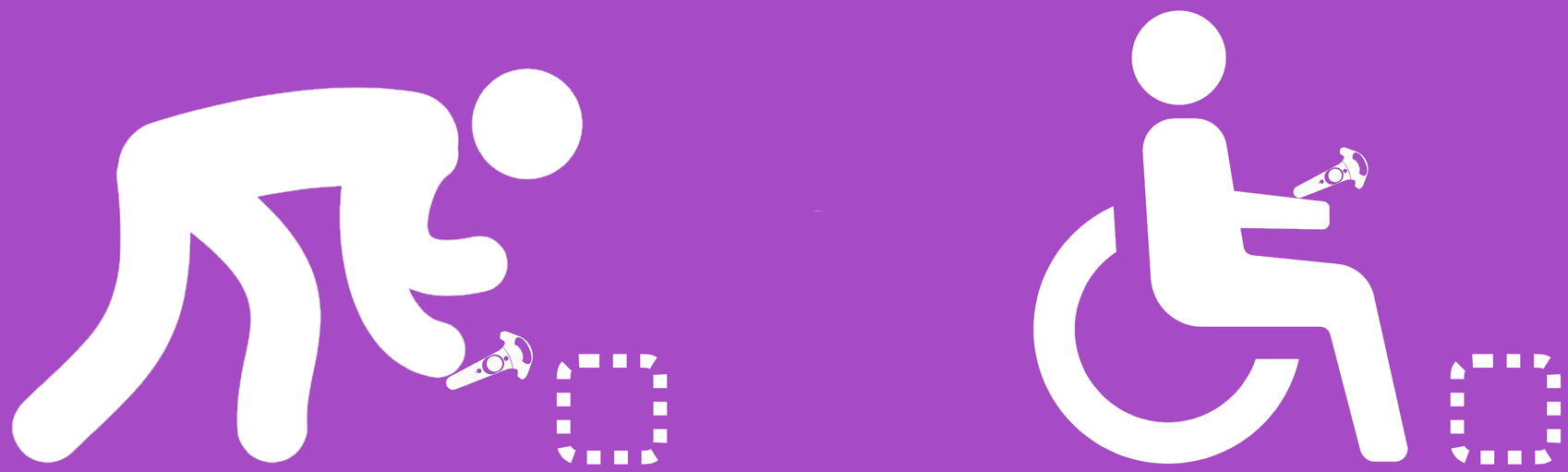
5

Reach & Balance

This barrier occurs when an experience requires the user to:

- **Reach objects** around them
- Reach the **floor**
- **Maintain** balance

Example



A user with balance or mobility impairments **drops a virtual object** and has to **pick it up from the floor**

Example

The user is unable to reach a **virtual object** within the environment from a **standing** or **seated position**

Example

The user needs to **maintain balance** while moving and interacting with virtual objects; such as **carrying an object** and **placing it into position**.

Common **Motor Barriers**

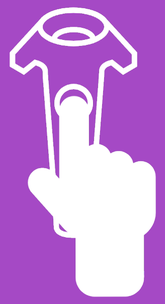
1

Holding

2

Orientation

3



Press & Hold

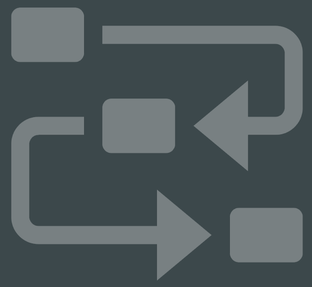
4

Multiple Input

5

Reach & Balance

Motor Barriers Deep Dive



~~Collecting the Data~~

~~Common Motor Barriers~~

Switch Control Schemes

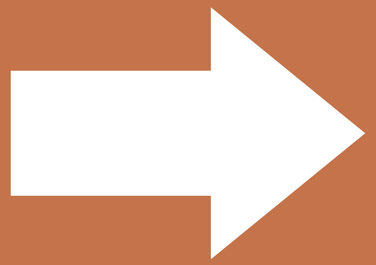
Switch Control Schemes

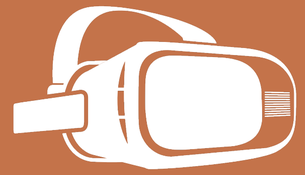
Out experiments with alternative controls

Solutions are not in scope for the project. These are not suggested solutions.

However, we had to solve some of the larger barriers in order to observe the smaller barriers.

The Goal





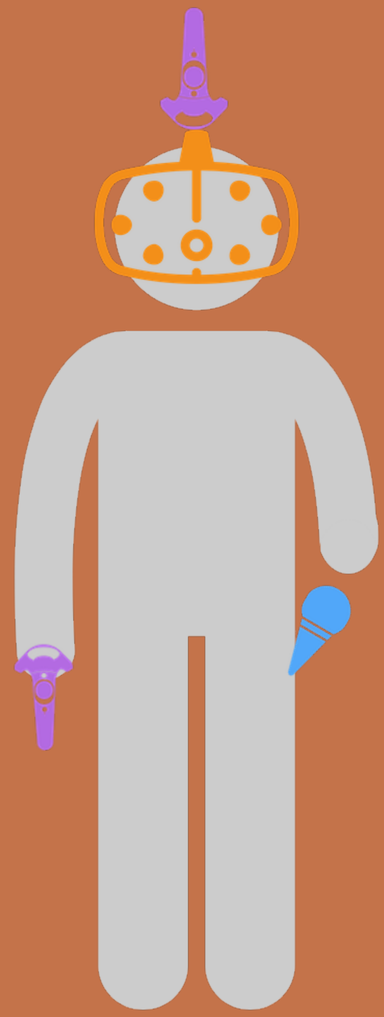
Press a switch in the real world

Something happens in the virtual world

Our approach focused on

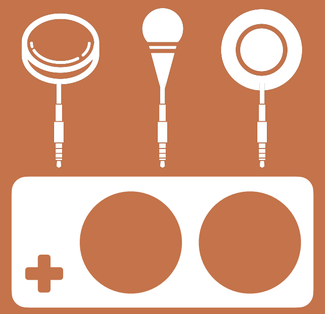
Control Schemes

A **control schemes** is a specific combination of hardware and software to interface between a user and the virtual enviroment.



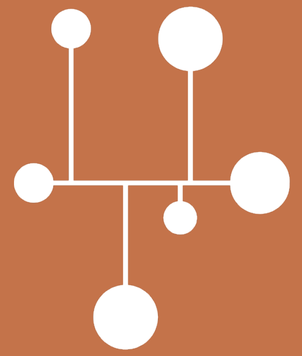
Control Schemes

Part 1: Hardware



Hardware selection & placement

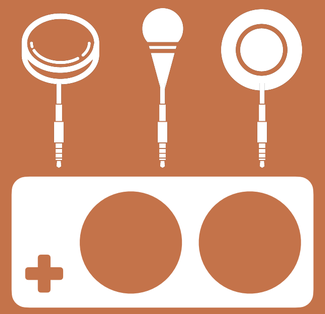
Part 2: Software



Mapping hardware to actions within VR

Control Schemes

Part 1: Hardware



Hardware selection & placement

- **Picking** the **switches** & where to **place them**
  e.g holding, pocket, attached to a chair
- Making **input visible** to the VR environment using a **controller base**
- **Map** between **hardware** controller button **being emulated**
  e.g left switch presses X button

Hardware end to end

1 + 2 The **Switch Input (1)** connects to the **Controller Base (2)**

2 + 3 The **Controller Base (2)** connects wirelessly to the **PC (3)**

3 + 4 The **PC (3)** connects to the **VR Head Mounted Display (4)**

Switch Types

Ping Pong Switch

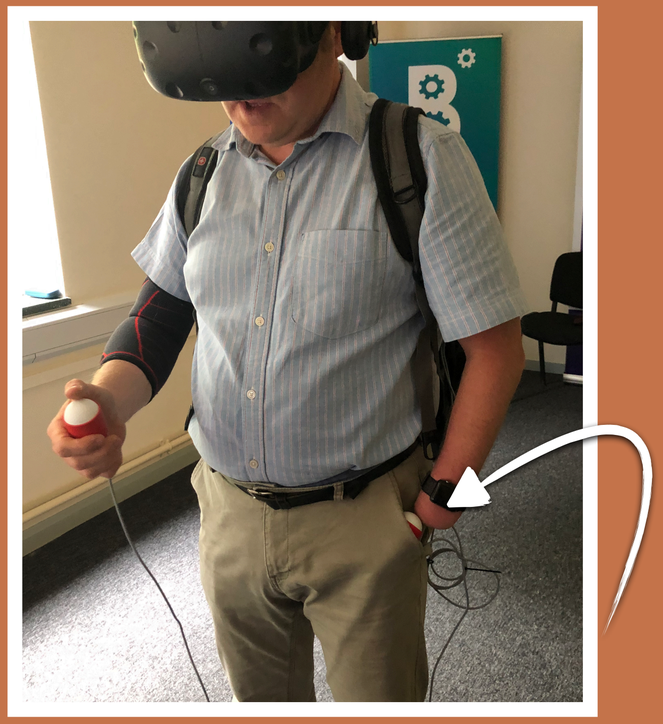
Controller Base (XAC)

“Lib Switch”

Switch Placement

Attached to wheelchair

Held in users hand

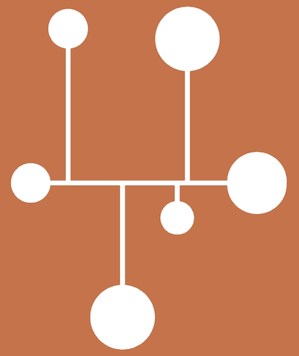


Placed in users pocket

Control Schemes

- **Mapping hardware** to **specific pre-existing actions** within the VR.
  eg. which switch triggers a teleport
- Adding **features** to the environment **specifically for switch use.**
  eg. press switch to reset user direction

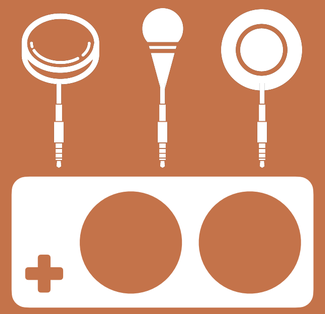
Part 2: Software



Mapping hardware to actions within VR

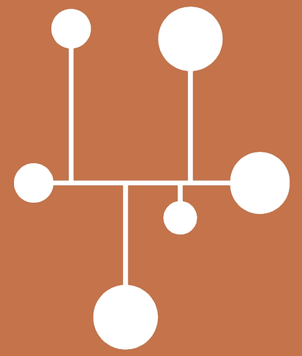
Control Schemes

~~Part 1: Hardware~~

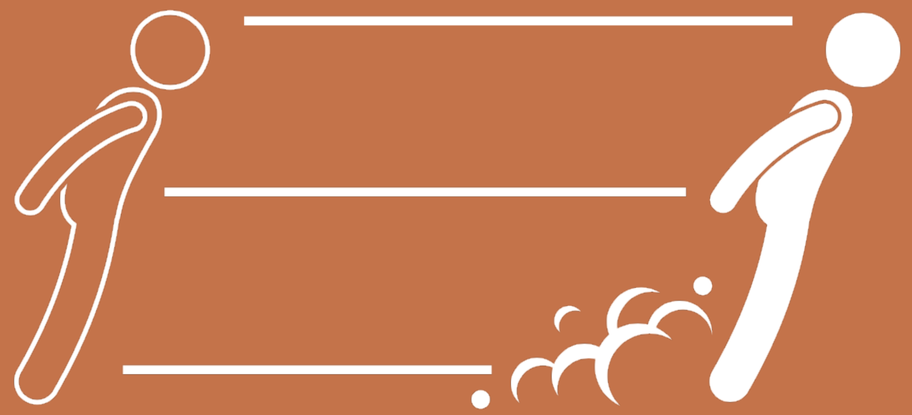


~~Hardware selection & placement~~

~~Part 2: Software~~



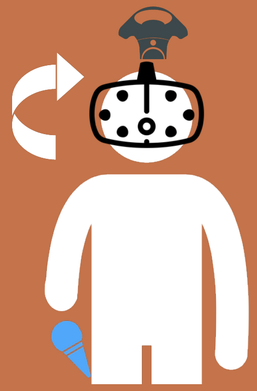
~~Mapping hardware to actions within VR~~



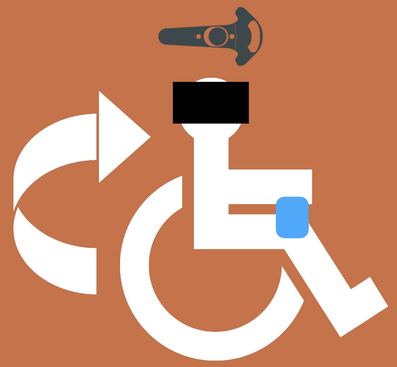
We developed **3 pre-build control** schemes which where then modified to suit each participants needs.

We focused on navigation / teleporting as this was the biggest barrier to achieving other goals.

Control Schemes Offered



Head Tracking + Switch Activation



Fixed Tracking + Switch Activation

Movement with buttons

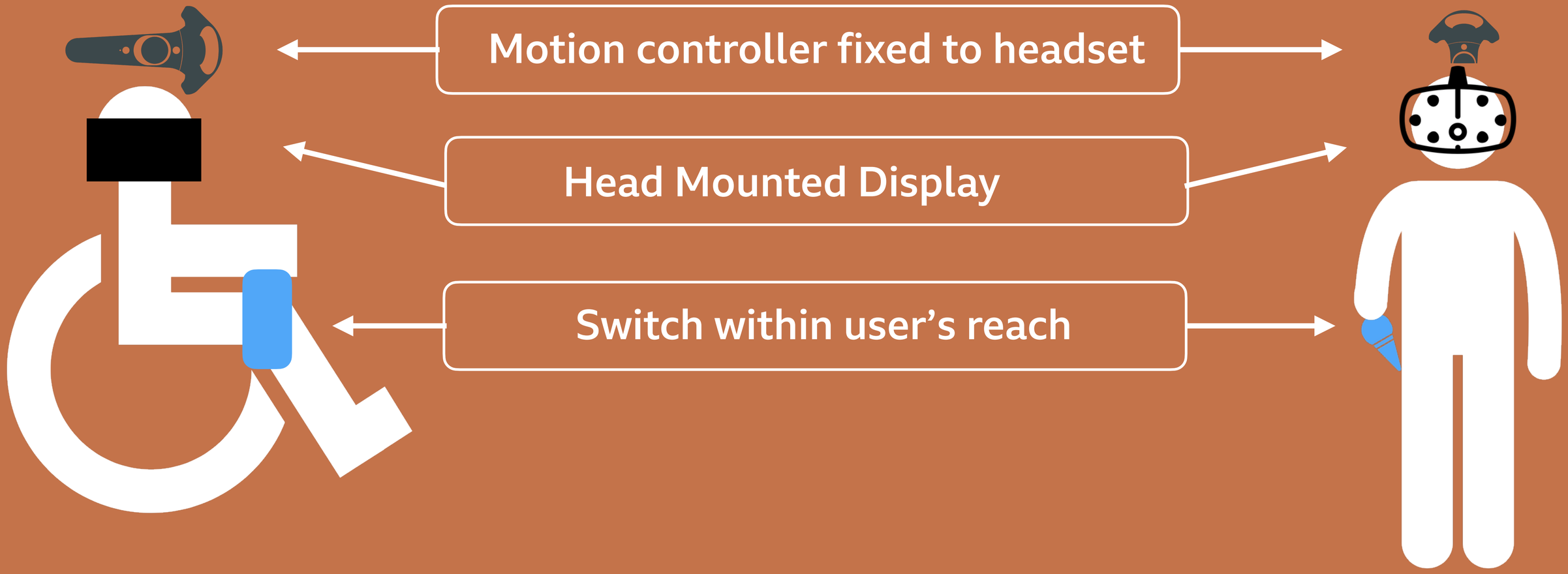
Control Scheme 1

Scheme 1: Head Tracking + Switches

The motion controller is mounted to the headset with a switch within reach.

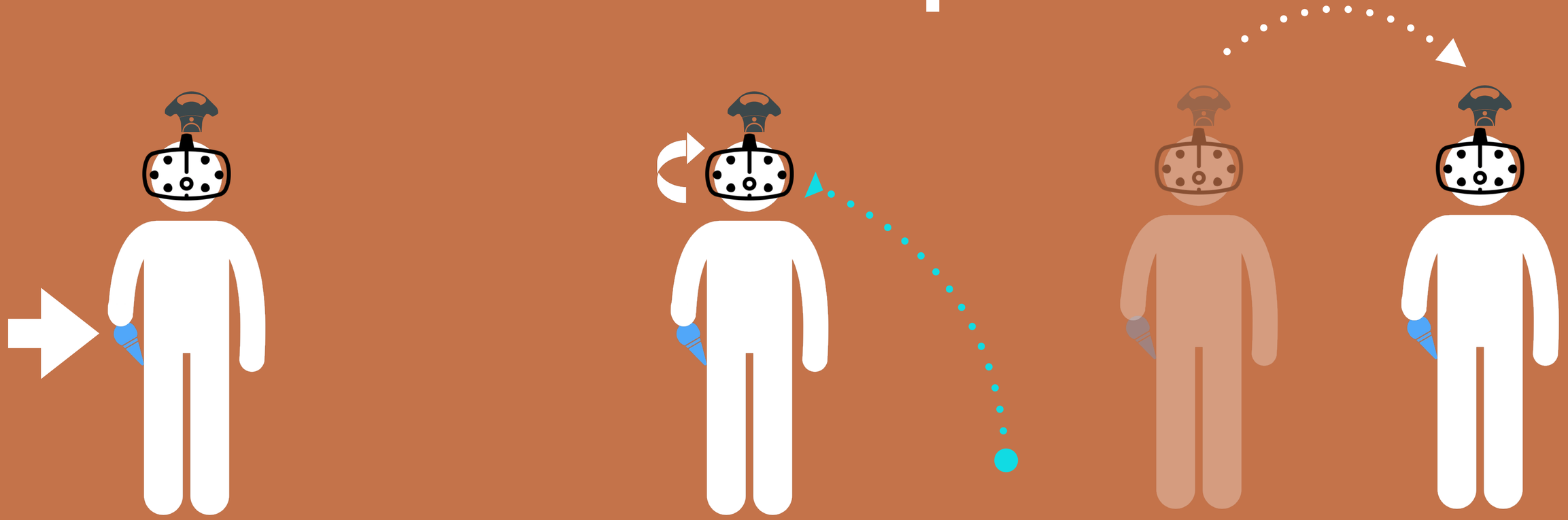
This control scheme was developed for participants who could not hold and orientate the motion controller but had good head and neck control.

Control Scheme 1



Control Scheme 1

How to teleport

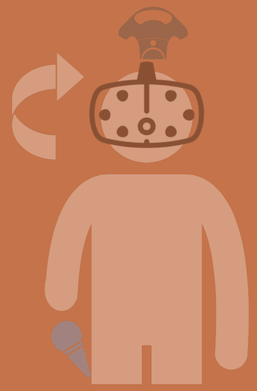


1. Press & Hold switch to enter teleport mode.

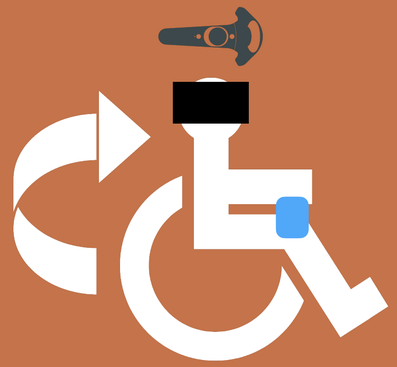
2. Turn head to select teleport location.

3. Release switch to initiate teleport

Control Schemes Offered



~~Head Tracking + Switch Activation~~



Fixed Tracking + Switch Activation

Movement with buttons

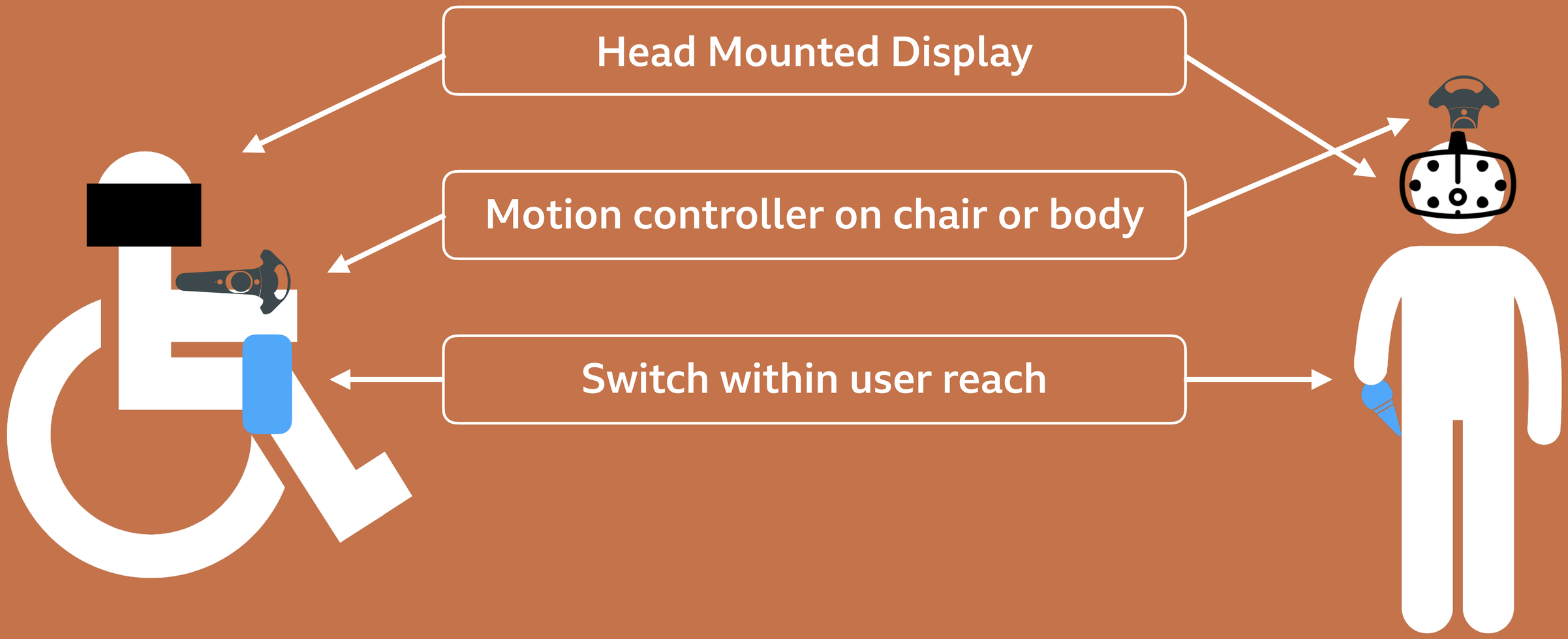
Control Scheme 2

Scheme 2: Fixed tracking + switch

The motion controller is mounted to the user’s wheelchair or body in a fixed position with a switch within reach.

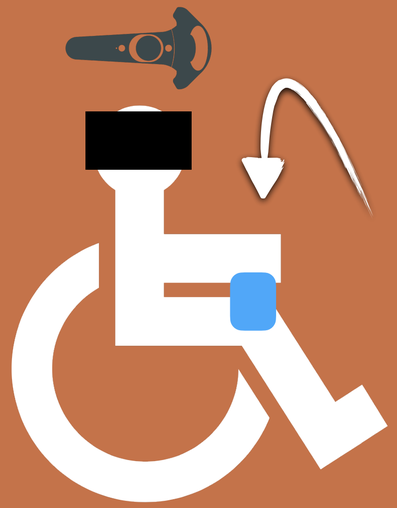
This control scheme was developed for participants who could not hold a controller or orientate it using any part of their body.

Control Scheme 2

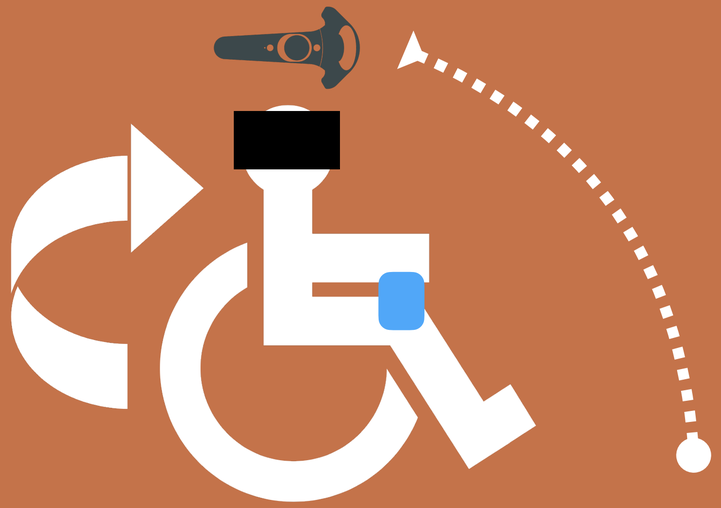


Control Scheme 2

How to teleport



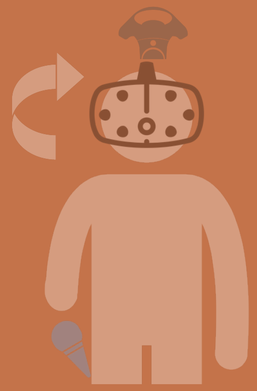
1. Press & Hold switch to enter teleport mode.



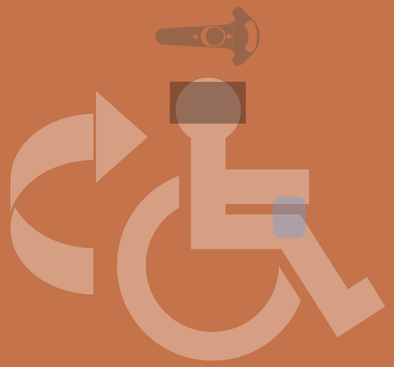
2. Turn chair or body to select teleport location.

3. Release switch to initiate teleport

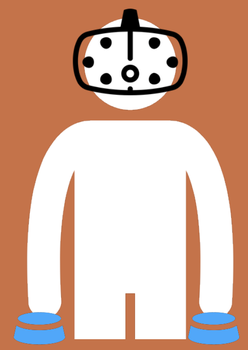
Control Schemes Offered



~~Head Tracking + Switch Activation~~



~~Fixed Tracking + Switch Activation~~



Movement with buttons

Control Scheme 3

Scheme 3: Rotate + Forward

No motion controller is used. Movement is controlled using switches alone.

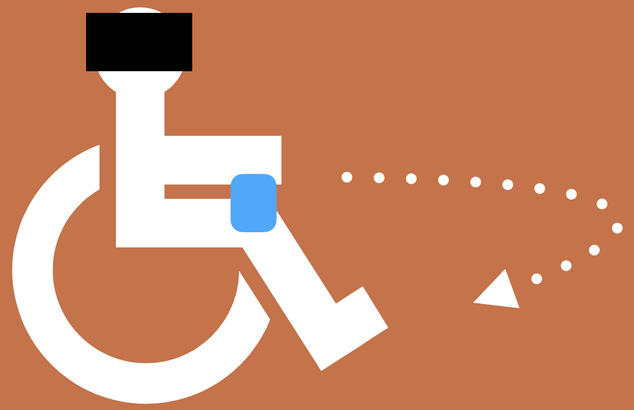
This control scheme was developed for participants who are unable to move.

Switch A:
Turn on the spot

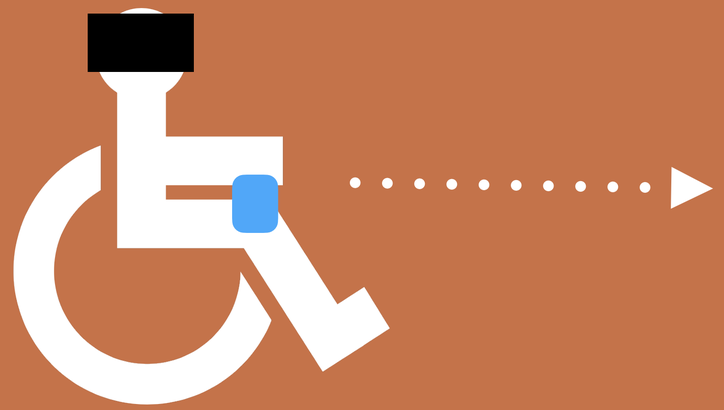
Switch B:
Go forward

Control Scheme 3

How to move

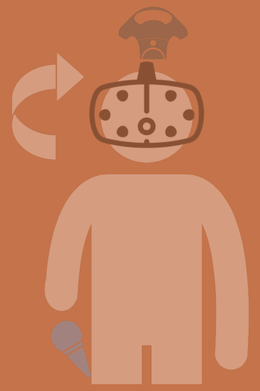


1. Press & Hold switch A to rotate in VR

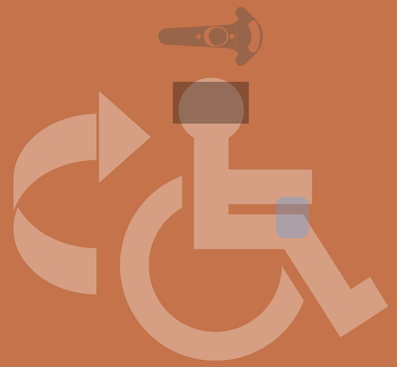


2. Press and hold switch B to move forward in VR

Control Schemes Offered



~~Head Tracking + Switch Activation~~



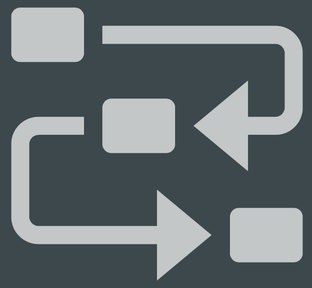
~~Fixed Tracking + Switch Activation~~

~~Movement with buttons~~

Control Schemes - Findings

- No single perfect solutions.
  e.g dynamic remapping, one button reset
- Needs change during the session
  e.g fatigue, different interactions
- Huge scope for innovation, barely scratched the surface.

Motor Barriers Deep Dive



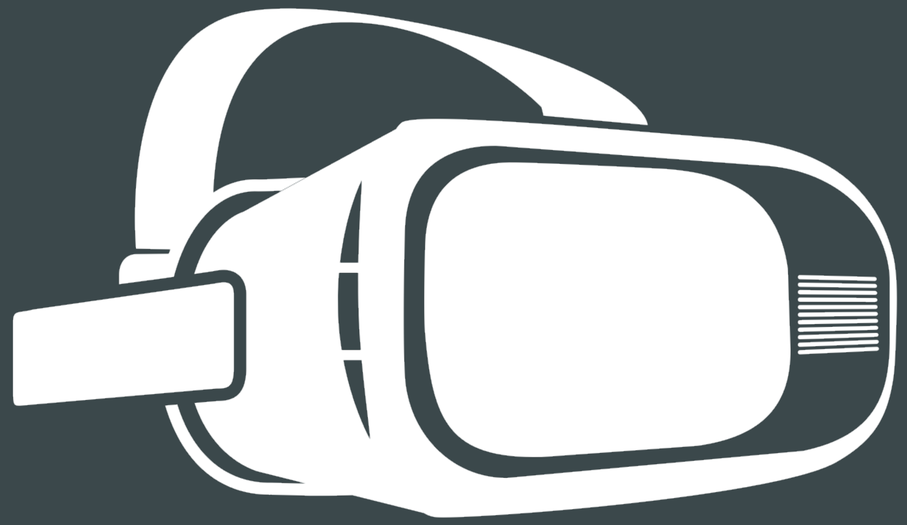
~~Collecting the Data~~

~~Common Motor Barriers~~

~~Switch Control Schemes~~

Extremely Encouraging

Participants describing VR as more accessible than the real world



VR is the creation of new **environments**

& the creation of new **barriers**

If we get this right we can turn **potential** into **reality** for **billions** of users.

Q&A