

# Architectural Design

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# Contents

<b>1</b>	<b>MoSCoW</b>	<b>3</b>
1.1	Functional . . . . .	3
1.2	Non-functional . . . . .	4
<b>2</b>	<b>Product Backlog</b>	<b>5</b>
2.1	User stories of features . . . . .	5
2.2	Initial release plan . . . . .	6
<b>3</b>	<b>Roadmap</b>	<b>7</b>

# Introduction

## Design Goals

The design goals are things we want to accomplish in terms of our design of the product. These can be divided in several categories.

### Fully tested and integrated

Every week a working build is produced with high coverage testing and integration with Unity Cloud Build. We must ensure that a user will not experience any system breakdowns or bugs. The people who will use our system are often mentally fragile and any negative experience can have longlasting or permanent negative consequences.

### Performance

Immersion is a key part of virtual reality and to get the best experience we need to deliver a product that can maintain a consistent and high frame rate. Since the Oculus Rift can display images at a refresh rate of 90Hz our product needs to be able to deliver a minimum frame rate of 90 fps.

### Tracking precision

We need to allow users to pick up items within the virtual world. Manus VR and the Leap Motion will allow these interactions with high precision tracking of the hand and fingers. The kinect will be used to track the rest of the body for extra immersion.

### Loss of tracking

Immersion can be compromised when we lose tracking of a part of the body. We can't prevent these moments when tracking is lost but since we have multiple tracking devices we need to use data of another device to fill in the gaps. If no data is available for the current position we can still predict the position using using old tracking data.

# Chapter 1

## MoSCoW

This chapter lists both the functional and non-functional requirements. The MoSCoW method is a prioritization technique, we divided our requirements into must, should, could, and won't have.

### 1.1 Functional

#### **Must have**

*Essential features required for a successful product*

- The user must be able to see his whole virtual body within the virtual world
- The user must be able to move his virtual body by moving his real body with the use of the Kinect
- The user must be able to move his fingers separately using the provided tracking hardware: Manus VR and Leap Motion
- The user must be able to pick up items using a grabbing gesture with his hands
- The virtual body must behave in a physically possible way, avoiding unnatural bending, and not distressing the user

#### **Should have**

*Features that greatly improve the quality of the product but aren't essential*

- The user's virtual body should not clip through objects in the virtual world
- Virtual items should not clip through objects in the virtual world
- The user should be able to put grocery items in a shopping cart or basket

### **Could have**

*Non-essential features that are only implemented if there is enough time*

- The body of the user could be represented by a realistic looking 3D model
- The user could move around in the virtual world with a controller
- The user could interact with objects in another way than picking up, like pushing

### **Won't have**

*Interesting features for future development that are not going to be implemented*

- The user won't be able to move around in the virtual world using a VR walking pad like the Virtuix Omni
- The hands will not get tracked when outside the vision of the leap motion (in front of the player)

## **1.2 Non-functional**

- The project must be developed on Unity3D
- Classes must be unit tested when not hardware related
- The frame rate must stay around or above 90 fps
- The final product should be finished before June 23, 2016, 18:55

## Chapter 2

# Product Backlog

This chapter describes the user stories. The features are sorted by priority from high to low.

### 2.1 User stories of features

1. As a typical user I want to interact (in terms of grabbing and dropping) with an virtual item in a virtual world in a realistic fashion.
  - This is the most important feature of the product. CleVR has stated that this is the main problem that must solved and the simulation of this must be as realistic as possible.
2. As a user I want to be able to see my own virtual body in the virtual world.
  - Since the focus of our project is on a working, realistic and interactable environment, the ability to see your own (part of the) body is of major importance to maintain a realistic setting.
3. As a user I want to be protected against visual glitches caused by loss of tracking, assuring a safe and visually realistic experience.
  - This is very important because we expect the user to have psychological issues, therefore we must be sure that no visual artifacts show during loss of tracking because this might cause more psychological harm.
4. As a user I want to be able to move my virtual body, while remaining in the same physical place.
  - While not the most important feature, the user should still be able to move through the virtual world. The location of the user in VR must only be altered if he explicitly wants to.
5. As a user I only want to interact with items that are set to be interactable, to prevent making a mess in the virtual world.
  - This may be in contradiction with the reality, but there has to be limits set on the extend to which objects in the environment are interactable with, both for performance reasons and to keep the virtual environment clean. CleVR has stated this as an feature that should be upheld.
6. As a user I don't want my virtual body to pass through other virtual objects, avoiding a ghost like appearance.

- To ensure immersion during the simulation, we must be sure that any body interaction in VR with virtual objects are treated realistically. This is an important aspect of the simulation that we should strive to achieve.
7. As a user I want to be able to use both hands individually to grab two different items at the same time during the simulation.
    - This is less important than the possibility to move and grab items, but should be included anyway since it could affect reality of the experience
  8. As a user I want to be able to pass an object from the one hand to the other during the simulation.
    - This is less important than the possibility to move and grab items, but should be included too both prevent a mess when the user tries to do this and to improve the experience.
  9. As a therapist I want to be able to use the product even when one of the hardware components (Kinect, Leap Motion or Manus VR) is unavailable.
    - Even though we cannot ensure the quality of the tracking when not all of the hardware is available, it does enable the therapist to use the product while waiting for a replacement. The priority for this feature is fairly low since it is not necessary for the basic functionality.
  10. As a user I want to be able to put the item I just picked up into a shopping cart.
    - CleVR stated that this feature should not be focused on and should be considered extra.
  11. As a user I want to be able to push the shopping cart to a new destination.
    - Moving the shopping cart will increase usability and immersion but as the shopping cart itself was already an extra feature this will not have a high priority.
  12. As a user I want the groceries I put in the shopping cart to stay in the shopping cart.
    - Just like stated in point 5 we want to protect the user from an unintentional mess and will have a high priority if we implement the shopping cart.

## 2.2 Initial release plan

**Sprint 1** Draft product plan, product vision

**Sprint 2** Basic Unity3D environment (empty room with item shelf).

**Sprint 3** System that can grab virtual items using Leap Motion.

**Sprint 4** System that can grab virtual items using Leap Motion and Manus VR.

**Sprint 5** System that can grab virtual items using Leap Motion and Manus VR and represent the physical body in the virtual world with Kinect.

**Sprint 6** System with updated supermarket environment with shopping cart

**Sprint 7** System with improved handling of tracking functionalities

**Sprint 8** Final product

# Chapter 3

## Roadmap

- Sprint 1**
- Set up GitHub repo, google drive and other platforms necessary
  - Product Vision draft finished
  - Product Plan draft finished
  - Architecture Design draft finished

*Relevant user stories: 4*

- Sprint 2**
- Setup Unity3D environment and project
  - Product Vision finished
  - Product Plan finished
  - Project Skills assignment 1 finished
  - Create a basic Unity3D map, does not contain any objects other than the player and a flat plane
  - Create simple controllable object to traverse the map for testing purposes

*Relevant user stories: 4, 5*

- Sprint 3**
- Basic visualization of hands implemented (rigged without textures)
  - Hand tracking and finger tracking with Leap Motion implemented
  - Integrate Manus VR finger tracking
  - Combine Manus VR finger tracking with the Leap Motion
  - Improve existing Unity3D map to represent a virtual supermarket
  - Implement picking up items using Leap Motion and Manus VR

*Relevant user stories: 1, 2, 3, 7, 8, 9*

- Sprint 4**
- Visual model of body finished
  - Integrate Kinect into system to provide body tracking for the simulation
  - Bind Kinect data to the body model
  - Optimize grabbing to prevent virtual hand going through objects

*Relevant user stories: 1, 2, 3, 5, 6, 9*

- Sprint 5**
- Testing with VR headset
  - Fix possible problems found when testing with the VR headset
  - Apply positioning and rotation of head tracked by VR headset
  - Prevent virtual body from clipping through objects

*Relevant user stories: 3, 5, 6*



- Sprint 6**
- Add a shopping cart to the environment, in which objects that are picked up from the shelves can be put.
  - Allow the shopping cart to be moved without creating a mess.
  - Allow objects to be passed from one hand to the other, without having to throw or drop it first.

*Relevant user stories: 8, 10, 11, 12*

- Sprint 7**
- Improvements on previously built functionalities
  - Implement input filters (if hardware loses connection or delivers strange input, solve this in a visually realistic way)
  - Optimize the system for combining all hardware components
  - Finalize all features of the system

*Relevant user stories: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12*

- Sprint 8**
- Improvements and bugfixes
  - Architecture Design finalized
  - Final Product

*Relevant user stories: 1, 2, 3, 4, 5*

- Sprint 9**
- Interaction Design Quiz (individual)
  - Final Report