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# Sync, Hug, Moclap, Action!

## An exploratory study of budget motion capture

Medialogy

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by  
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Aalborg University Copenhagen  
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## **Abstract**

This project looks at the difficulties that motion capture novices encounter when trying out Rokoko motion capture with Vive tracking for the first time. The thesis focuses on giving an overview of motion capture options that are available on the market but primarily on lower budget solutions for the actual experimental part of the study, specifically Rokoko smart suit. Through action research, valuable information on how the industry uses the equipment and what kind of considerations and problems that occurs under real use conditions. This study also performed a user test to see what problems novices encountered. It was found that most of the problems associated with the motion capture system derived from external problems that were usually not within power of the novice users to solve. The experiment showed that besides glitches and connection issues, users had more problems with the physical part of setting up than the technical part.

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# List of Abbreviations

**Mocap** - Motion Capture

**Vizarts** - Visualizations and Adaptive Real-Time Storytelling

**VFX** - Visual Effects

**CGI/CG** - Computer Graphics Imagery/Computer Graphics

**MoBu** - Motion builder

**Previz** - Previsualisation

**Post** - Post-production

**3D** - 3-dimension or 3-dimensional



## Chapter 1

# Motivation



Figure 1.1: Researcher in Rokoko smart suit. The researcher of this study wearing a Rokoko suit during a Vizarts event.

I have always had a love for characters. Started from very young by drawing creatures or pretend to be heroes or villains while playing with friends. This interest in characters developed into a passion for roleplaying games and taking on these characters as part of a performance for others. Finding motion capture as part of my study has opened the door to making these characters more real than ever before. I still think back fondly of the times as a child where we would play pretend. The development of low-budget motion capture makes these tools more available to people who have this same interest in using characters to tell stories. However, there is a technical barrier to using these technologies. Even

if you have an interest in motion capture, it can seem like a technology daunting to try to get into. I was, at the time of writing, starting a company, called Amunet Studio, together with three other graduates. The company works with film-makers to introduce real-time engines and new technology into productions to create a better and more efficient pipeline than the traditional one that many still use. As part of this company we also provide consultancy on motion capture and virtual productions.

There is also an academic angle to what kind of problems novice users commonly encounter while using motion capture. This both gives insight into what to prepare for and how to solve these problems so the novices and their intended production can benefit from the potential that motion capture has. Where lies the difficulties and what form does it take? Is it the equipment or the software? From looking at how users interact with motion capture, we seek to form a picture of what some of these answers are.

Knowing what kind of problems that the technology presents to new users can create an opening for people that already work within industries that can benefit from using motion capture. It might make directors and other content creators more willing to experiment with this technology as it is made more available. By indentifying the common problems, it becomes easier to address these issues. This can make it less of a technical obstacle to adopt and it might also become less of a risk to the production.

The research should form an overview of the kind of problems that motion capture presents. The information gathered for the study can potentially inform the presentation of motion capture and what aspects of the experience that can be improved to either make it easier to use or more novice-friendly.



## Chapter 2

# Introduction

"It is going to be cool; there are three different things that we are going to talk about. [...] They are coming, and they are coming fast" (Roble, 2018)

These are the words used by Doug Roble at the Oscars during the "Acting / Performance Capture: A Revolution in Technology & Collaboration" talk to describe the rapid progress we see in motion capture used in films, VFX, animation and games. He brings up three significant changes that are not ready yet for prime time but are on the horizon. He was talking about real-time motion capture, markerless motion capture only using a phone, and finally, the applications of these advances (Roble, 2018).

Andy Serkis, one of the most iconic current motion capture actors, speaks of how motion capture started in the medical industry and how it then moved into early game development and over time became this vast journey of evolution for the technology, which is the hardware, the cameras and the software that became what we are using today (Serkis, 2017). Because of these advances, it could be exciting and beneficial (due to the potential of low-budget systems) to look into the use of these motion capture tools in the industry and how they can be made more accessible to those who produce content whether that be games, movies or for other kinds of movement analysis. Also, the use of game engines allows for real-time pipelines where all changes are visible instantaneously, as can be seen in projects like Beehive by Glassbox which is a collaborative tool for syncing elements of virtual production to make it possible to streamline the real-time process in game engines (Glassbox, 2019). Up until now, these kinds of systems have been mostly possible through the use of programs like Motion Builder (section on Motion Builder is located on page 13).

Products like Rokoko's smart suit (Rokoko, 2018) and Ikinema's Orion (Ikinema, 2018) are trying to make budget solutions that are easy to

use. This approach has the potential of making this kind of technology more attractive to content creators.

However, based on personal experience working with the film industry and students in the film-making field, there is a great interest but lack of adaptation. Having had a chance to work with people that took the risk and picked up motion capture technology, it is fascinating to see how this trend can be spread to more people.

For this research the approach chosen was to find out different relevant aspects of motion capture. This includes looking at what solutions are available, what the strengths and weaknesses of the different types of motion capture are, and how it can be used. Going into this background analysis of motion capture the guiding direction was on how to make these systems more accessible and so working from financially easy entry point.

Based on the initial intentions going into the project, the initial problem that this study was trying to address was:

**How to make low-budget motion capture recording solutions more available to users?**

This thesis first goes into the background of motion capture and some of their application options. The background was used to understand the problem better and specify the final problem statement to focus on in the study. After that, with the use of the understanding from the background analysis, the methodology for the project was formed. Then the action research performed throughout the project is presented with a focus on experiences and lessons learned as well as related theories from work with motion capture. After presenting the practical experiences from the action research, the findings are used to design and create a guide showing how to set up and use Rokoko motion capture with Vive tracking. The following chapters describe the testing of the guide, where after the results are evaluated and discussed. Then everything is rounded off with a conclusion of all the findings and a proposal of how to possibly expand this study in the future.

## Chapter 3

# Background

This background chapter explains motion capture history, some of the available solutions and how motion capture is being used today and where trends seem to be going in the future based on state of the art projects and cases. To find out what technology can be introduced to the content creators, there first needs to be an understanding of what technologies are available, how they work, and are applied.

### 3.1 Motion capture

Motion capture is defined as "The creation of a 3D representation of a live performance. (Menache, 2000)" Motion capture is the tracking of the body and motions of people and animals, anything that moves. It is used in the medical industry and military for analysis of movement, that goes to evaluate and compare movements and use the data to further innovation in both fields (Kitagawa & Windsor, 2012). However, the motion capture that most people see and know of is the motion capture used in media, prominently in animation for movies and games (Serkis, 2017). Motion capture can be done in different ways, but are almost always done with the purpose of capturing the real rather than recreate it by hand as in traditional animation (Cooper, 2019). There are exceptions to this and most current motion capture data need some level of clean up or processing to be usable for media (See action research, Chapter 5, Page 25).

Motion capture is created by gathering information on different points on an actor's or subject's body. This process is usually done with sensors or markers placed on a suit or harness on the subject (Example of sensors from inside a Rokoko smart suit can be seen in picture 3.1 below).



Figure 3.1: Rokoko Smart suit sensors.

These sensors and indicators are used to create points in digital space that can then be used to form the movements of the subject as the points move. In motion capture, it is the movements of the points that are interesting and how they translate into a virtual space. These points are relative to each other and depending on the method more or less work needs to be done in post-production (or just "post" for short) to get a clear picture of what the movements would look like on a virtual representation (Kitagawa & Windsor, 2012).

Post-production is the process that takes place after the main bulk of the work for a media artifact. For a movie it includes the editing process where the different shoots are put together to form a whole and where it is possible to make changes to the product as a better picture of the whole is achieved. Sometimes it can be difficult to predict everything, and post processing tools allow editors and artists to "fix things in post".

After recording motion capture there will still be elements that are not exactly as required in terms of quality or features and so the motion capture data is cleaned up by an artist that fixes these elements. It is generally considered a rule during motion capture recording to get as close to perfect as possible to not push more work over on the animator. In many cases motion capture was used in the first place to reduce animator work.

With innovations in machine learning and computer vision, systems that can create motion capture data without indicators or sensors are starting to surface. Some of these systems that can create data from simple footage and that does not have the need for specialised equipment like most forms of motion capture (Roble, 2018).

### 3.1.1 Types of Motion Capture

There are four types of motion capture that are generally used; Optical systems, mechanical system, magnetic systems and inertial systems. While optical is the most common kind of system used professionally in the industry at this point, there is a surge of systems in the other categories starting to come out on the market (Cooper, 2019). Traditional optical systems take up much space and are not a very portable setup, which makes the other systems alternatives that provide different benefits. Here is a short run-through of the four main types of motion capture.

#### Optical Motion Capture

Optical motion capture is the industry standard currently and the most used for media application (Kitagawa & Windsor, 2012) (Cooper, 2019). The standard is still using systems that include multiple cameras and actors with markers on their bodies to work as data points.

The cameras in a traditional system are made to capture the light of the markers (Cooper, 2019). In a passive system, the light is emitted from the camera and reflected off the markers on the motion capture suits. In an active system, the markers emit light, and the cameras again capture that light. The system is developed to identify these points in space based on the light captured and is processed into digital space. This data can then be further used as motion capture points as they move in 3D space (Kitagawa & Windsor, 2012).

In modern systems, many cameras make use of infrared lighting while the first systems made by, for example, Vicon used ordinary LEDs. A significant drawback of using optical motion capture systems is the need for visibility making obscuring of points a common issue that needs to either be made up for during capture or in post-production (Kitagawa & Windsor, 2012) (Vicon, 2018).

These systems are usually costly and need at least three cameras to see each marker for the software not to confuse markers or for them to get lost (Cooper, 2019). This is why it is often an expensive and space intensive solution.

There is an evolution in machine learning and computer vision allowing systems to process footage without markers and use the data to map actors movements (Roble, 2018).

This type of motion capture falls under the optical motion capture category. It can be done with any camera, including those in smartphones, making it more portable than traditional optical motion capture and even less equipment is needed than from the other types of motion capture.

Facial tracking for motion capture also falls under the category of an optical system. Just like with the traditional motion capture system, it often makes use of markers on the actor's face to mark relevant movement groups in the facial musculature. While systems work better with markers, newer systems with the use of image processing can now work without markers. Often facial motion capture is categorised as specific capture or universal capture. Specific capture is when the system is pre-trained for a specific actor and need reconfiguration to work for other actors. Universal capture is when the system is made more general and can work for most actors without needing much pre-configuration. Universal often give less accurate and more general results, while specific facial capture often give better, more accurate results but takes longer to set up and needs preparation for each actor (Dynamixyz, 2018). There are multiple providers of facial motion capture such as Faceware (Faceware Technologies, 2018) and Reallusion's iClone software(Reallusion, 2018).

The development in optical motion capture using machine learning is not a new one, but now the technology and processing allowing these systems to be available for prosumers and in simpler forms for consumers on phones (Price, 2018).

### **Mechanical Motion Capture**

Mechanical motion capture systems are often made up of what is essentially an exoskeleton. It has straight rod elements and potentiometers that together measure the angle of joints and their movements in relation to each others placement. These systems do not have the risk of occlusion. However, they do not measure global transitions well. They are not influenced by magnetic or electronic interference, and they often work in real-time. These types of systems do not measure well when the subject leaves the ground while for example, jumping. Mechanical systems are often paired with magnetic systems or trackers to fix this problem and create a better capture. Often mechanical systems also restrict the subjects movements and these kinds of systems also tend

to have elements that are breakable on the subject making some scenes more difficult to capture without damaging the equipment (Kitagawa & Windsor, 2012).

### **Magnetic Motion Capture**

Magnetic motion capture uses sensors that track the signals of a low-frequency magnetic field created by a magnetic transmitter to define points in space. The information of the sensors are then gathered at a hub unit that sends the changes in sensor locations to a computer that can process and interpret the changes as movements and rotations in the virtual space (Metamotion, 2018a) (Kitagawa & Windsor, 2012).

Inverse kinematics is usually used to simulate the angles of joints as the sensors are placed on the elements that move like the forearms or thighs, so the system needs to make up for the bending points in post-production. As with most sensor-based motion capture with movement, the sensors also start to move during use around the body, which can result in inaccurate data and there needs to be made multiple recalibrations during a session. This type of system is influenced by magnetic fields and metal in the motion capture space, which can interfere with the data. It is therefore important to test locations out before starting the proper mocap sessions (Metamotion, 2018b) (Kitagawa & Windsor, 2012).

### **Inertial Motion Capture**

Inertial systems also called accelerometer suits (Cooper, 2019), use the orientation detected by sensors on the actor's body to detect rotations and placements in space. The information of the placement and orientation is sent usually wireless to a router that is connected with a computer, and the computer processes the data as motion capture points (Kitagawa & Windsor, 2012).

One of the benefits of sensor-based systems like the inertial system is that it can all be contained within a suit making it more portable than a traditional optical system. All that needs to be brought along is a suit and a laptop, and then it is possible to make motion capture practically anywhere (Kitagawa & Windsor, 2012) (Rokoko, 2018).

Many inertial systems are sensitive to metal and magnetic fields, just like magnetic systems are. Inertial motion capture is considered to need more clean up after recording the data in that it does not produce as high quality of data as tradition setups. Inertial systems often appeal

to low-budget productions or for previsualisation purposes, where after more expensive solutions can be used for the final product (Cooper, 2019). After getting a broad overview of motion capture, it would be relevant to get an idea of current motion capture and its' uses.

### 3.1.2 Current Motion Capture

Motion capture has evolved over the years starting from profile pictures of horse riders, to black suits with white stripes and then on to rotoscoping. It then moved on to motion capture that seems more like what is seen today, with markers on the actor's body and multiple cameras to capture the data to then later be processed (Kitagawa & Windsor, 2012).

Motion capture has come a long way, and today, multiple companies are all offering different solutions for motion capture, and it has developed into a massive market with many contenders and rapid innovation. Vicon has for a long time been one of the leading players on the optical motion capture market, being one of the first to sell optical motion capture systems commercially (Kitagawa & Windsor, 2012) (Vicon, 2018).

Today they offer different solutions depending on the needs of the consumer both in regards to the size of the system and complexity. They also create facial capture head rigs and sell software for facial tracking, allowing for full performance capture within the optical motion capture market (Vicon, 2018).

Alternatively, the company Rokoko makes use of an inertial system. Their system has the actor shown as a visual avatar in their smart suit studio software that in real-time retargets the data to a character on screen making it easy to see the resulting data and calibrate accordingly (Rokoko, 2018).

Motion capture is used in a lot of different ways that go beyond the conventional use for animation. It is also applied for interaction and live performances. Motion capture has, for example, introduced the concept of virtual YouTubers, who are YouTubers that use digital avatars to represent themselves on their YouTube channels. They use motion capture and facial mapping to make simple but effective animations of their alter egos (Ikinema, 2018). An example of a virtual youtuber that uses the Ikinema Orion system is Ao Hibiki (Hibiki, n.d.). There are many other virtual youtubers, but Ao Hibiki is one of the few that has made it official what equipment that they use for the motion capture. They are therefore of particular interest since the Ikinema Orion system is among



the equipment used as part of the presented action research with VIZ-ARTS in this study (See Vizarts action research in Chapter 5, page 27). While working on the different productions during the action research multiple experiments with motion capture were performed together with real-time engines.

## 3.2 Real-time systems

Motion capture can be difficult to operate. Usually when working with motion capture a real-time simulation of the actor is previewed as part of the setup. This plays into how useful real-time systems are to visualise the elements that are being worked with, moving it from thoughts and numbers of data to actual visual representations.

### 3.2.1 Game engines

Game engines are the toolboxes of game development. While some games are programmed from scratch, game engines give a lot of fundamental tools that make game development quicker and more accessible. All game engines have their advantages and disadvantages, their specialities and limitations. Many games are made with in-house engines produced by the game companies themselves while others are made by public engines such as Unity (Unity, 2019a), Unreal Engine 4 (Unreal Engine, 2019) and CryEngine (CryEngine, 2019).

#### Unity

Unity is used commercially by many studios to create 3D experiences and productions. These productions all range in production size and capacity of the studio using it. Used both by small indie studios like Playdead and huge AAA-companies like Activision Blizzard (Unity, 2019a).

Unity is a game engine which means it has a long history in games and interactive experiences, but it is also starting to make an entrance in the movie industry, as it is becoming a tool for production and previsualisation of animation films and effects. Unity is primarily C# based in terms of programming language.

Unity has, for some, become a tool for real-time film making. Unity was used to create animation films such as Soba production's *Sonder* (Soba Productions, 2018) and Oats Studios' *Project Adam* (Oats Studios, 2018) (Unity, 2019b).

While Unity is trying to provide tools for real-time film making its platform is still in development. The ever-changing nature of the engine could raise some potential risks if used for a long term production, as

versions change and new features are added, and old ones become redundant.

Unity also makes use of the ARkit, created by Apple (Apple, 2019), which they have shown allows for facial MoCap using the depth camera of the iPhone X directly and in real-time in Unity. It records and saves the facial captures and allows them to be baked onto the avatar, so the avatar can be changed without having to redo the facial performances (Unity, 2018).

Unity has a history as a free game engine that has made it popular not only among upstart game developers but also among artists and media scientists for creating prototypes and experimental systems. For example, Unity has been used to create non-game apps for education and home design with the apps Shapes and Kavtek (Singh, 2019).

Unity has started to promote itself more to the film industry. Unity has in the past been used by Digital Monarch Media to do work on *The Jungle Book* (Favreau, 2016), *Blade Runner 2045* (Villeneuve, 2017) and *Ready Player One* (Spielberg, 2018) using the Virtual Film tools that Unity provide. Unity is being used in the industry to create previsualisations of scenes and testing out different approaches (Technologies, 2018).

### Unreal engine

"Unreal Engine 4 is a suite of integrated tools for game developers to design and build games, simulations, and visualisations." (Unreal Engine, 2019)

This quote is how Unreal describe their game engine. The unreal engine was first showcased in the creation of the first person shooter Unreal in 1998 which the engine was named after. Unreal engine is owned by Epic Games and has been used to create multiple successful games such as *Fortnite* (Epic Games, 2017) and the *Gears of War* series (Epic Games, 2006-2014). Unreal engine is relatively similar to Unity and has also been working with virtual productions and how to unite film-making with the real-time capabilities of game engines. Unreal was used for productions such as the new *Planet of the Apes* trilogy (Wyatt & Reeves, 2011-2017) and *Thor: Ragnarok* (Pohl, n.d.). These tools are both used as part of VFX work and to create previsualisation. Previsualisation is described further below. The unreal engine uses C++ as its programming language but has a visual programming system called blueprints that make it possible to create games and experiences without writing a single line of code.

### 3.2.2 Motion Builder

Motion builder, originally called Filmbox back in 1994 where its development began, is now an Autodesk software that provides different tools for animators but is particularly known as a real-time animation engine that has for a long time been the connecting hub for different external software and inputs (Failes, 2014). Among the tools that Motion builder has are different filters and tools, specifically making the process of animating characters easier (Motion Builder, 2019). While it has a steep learning curve, it stands out based on these features that in skilled hands can save much time, which on productions also means money.

## 3.3 Previsualisation

Previsualisation is the act of invoking a production before it has been made. It is creating an idea of what the finished product is going to be like. In some cases just showcasing a single visual aspect as kind of a proof of concept or a short scene to test out composition and layout. Previsualisation is done in different digital media but also some physical productions such as in the theatre. Previsualisation can be an essential step to not only plan out the direction of productions but also test the general look of the final product. It can also make production pipelines more efficient, quicker and cheaper. With a solid previsualisation phase as part of the production, it will also very likely increase the quality of the final product as it allows for more iterations and changes before committing to a solution or decision. It can also help to create a reference for everyone involved in a production to make it brighter when talking about changes or plans as there will be a visual representation of the product that can be used as guiding points. It is not just for the director but also those involved with camera work, actors, animators, producers and editors.

It is also used to create benchmarks or vertical slices, which are terms used for proofs of concept pieces in games and film productions, for a production to have a visual pitch that can be shown to investors or consultants for the particular project. Often vertical slices are used as very short snippets that looks exactly like the final product, while benchmarks shows how far the visual idea can be pushed in a short amount of time.

Previsualisation is different from animatics which have been part of the animation pipeline in many years in the industry. Animatics are put together by the editors using elements from illustrations and storyboards to give an idea of the composition, timing and flow of the animation. Today animatics are used as a reference for the creation of a previsual-

isation, and in some cases, depending on the production structure and team they go directly to previsualisation instead of animatics because of how quickly and easily it can be done (Herr, 2018).

Previsualisation is usually done by creating a simple version of scenes. Previsualisation often tests out effects or scenes in a simple layout or tests out particular elements while the rest of the scene is made out in lower fidelity. With the development of more powerful GPUs and the use of real-time engines, it is possible to make changes almost instantly, and in some cases to be made as the scene is running. This real-time work process makes it easier to test out new approaches and get instant visual feedback that can be continuously tweaked until a satisfactory result is achieved.

### 3.4 Findings

So based on the information gathered during the analysis, the motion capture field is being used for many purposes and with a myriad of different solutions and systems.

- Motion capture comes in many forms. Some are more advanced while others are cheaper and simpler.
- Rokoko smart suit, in unison with Vive tracking, is probably the best system to use for this particular study. The availability of the system and having existing contacts with both the company Rokoko and knowing people that wish to work with the system makes it a good fit for this project. It fulfils all of the requirements for the project in that it is a low-budget system and so it is not only because of external benefits that it would be the best candidate.
- A lot of the available information focuses on the animator side of motion capture or the more advanced technical side. There is not much information seemingly with the focus of practical use.

### 3.5 Final problem statement

All of this background was based on analysis from the initial question:

**How to make low-budget motion capture recording solutions more available to users?**

After looking at the background for the initial problem statement and formulating the findings from this analysis, a more precise problem takes shape:

**What usability and technical difficulties occur for motion capture novices when learning how to use Rokoko smart suit and HTC Vive tracking?**

With this new question the focus becomes the difficulties that might decrease the availability for users. Finding and solving technical and usability issues before they hinder users lies at the heart of making a system inviting. This approach will look at what kind of problems that users might encounter while making their entry into the field. Rokoko smart suit and HTC Vive were chosen as systems as they fit the low-budget category. Moreover as part of the research it was decided to do action research cases with different partners that were interested in motion capture. These partners all used Rokoko which made it a good fit for this study. Following the formulation of the main problem, the next chapter will delve into what methods were used to answer the problem.



## Chapter 4

# Methodology

This study is the collection of data with motion capture, gathered in multiple ways to form a better picture of the availability of motion capture and what kind of problems they present. The process of gathering information has been ongoing since the start of an internship with the national film school of Denmark in the autumn semester of 2018. Based on the internship, a small study was made, which formed the basis for this thesis. Since then, multiple action research cases have been conducted with different partners, and finally, an experiment using Rokoko motion capture and HTC vive tracking were conducted.

While describing the tests, when referring to the "test conductor" the researcher and author of this study is the one that is spoken of.

As part of the project, two types of data gathering were performed.

1. action research cases were performed, as described in the action research chapter (See page 25). These cases were planned to collect information and practical experience with the motion capture systems that could later be processed and evaluated to formulate some of the difficulties that was encountered.
2. An experiment which would put users in a practical situation of using rokoko smart suit and vive tracking which could produce relevant difficulties that could then be documented as they are encountered under controlled conditions.

### 4.1 Research philosophy and approach

For this study, the research onion was used to form the basis for the methods and approach philosophy. A model illustrating the research onion can be seen in figure 4.1.

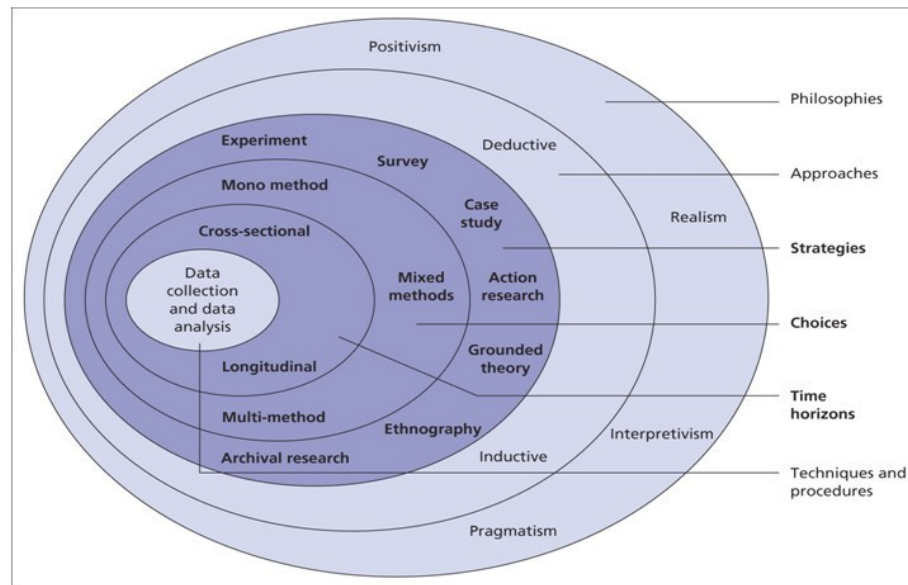


Figure 4.1: Research onion model. Illustrates the different layers of approaches and philosophies as it approaches the core of the scientific method which is data collection and analysis.

This project follows an ontological philosophy using the deductive approach, making use of surveys, experiments and action research to gather information. The data gathered are both qualitative and quantitative, and so the method types used are considered mixed. The project does not observe effects over a longer time, but takes individual samples of data and evaluate their instant effect. This short term data gathering means the study concerns itself with the data cross-sectional rather than longitudinally (University of Derby, 2019)(AllAssignmentHelpUK, 2017).

## 4.2 Target group

The project is targeted at motion capture novices. That means users that have not used motion capture equipment before. In most cases, it will not be directors or people that have a purely administrative or creative role in the production that will be using the equipment. So while the target group is motion capture novices, the users are still allowed to have a technical background since that will more realistically reflect the people that would use the guide.

For the test, information can be gathered from two groups; motion capture novices and motion capture experts. The novices comments and data were presumed to give mostly data about the usability of the guide, and how beginner friendly the equipment is. Motion capture experts,



on the other hand, would be able to give more insight into flaws and limitations of the guide, and how the guide would be used as a reference rather than a teaching tool.

### 4.3 Action research

The action research represented the bulk of the practical and technical research done during the project. The action research was planned to build experience with the equipment and learn of the problems that the system and motion capture process presents. The action research will be divided into an objective that describes a focus problem for that particular case, an analysis going into describing that particular case and what was experienced during its cause. Then each case will end with the findings of that particular case.

### 4.4 User experiment

The focus of this project is to test and evaluate the Rokoko motion capture system and the workflow guide created for this study. The workflow focuses on a minimalistic setup to present a simple and clear entry for novice users without overwhelming them with equipment and information.

For the user test, which has both quantitative and qualitative data gathering but focuses on the qualitative data. Participants were planned to be chosen through purposeful sampling (CIRT, 2019). The researcher should seek out a mix of people in the film industry that are either experts or novices with motion capture, that they believe have meaningful commentary to give about the setup and the subject.

The experiment aims to get around 5 participants. It is presumed that based on the guidelines of the Nielsen Norman Group (Nielsen, 2017) that around five users will provide enough data before hitting saturation. As most often after 5 users 80% of errors or in this case potential difficulties are encountered. Difficulties are what this test is looking for. Based on this it is considered that it could be more beneficial to potentially run more small tests with different changes, for example to the setup, the guide or who it is tested on. This would be the alternative to run the same test on more participants. The five users will be a mix of new and experienced users from motion capture to both get the opinion of novice users and more knowledgeable users. With more time, multiple iterations of the guide could be tested improving on it to try to eliminate these difficulties. In the discussion and future work chapters there will be a further elaboration on alternative methods and potential future iterations (see page 49 for the Discussion chapter or page 53 for the Future works chapter).

The gathered data should be representative of the usability of the equipment and the provided pipeline guide. The data is needed to create a base for which other guides and motion capture systems can be compared to in the future.

The reason that the project did not use Rokoko's video tutorials that already exist on youtube and their homepage is that they only teach about the use of the suits, not of the Vive trackers that are part of the motion capture virtual production setup. The analogue guide is a collected piece with all the information gathered in one place to make it easier to use.

#### 4.4.1 Test procedure

Below the precise plan made for the user experiment is described.

First, the participant will enter the room and will be given a moment to orientate themselves. The participant should feel comfortable in the test environment to simulate a natural situation. They will then be presented with the test and its content. Before the test starts, they will be given a consent form wherein they will be asked for their consent to participate in the test. The participant can choose to which degree they consent to be documented. They can choose whether they wish to be filmed and or photographed or neither. Their data will stay anonymous. No information about the test participants identity will be retained, and the recorded data will be kept strictly confidential.

Then they will be asked to answer a preliminary questionnaire. Following the preliminary questionnaire, the participant will be presented with a guide and the motion capture equipment. They will be introduced to what the different equipment is, but as for its use is up to the guide to inform them. A timer will be started at this point to time the participants' process to further get data on potential difficulty or experimentation with the system. The motion capture equipment presented to the participants will include a computer with Rokoko studio installed, two base stations, one Rokoko smart suit, two HTC Vive trackers (one of the trackers attached with a frame for the suit).

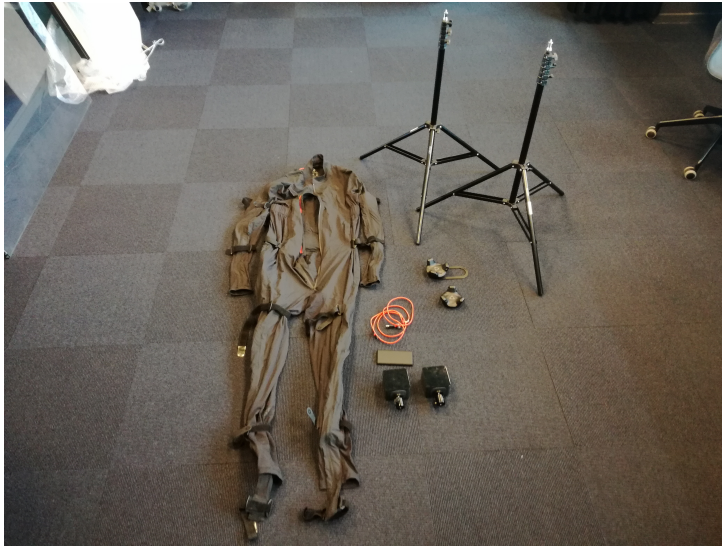


Figure 4.2: Motion capture equipment used for test. Lays out the motion capture equipment used for the user test.

They will be asked to follow the guide to set up and record a short bit of motion capture to see if they understand the guide. The tester will read out the specific motion capture tasks for the participants to record once the participant is done setting up and putting on the suit. These tasks are the same for all participants. Their tasks will be to prepare the motion capture suit, to make the system ready to record, to set up the virtual production with Vive trackers and to record four short bits of motion capture. They need to wear the suit to record this data. The four tasks that they will be asked to record are walking, waving with both hands, sitting down and jumping.

To ensure that the data is properly organised and to not give away confidential information as part of logging into the Rokoko studio software, the computer will already have Rokoko studio open with a project ready that is named corresponding to participant number and day of testing. Following the completion of all tasks, both setting up and recording, the participant will be asked to answer the post-experiment questionnaire. After the questionnaire, they will participate in a short semi-structured interview, and then they are done. The participant is thanked for their participation and asked to leave. Their setup will then be evaluated, rated and documented. Each task will be rated from 0 to 5, where 0 means nothing of the task was done correctly, and 5 means everything was done perfectly. The equipment will, after documentation be packed back down and made ready for the next participant.

The exact conduct of this test procedure can be found in the testing section on page 39.

#### 4.4.2 Data gathering

The questionnaire will gather information before and after the experiment and the evaluation of the participant's completion of tasks. The questionnaires will provide a combination of qualitative and quantitative information, while the evaluation will provide purely quantitative information. The test conductor will also take notes during the test and record the audio of the interview at the end of the test. The notes and interviews are purely qualitative.

##### Preliminary questionnaire

Demographic questions:

Participant number - (answered by the test conductor)  
 Gender - Male, Female, Other (fillable), Prefer not to say  
 Age fillable  
 Profession fillable  
 How much experience do you have with motion capture? (none)1-7(expert)  
 What is your expectation for working with motion capture as part of the test? fillable

##### Post-experiment questionnaire

Had you heard about Rokoko motion capture before the test? y/n  
 If yes, then from where? fillable  
 Have you worked with Rokoko motion capture before? y/n  
 If yes, then in which capacity? fillable

##### Likert Statements

I found the guide easy to use; (strongly disagree) 1-7 (Strongly agree)  
 The guide did not make it clear enough what I had to do;(strongly disagree) 1-7 (Strongly agree)  
 The guide went into too much detail when explaining the procedure; (strongly disagree) 1-7 (Strongly agree)  
 I found the language in the guide easy to understand; (strongly disagree) 1-7 (Strongly agree)  
 I found the equipment difficult to operate; (strongly disagree) 1-7 (Strongly agree)  
 I found the guidelines complicated to follow; (strongly disagree) 1-7 (Strongly agree)  
 There were terms in the guide that I did not understand; (strongly disagree) 1-7 (Strongly agree)  
 I had a good experience using Rokoko smart suit; (strongly disagree)

1-7 (Strongly agree)

If I needed to do motion capture in the future I would like to use Rokoko again; (strongly disagree) 1-7 (Strongly agree)

Final questions

What did you think of the guide? fillable

How long do you think you spend on this test since you entered the room? fillable

Is motion capture relevant to you, professionally or in a hobbyist capacity? y/n/maybe

How confident would you be if you had to set up motion capture again in a week without the guide? (Not confident at all) 1-7 (Very confident)

How confident would you be if you had to set up motion capture again in a week with the guide? (Not confident at all) 1-7 (Very confident)

Would you like to work with motion capture again? y/n/maybe

Why? fillable

#### **Post-experiment semi-structured interview**

At the end of the experiment, the participants will be asked to answer a few questions about the experience. These questions will have the purpose getting a more in-depth answer as to how the users experienced the process of setting up the equipment, where they had difficulties and how they felt about the form of the guide.

#### **Pre-structured interview questions**

How did you feel about the guide being analogue?

Did you feel like there were any loose in information because of the guide only having still images in comparison to a video?

What did you feel like was the most difficult part of the test?

### **4.5 Observations**

The test conductor will be observing the test participant and take notes of their process with the equipment. The notes were used both as part of data gathering and also as a reference for questions during the post-experiment interview.

The notes also worked as a personal reference for things to improve in future iterations. The test conductor also works as a support hub if the test participants need help. If the participants are unable to solve the tasks or encounter technical difficulties, the test conductor is there to help them so that the test can proceed with as little effect on the test

results as possible. The test conductors primary function is to document the difficulties and solutions that the users consider, and to only help when necessary.

## 4.6 Evaluation

During the test, the test conductor will observe and take note of the motion capture setup that the test participant performs. The criteria for the system to be set up correctly are:

- The suit is equipped correctly for motion capture | The suit has the battery in the right pocket and is connected. The headband is out of the suit, all zippers are closed shut, and the hub is on.
- It can capture suit data | Rokoko studio is on, and the preview character is connected to the suit in the software.
- Vive tracking is properly setup | A two Vive trackers are on, and one is placed in the upper pocket of the back of the suit, and another is in the middle of the setup. The base stations are set up correctly 2,5 m up pointing around 24 degrees down from horizontal towards the middle of the room. Virtual production is on in Rokoko studio, and all trackers and base stations are correctly visible in the scene.
- A short recording has been made | The participant has recorded four takes of motion capture, and it has been saved to the project.

With the plan for the project in place, the next step was to gather information about the industry, the users and the technical obstacles. The following chapter describes the experiences and findings during the different action research cases that were conducted before and during the project.

## Chapter 5

# Action Research Cases

As part of the study, work was done in collaboration with multiple people working in the entertainment industry or who were studying to later join the industry. During the action research, knowledge was gathered on what kind of problems that emerge while working with Rokoko and other motion capture system but also how to solve some of these problems as they occur.

Some of the observations done during the action research cases were during the recording of productions and so it was not possible at the time to do more in-depth tests to verify theories of what might cause problems at the time and make certain that the solutions found were based on isolated changes. This means that some of the solutions described here might not have been the actual cause of the fix and some unknown variable might have made the change but these solutions are described to the best of ability in relation the experience at the time. Similar issues might occur where these solutions do not work, but they serve as suggestions for what can be done to bypass problems and to create a better understanding of considerations to take while instructing motion capture actors and while planning motion capture.

Since these action research cases were performed personally by the researcher and illustrate a subjective perspective from working with the different partners, the following part refers to the researcher in the first person.

### 5.1 Action research Case: Internship at the national filmschool of Denmark

#### 5.1.1 Objective

**What are the personal first experiences with Rokoko as a new user?**

### 5.1.2 Analysis

Starting in September 2018 an internship programme was initiated with the national film school of Denmark as part of the 9th semester at the study. The theme of the project was story worlds, and as part of the programme, six groups were created with the intent of creating a learning experience and producing a short animation vertical slice for each of the groups. Each group had a director leading the team together with a technical director. Besides those two roles, each group also had a 2 - 3 CG artists. Besides the six groups creating the productions, there was also an R&D group. The R&D group's purpose was to create tools and provide technical help to the groups when they needed it. As part of the R&D group, there were different responsibilities to be taken early on in the process. Taking on the role of motion capture technician an opportunity to get familiar with the equipment presented itself. An academic report was created as part of the programme also focused on the use of motion capture, and this research formed the basis for the personal experience and knowledge of motion capture initiated this study. During the programme experiments with real-time motion capture in unreal were performed using Rokoko smart suits and forwarding data from Rokoko studio into the Unreal Engine. Some of the experiments were successful while others were not, but this process also formed some fundamental rules for how to work with Rokoko and what to consider as part of the setup procedure and the pipeline when using motion capture.

### 5.1.3 Findings

## 5.2 Action research case: Working with Allan O. Luckow, Clubhouse

### 5.2.1 Objective

**What are the requirements for motion capture at a professional set?**

### 5.2.2 Analysis

Some of my associates and I all got invited by Allan O. Luckow to a project involving real-time motion capture for a music video. The music video in question was 4livet/Capitan by Sivas (Sivas, 2019). Firstly our role was intended to be as spectators but as the project turned out to be missing elements that we could provide to make the motion capture part of the production possible we took a more active role in the preproduction of the motion capture setup. Our company, Amunet Studio, also appears in the credits for the video. The project was missing a model, and there were problems with syncing up the position of the



suit, actor and camera in relation to the position of the virtual character in the space used to render the character. The character also needed proper rigging to make it usable with Rokoko, which was the used motion capture system for the project.

Working with Allan O Luckow at his workshop gave an exciting look into the equipment that at our university would usually be something that would be needed to build by the students. Here was a chance to see professional equipment used to a professional capacity. It was encouraging to see that it was too different from the conditions and equipment available at the university but there was access to more expensive equipment and it also gave insight into another philosophy than what would be standard at the university. "If you lose a recording then you are done in the business," Allan said which makes complete sense. Productions are massive and are incredibly expensive. Every recording lost is time and therefore money lost. At the university, we are always testing and trying out things. If something goes wrong, we can try again, learn and improve from the experiences. While working with Allan O. Luckow, he showed a great interest in what can be done with Unreal. In his experience, there are not many in Denmark that learn how to use that particular engine for technical film productions and instead chooses to use Unity. In his opinion, Unreal is a powerful visualization engine, and more should look to get into the engine in Denmark rather than bind themselves to Unity even if it has its roots and headquarters in Copenhagen. While most of the experiments with a virtual camera that was done with Allan O Luckow was done in Unreal, the music video was done with Unity.

### 5.2.3 Findings

- The film industry has different philosophies from the academic world. While they can still work well together its an important consideration going into such a work environment or partnership.

## 5.3 Action research case: Working at VIZARTS

### 5.3.1 Objective

**How different is Ikinema to Rokoko in setup and how does it compare at a glance?**

### 5.3.2 Analysis

For the major part of the duration of this project, I worked as a volunteer at the events facilitated by VIZARTS that looks into the use of

current technology for media-creation. The ultimate goal was to use the knowledge gathered at the events to formulate and produce a real-time adaptive story world. While the concept has much grounding in existing media, the implementation of an actual real-time adaptive story world is yet to exist. During my work with VIZARTS, I made some observations about the use of motion capture. Both some of the possibilities with the method but also some of the problems that arise while using different kinds of motion capture. To be specific, I made use of the Rokoko smart suit and the Ikinema Orion set up. The Ikinema Orion yielded surprisingly precise and consistent motion capture data. As part of Vizarts presented an array of exciting challenges. Setup up Rokoko with virtual production in Unity was one of those projects. Another project was to combine 3d avatars and real-life actors in real-time in a virtual scene using green-screen.

### 5.3.3 Findings

- The difference between building keying methods yourself and using the tools that are pre-made and tested.
- The procedure with motion capture equipment and making it communicate with other software or hardware is crucial. While the system itself should allow for differences in the steps sometimes taken, elements of the process make it impossible to do in any other way than those that you find from trial and error.
- While working with Unreal, it is vital to keep an overview of the different elements of the scene and project that you are producing. For example, it is important to understand the game mode that is being used and the scene blueprint. Also, when using things like the media player component, it has a particular setup that if not set up correctly needs the user to change the capture device stream setting after the project is running. So it needs to be changed in run-time which if not in a development environment is not possible in most cases.

## 5.4 Action research case: Production work with the National film school of Denmark

This project is in big part motivated by the work done with the national film school of Denmark. I was initially starting to use motion capture as part of my internship at the film school, which ignited my interest and was the primary reason I worked with it.

A big problem with using Rokoko turned out to be the general inconsistency of the system. Every patch changes significant parts of the software and add new features or tries to fix existing problems. Over time software gets updated, and it might present problems. These changes in the software made the process of working with Rokoko unreliable and troublesome. I have been lucky and have been able to use all of the equipment for free and to be working directly in collaboration with Rokoko which has both made it possible but also given me an insight into the workings of the system and access to experts that are producing the motion capture suits and software. During my work at the film school, I assisted on two projects. One was a production called "Ibbermand", where I worked as the mocap technician. They wanted to create an animated rotoscoped motion capture character that should be part of a real movie. The other project was an animation film called "U C ME?", where I was the technician responsible for motion capture at the set during the recording of the actors.

I was asked to make a workflow plan and guide for the "Ibbermand" project and received a workflow procedure for the other project. These two documents helped to make the foundation for the overall guidelines used for the experiment of this study.

#### 5.4.1 Action research case: Ibbermand Production at the national filmschool of Denmark

##### Objective

**what is the pipeline like for Rokoko motion capture with Vive tracking for composite productions?**

##### Analysis

During the production of Ibbermand, there were multiple opportunities to test the Rokoko suit and Vive tracker setup away from studio conditions. Early in the preproduction, it was clear that it would be difficult to allocate enough time from this study to work full-time on the production. This lack of time meant that during this time of the production, an operator for the motion capture equipment needed to be taught. A candidate was found that was studying at a film university college (or Højskole) that was located close to the place of the shooting and he had a preexisting interest in technology and VFX.

Teaching him to become a motion capture operator gave information on how to teach the systems to new users and what kind of problems they would have with the equipment. The process of teaching him included an initial session of just showing him the setup and teaching him how to do it too. Afterwards, he was taught how to operate the software.

After having tried to set up the system a couple of times, he built a familiarity with the system and became proficient in identifying problems and think of potential solutions by himself. During his learning period, he was asked if he had questions or if anything stood out as confusing or difficult to him. He mostly had questions that were about the computers used with the system and about the hypothetical situations with the setup. Already having experience in film-making in different roles from his time at the university college he knew a lot about the traditional procedure which became valuable information in how to write the guide and how to make the motion capture process more efficient.



Figure 5.1: Image from motion capture interaction test. Still image from one of the test recordings at the national film school of Denmark for the project Ibbermand. Specifically for a test scene where the virtual character needs to interact with the real actor.

The production needed the motion capture to be recorded on location, which presented multiple problems that gave new experience with the system and lead to compelling solutions to problems that would not have been encountered during studio conditions. During the test setups, it became clear that there was a power problem that needed to be addressed concerning all the power cords that needed to be dragged around on set to power the base stations of the Vive lighthouses. To fix this, it was suggested to add batteries to the lighthouses so that we could move them around without having to relocate cords.

Another problem was the minor vibrations that the lighthouses produce while running. If the base stations are placed high up on a tripod as they are in most situations, uneven ground can cause the lighthouses to generate resonance in the tripods, increasing the intensity of the vibrations. These vibrations can cause the system in the lighthouses to

incorrectly detect changes in their placement and so try to recalibrate the Vive room setup. Because the vibrations continued for as long as the system was on, the system continued to try to recalibrate the system which interfered with the recorded motion capture data.

Other important considerations are the distance between the suits and the router being used. The distance can cause glitchy or choppy data while using the full setup with Vive trackers but also increases character sliding and worsen the local placement of the suit when not using Vive trackers.

Something that was new to the team and became something everyone needed to learn to consider was the view of the lighthouses. The lighthouses, even though hanged high from the ceilings would get blocked by lighting equipment and tools usually used by the camera people. It became a balance of having to make a live-action movie but also needing the Vive equipment to be usable. The house used as the location for the movie was small and had multiple small rooms which gave restricted space for the Vive setup and film equipment. The lack of space also meant that at many occasions, it was necessary to call out to clear the room so that we could ensure a free view to the trackers while calibrating.

Because the Ibbermand production is using a kind of rotoscoping technique to combine 3d animation and live-action film the motion capture data and the live movie recordings needed to be synced in post. To give the post-production team something to work from it became a routine for the motion capture actor to walk into the scene clap and only then take their starting position. This routine would make it easier for the sound and the motion capture, and recorded footage to all be synced up. This step was called a "moclap" as part of the recording workflow.

While filming at the location, bad data started to occur. While filming a scene where the actor had to sit down, the data would start spinning the avatar's legs around them, pivoting around the pelvis. First, a couple of actor related solutions were tried, such as changing their leg position or make them sit on a pillow to have the actor sit higher than their legs. In the end, it was noticed that one of the sensors on the hip was registering poorly, and its checklist stated that it did not trust the local setting. This lead to an attempt to fix everything by giving the actor another suit to wear. There were multiple suits available at the location, so it was not an issue besides the time it took to get them out of the suit, into the new one, getting them calibrated and getting them a microphone in the new suit. Changing the suit fixed the problem.

Earlier that day there were recorded bad data which at the time was circumvented by changing the actor's actions in the scene, but after the positive result from changing the suit, it was discussed that the poor data earlier probably also was because of the faulty sensor in the first

suit. During a shot outdoors frame drops on the mocap data started to occur. We did not use Vive trackers for this scene and used the suit alone without any tracking besides the signal send from the smart suit itself to the router. The actor in the suit was asked to step aside from the rest of the crew while still in the suit to try and triangulate the problem. When that did not change the problem, the production was set on standby, and the actor moved up to the mocap station. The data became good again as they approached, and it was concluded that it was a problem with the distance. While the system had proven during tests that it could reach for a surprisingly long distance, the data seemed to get consistently worse as the actor got further away.

It was also a very windy day, and while that should not have an influence on the sensors or transference of data, we still considered that the poor weather conditions might affect the system. During the test where the data stayed good even on a very long distance, the weather was much less windy, and therefore the thought.

During the last day of recording problems were encountered where the preview character would start to drift. After some consideration, it was suggested to make the actor stay aware of how they walked and make more defined steps during the scene from then on. Making the actor change how they walked improved the data substantially. The character, Ibbermand, who the motion capture was for, had a very particular movement pattern. These patterns included restricted and heavy movements and at other times very strained and stretched movements. For the particular scene, the actor was dragging their legs while walking around the house. This dragging seemed to confuse the system as it could not determine where the character was in space based on the locomotion since the contact with the floor was not as defined from the walking pattern. This walking pattern was most likely what caused the drifting of the character.

#### **5.4.2 Action research case: U C ME Production at the national film school of Denmark**

##### **Objective**

**What is the pipeline like for Rokoko motion capture with Vive tracking for animation production?**

##### **Analysis**

During the recording of motion capture for U C ME extra workflow steps emerged. The production used three actors in motion capture and with head-rigs for facial capture. As part of the calibration, an extra step was added to test the spacial relationship between the data from the three suits. After every calibration, the actors were asked to "hug",

which meant all three of them had to gather, stand in a circle and hold on to each other's arms as if group hugging or huddling together. This method could tell us if the character data worked in terms of spatial positioning of the avatars, but also how well calibrated the characters were for interaction with each other. It worked as a kind of extended step to test the range of motion and give an idea of the data quality. To sync up the motion capture and the facial capture which was recorded with separate programs actors did what we called a "moclap" which in this case was the actors in motion capture clapping and blinking at the same time so that the data could later be synced up.



Figure 5.2: Image of actors on U C ME performing a calibration hug. Used as a reference while calibrating to determine spatial placement in relation to the different actors and precision of interactions.

### 5.4.3 Findings

- Once again it became clear that the philosophy of the film industry and the academic world collided. While the university had fathered a doctrine of "Its always in beta", the film school had taught the idea of "if something does not work contact the people so you can get something does". With this experimental equipment, there is no easy fix. All you can do is work with it. This condition is not what all are used to in the film industry, which is important to talk about early on while setting expectations.
- At a film set everyone has a function, and so it is not the director or other people at the set that comes in to operate the motion capture system. The director and producers need to feel confident in the abilities of a technician or operator that is going to work

the motion capture system. Therefore it the guide should try to appeal to all motion capture novices but presume some technical foreknowledge since it is almost certain that it is going to be technical people that take on the responsibility of working the motion capture equipment.

- Many elements can play into the quality of the motion capture data recorded from Rokoko. Sometimes problems can be solved by restarting the system or keep retrying the same procedures. Other times the problems can be solved physically by changing something in the setup. Because of the nature of Rokoko, there are also cases where the problems are just part of the software and how it works. In those cases, the solution is to work around it by using another version of the system or changing something substantial in the setup. In other cases, the solution can be to wait for Rokoko to fix it with an update. It is however also part of the experience that sometimes the system is only made less usable with new patches, or something else is broken, so it is better to stay with the old version where it is already established what the problems are.

The next step was to implement the knowledge and design the guide using all of the findings and experiences gathered from the action research cases, that would be the output of this study. The following chapter goes into the design consideration of the guide and the implementation of said guide.



## Chapter 6

# Design and Implementation

The purpose of this study is to answer the problem statement formulated in the background chapter (See page 5). The problem statement is repeated below:

### 6.1 Problem

**What usability and technical difficulties occur for motion capture novices when learning how to use Rokoko smart suit and HTC Vive tracking?**

The basic setup for using Rokoko with Vive tracking is a setup similar to the one used for both the Ibbermand and U C ME projects. The setup is scalable in that there can be added more lighthouses to improve spatial coverage, added more trackers for objects to the scene or virtual camera and more suits to allow more actors to interact in the scene. While these equipment elements might increase the setup stays virtually the same, meaning if the standard setup can be taught it properly, it should, in theory, allow for easy access to the bigger setups with more lighthouses, suits and or trackers.

Rokoko already provides tutorial videos, but they do not show how to use the Vive trackers with the setup. That needs a separate guide that they have made which still needs external guidelines from HTC Vive on how to set up the base stations. At the time of writing its still a relatively new feature to the Rokoko system to offer virtual production using the Vive trackers. During the action research done as part of the project, some experiences and lessons turned out to be invaluable in being a time of practical learning with the systems but also providing insight shaping what became the final problem statement.

## 6.2 Solution

So to teach the system, a guide was created. This guide needed to convey large amounts of information and needed to take into account that some users might run into problems that could potentially hinder further progress.

## 6.3 The Equipment Setup

For the test, it was important to consider the specific setup to be presented in it. The setup needed to be scalable and to offer a level of versatility that could make it applicable to more production. Most productions have particular needs, so the setup had to allow for some customisation. For this setup, it was decided to stay with a duo base station setup. The setup was the most simple and minimal requirement system to record Rokoko motion capture using HTC Vive tracking. At the same time expanding the setup to three or four base stations instead made no difference for the setup itself except needing to connect power to more lighthouses and setting the area up. With three lighthouses, the work area was shaped like a triangle while it became shaped as a square when using four.

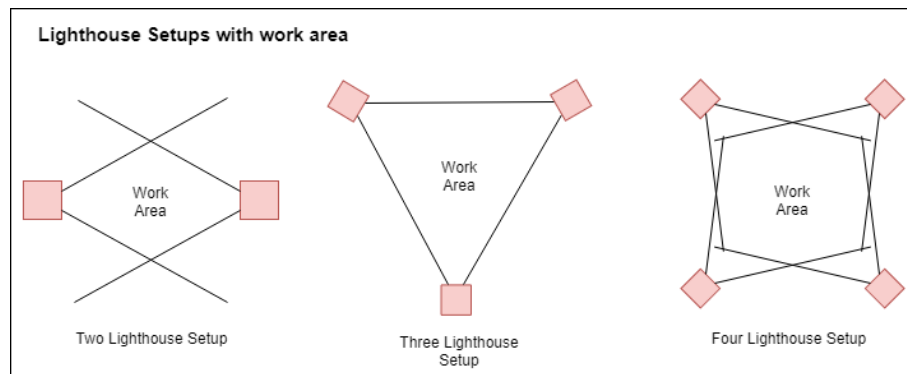


Figure 6.1: Lighthouses setup with work area.

## 6.4 Guide Design

The base for the guide was built from the experiences from the action research and from the questions and problems that coloured those cases. While the general setup was pretty well documented on the homepage for Rokoko motion capture, their video tutorial does not go into the many problems or bugs that might decrease the quality of the motion capture. While the guide should give the users the best possible conditions for setting up the system it should also provide pointers for how to get

the best data and what to do for some of the most common bugs and problems.

The workflow guide (see workflow appendix on page 65) that was created in the preproduction for "ibbermand" (See page 29 for Ibbermand production) was used as a foundation for the guide. Many of the guidelines given in the guide were based on the phrasing from the workflow guide just translated and divided into more straightforward steps. The workflow was created with the whole production crew in mind but was intended as a guide to be used only by the motion capture operator that was trained during the preproduction phase. While it did not go into more detail than needed to set up the equipment, it was attempted to make it phrased in a way that would allow the people from the crew to follow it. The crew did not need to understand the motion capture process and equipment. They needed to know what went into the procedure and how the equipment was set up so that for example, the set-producer could use it to estimate the time needed for setup.

The different tasks were presented in chronological order of how the researcher had been setting up the equipment over their different experiences with the Rokoko smart suit and HTC Vive tracking to create a better workflow for the guide (See page 25 for action research chapter). Then after laying out the steps, they were categorised. The categories that occurred were:

1. Physical setup - first setting up the lighthouses, suits and trackers
2. Software setup - then starting up Rokoko studio and connecting the suit and trackers to the application
3. Recording - then recording data from Rokoko studio

One element that is missing from this structure is a section describing the different technical issues that might occur while working with the equipment. Rather than writing all of the different proposed solutions in the middle of the guide potentially overwhelming the user with unneeded information (since the technical problems only happen situationally) the solutions of the problems were put into a category of their own. This category was called troubleshooting and was placed at the end of the guide as a separate tool that the user could refer to if they encountered problems. This separate tool then presented the problem of how the users could find specific solutions for the problem that they were having. For this, the same approach was used as many troubleshooting pages for hardware or software companies, where the problems were formulated as statements that present the problem as it appears for the user and then followed by different solutions. The different problems were numbered with the same enumeration as the step when it occurred in the guide to make it easier to navigate through. This system meant that if the user

encountered an error on step 4.b, then they could find known problems relating to that step in the troubleshooting section, under 4.b. This meant the user would not need to read through every statement until they found one that read like the problem they were witnessing.

The guide will have the troubleshooting organised in the same order as the steps from the guide so if the problem is not explicitly noted for the step that the user was on, the problems noted in the step before or after might be the problem that they were searching for. So if the user has a problem on step 4.b, but there are not troubleshooting for that step, the solution that they are looking for might be under 4.a or 4.c instead which should be just next to the initial step.

## 6.5 Implementation

The guide was written using Google Doc as a continuation of the workflow guide made for the ibbermand production (see Appendix B on page 65). The choice of writing tool presented some difficulties in terms of the layout and formatting of the guide.

## 6.6 The guide

The guide can be found in its full form in the Appendix on page 69.

After having completed the creation of the guide, the next step was to try and test it on real users. While the guide itself only had one user-ready iteration, it was an evolutionary piece that got more and more complete as more information was gathered. The following chapter describes the exact testing done with the guide, describing the process and changes from the original plan, which was set in the methodology chapter (see page 17).

## Chapter 7

# Testing

Up to this point all information gathered to try to answer the problem statement was based on observations while working with different partners in the industry. This following chapter describes the design test conducted to gather data more controlled conditions and with tools to document the results in place. Because of a lack of time, while the test was originally going to use purposeful sampling, the researcher ended up using convenience sampling in testing on those around them that still fulfilled the requirements originally set. This was users that are novices or highly knowledgeable with motion capture.

### 7.1 Pilot test

Before the actual test, a pilot test was made. This test was not used for data gathering but to refine the conditions of the design test and make sure that it would run with as few non-test related problems as possible. Based on the data gathered adjustments were made to the guide and the test procedure. There were a few typos and missing elements in the guide used during the initial test as a result of an oversight on the researcher's part. The missing elements made some of the steps of the test unclear, and so these problems were addressed.

## 7.2 Design test

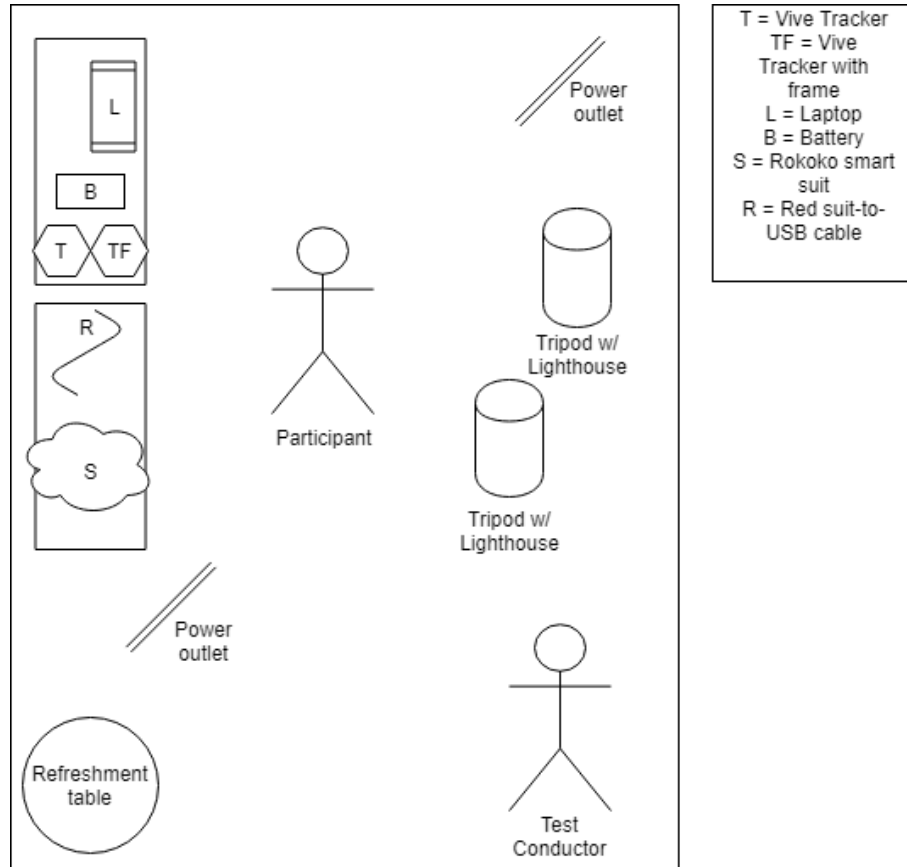


Figure 7.1: Design test setup diagram. Here is a diagram showing the setup of the design test.

After the initial test, a script was developed to create a natural flow in the test. First, the participant is welcomed and asked to read the consent form. If they agree with the terms, they sign it and choose to which degree they are comfortable being documented during their test. They are then shown to the computer for the pre-experiment questionnaire focusing on demographics and expectations. As they are sat down for the questionnaire, a stopwatch is started to take the time of the test.

After answering the questionnaire, the practical part of the test began. The participant was introduced to the equipment and where to find everything that they would need as part of the test. They are then given the guide, and the test conductor stepped aside to give the participants space to set up the equipment. The test conductor would then from the side, observe and take notes while the participant followed the guide. During the initial test, it was noticed that the internet

gave problems while being connected to both the router and the wifi, which could potentially mean losing data. So when the participant was stepping away to set up parts of the equipment, the conductor would go and reconnect the computer to the router that would be used as part of the motion capture setup. While by the computer to connect the router the test conductor also opened Rokoko studio and created a new project with the participant's number to make it easier to compare data later of the participants answers to their motion capture recordings.

When the test participant was done setting up and was wearing the suit, the test conductor would instruct them in the four recording tasks. First, they were asked to turn on the recording and then perform a task. When the task had been performed, they would be asked to stop the recording. Then for the following task, they would be asked to start a new recording. Making a new recording would mean that each participant would have four separate recordings. One recording for each task, making it easier to potentially compare the data also between participants without having to time code all the motion capture files. After completing all four tasks, the participants would be asked to take off the motion capture suit and take a seat by the computer again to answer the last part of the questionnaire. During taking off the suit and answering the questionnaire, the participants would be offered refreshments in the form of muesli+ bars of different varieties and bottles of water. The motion capture suit is warm to wear and move around in so the refreshments were chosen to keep the participants comfortable, hydrated and clear during the test. After answering the last questionnaire, the test conductor would stop the stopwatch taking the time for the test. Then a smartphone was placed between the participant and test conductor to record the interview. The participant was asked the structured questions and additional questions for clarification or to pursue emerging topics from the test. After finishing the interview, the participant was thanked for their participation, which concluded the test. After each participant left, the equipment was reset and arranged to stand as it did before the test. The router was unplugged, and programs related to the test were closed, for them to be turned back on when needed for the test.

From the testing of the guide, results were gathered. These results can be seen unprocessed in the following chapter. The processing and evaluation of these results can be found in the Findings chapter (See page 47).





## Chapter 8

# Results

Here the results of the design test are presented. The data is in a non-processed or analysed form.

### 8.1 Design test results

#### 8.1.1 Questionnaire answers

All answers can be seen in the questionnaire answers appendix on page 83. Below a selection of results has been made but only as they will make the basis for the findings in the chapter follow this one.

#### Likert answers

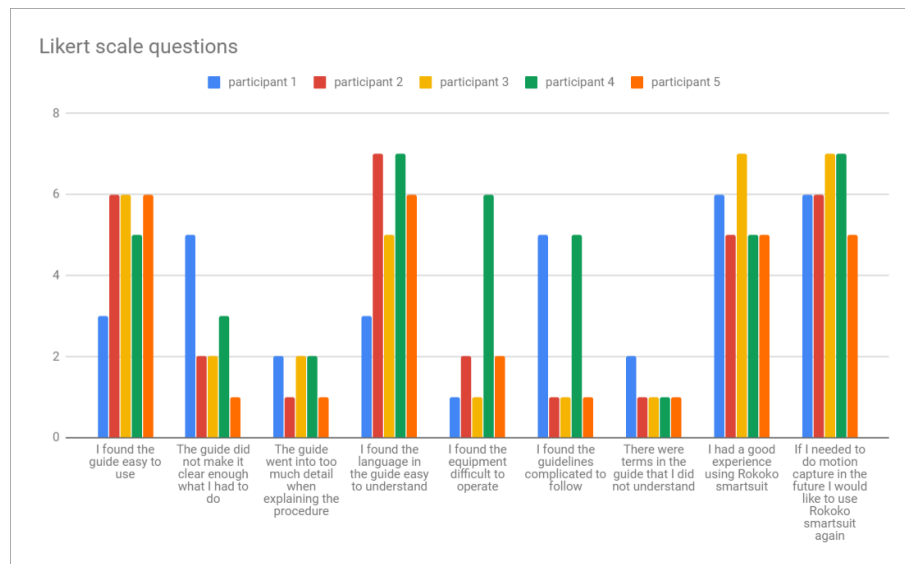


Figure 8.1: Figure of Likert scale answers.

### 8.1.2 Interviews

All five participants interviews were recorded as m4a files. With the submission of this study, the audio files of the interview were also submitted.

4 out of the 5 participants mention a preference for the analogue format. They expressed usefulness to the guide being printed out like a manual since it let them work with the equipment while still having the guide at hand. They could use one hand to hold the guide and read from it or compare images from the guide to their setup.

### 8.1.3 Practical evaluation

The table below presents with the evaluations of each participant's setup

Participant nr.	Suit	Connection	Vive	Recording	Time
Participant 1	5	5	4	5	47 min
Participant 2	5	5	5	5	34 min
Participant 3	5	5	5	4	26 min
Participant 4	5	5	5	5	33 min
Participant 5	5	5	5	5	36 min

### 8.1.4 Observations

Many of the participants seemed overwhelmed by the guide. The guide was 12 pages long, which made it appear as a long piece to go through. During the test, it was noted that the test was potentially very long and had too much reading, which could influence the test participants opinion. During the test, 3 out of 5 test participants reacted audibly excited over the appearance of the 3d avatar in Rokoko studio when they connected to successfully to the router. The same reaction was also expressed when the character was successfully calibrated and so simulated the user's movements. One user moved the towers together to compare their heights. The size of the suit was a problem for some of the participants. Some would have needed a small suit while others could have used an extra large.

One of the participants did not follow the guide but used it as a reference when they needed information.

Most of the participants raised the tower before connecting it to power despite the guide suggesting connecting to power first. This approach meant that some participants had difficulty reaching the lighthouse to connect the power cord. Participants would then tilt the whole tripod to be able to reach the lighthouse.

As participants went through the guide, they would put aside pages in which they had completed the steps.

After presenting the raw results from the design test, the following chapter will start to analyse and interpret these results.



## Chapter 9

# Findings

Based on the results from the action research and the design experiment some tendencies and

A tendency that was apparent from both the action research and the design experiment is the importance of hands working with the equipment. During the action research, multiple difficulties occurred because of the multiple roles put on the technicians beyond just working with the system. Likewise, in the design experiment, many of the participants commented on putting on the suit as the most challenging part. In a real situation, the technician would only be working with the motion capture system and would not also be wearing the motion capture suit and do the acting.

Based on the comments and ratings of the guide and the participants' performance, some of the future changes that would be needed relates to the language and the visual aid of the guide. All participants got a pretty high rating in their setup, hinting that either the participants were very proficient using the system, the system only allows for limited errors for completion or the guide in its current form gives the necessary information to complete the setup with high performance. Some of the errors that were observed could most likely be avoided with better visuals and language in the guide. Based on the observations during the design experiment particularly the WiFi and Vive setup sections of the guide seems to be where participants struggle the most, whether that be from lack of guidance or technical issues with the system.

After having made the findings from the design test, these findings will make the basis for a discussion on potential biases surrounding the study and the possible meaning of the findings.

When giving instructions a participants expressed wanting to have the procedure explained as if they were five years old. While it was only a single participant that expressed this need it suggests the guide appealing to a more knowlegdable user, which might needs to be addressed.



## Chapter 10

# Discussion

After collection all the information, from the action research cases, from the user test and processing all the finding, this chapter will take a step back and try to discuss the findings, what they mean and some of the potential problems with how the study was conducted.

This study leaned much on personal experience working together with external partners to learn about the problems of using motion capture and get the information needed to answer the problem statement. A criticism of the way the action research was conducted would be the lack of traditional data gathering as part of the cases. The project could have benefited from more rigorous documentation and the use of methods such as planned interviews or questionnaires with the production teams or end users that was worked with. Most of the information gathered is only documented subjectively through writing by the researcher. The information gathered during the action research is purely produced from memory and documents from the time working with the external partners. This lack of documentation puts the findings from the cases into question and makes them seem less reliable.

The result of the action research findings to an extend was the test guide used during the user test. This guide tried to make use of all the observations done during the action research to form useful guidelines for the participants. This guide could potentially have been a bigger part of the project but it would have taken most testing and dive into theories on how to create learning tools for technical equipment. Many technicians look for answers to problems online but focus on forums and practical projects rather than academic pieces. With more work the guide could be more than just a test guide and potentially help creating that availability for novice users as initially suggested in the first initial problem statement.

The concept of a collected guide has multiple benefits. Most productions have a workflow guide for equipment, and this guide could be a

tool on set for how to work with the equipment. The guide would be an alternative to watching videos and find answers online.

The test participants seemed to like the analogue format of the paper guide. At the same time, some of the participants expressed some of the steps for the setup would maybe be easier with a video rather than still images. On the other hand, others preferred still images. This difference in preference raises the question of whether a simulated analogue guide would be able to fulfil both needs without dismissing one side of the argument. An alternative design of the guide could be made for digital tablets, where the user can hold it in one hand and read while still being able to implement media like videos. The videos could be thumbnailed to show the picture that would correspond to the still images used in the original guide design, but with a click on the picture, it would play a video that could potentially make the step clearer or illustrate it more visually. This design would also allow for fixes as the systems that the guide teach are updated, interfaces are changed, and new features are added. This proposed design also hints to an initial concern of whether the guide is redundant in comparison to the tutorial and guides that the companies behind these motion capture systems provide themselves. One way to keep the guide relevant could be to make it a gathering point for the different technologies that can work together with a single system at the centre. This system could, for example, be a specific motion capture system or a real-time engine. At the time of the testing, there was not time to implement the hybrid guide concept. However, that is also why it was decided to continue iterating on the initial analogue concept but make questions relating to the idea of a hybrid guide part of the questionnaires and interviews for the second iteration.

The target group for the project were motion capture novices, but what qualifies as a motion capture novice was not specified during the preparations for the research. Initially a target group like "novice film-makers" were considered but that again does not make the aim quite clear enough. After having worked on a few productions and talked with people with different roles within the film-making trade, it is clear that the technical ability varies a lot. Some roles require a great understanding with technical equipment while others require more of ability with management or creative trades. With further work the project should specify its target group more clearly. This could be VFX people, technical directors or people with an interest in technical film-making tools. In any case, motion capture novices is too broad and there should have been a specification of the users external foreknowledge of other technologies. It could be interesting to compare the results between complete novices with no relevant foreknowledge and other novices with some technical knowledge while still being new to motion capture.



On the topic of target group, for the user test only students were used as participants which introduces a lot of bias. More over all of the students were medialogists and associates of the research. While all of the participants fitted the target group, with some of them being novices and some of them closer to expert level, the validity of their answers might be compromised. With further test beyond specifying the target group, it should also be avoided using people from the study as the only participants. Had the sample size been bigger it would have had less of an effect but with the user test using usability testing principles the data would probably be saturated early on so more participants would not add much to the findings. But with the use of multiple iterations would then make this point more valid.

Resources and time constraints affected the depth of the project as a whole. The scope of the project was reevaluated multiple times during the span of the study. This meant the focus for the project became unclear at different points of the project and this might still be evident in this report. The project should have had a sharper focus from the start as the lack of documentation in the action research also in part can be attributed to unclear goals and an uncertainty in how to address the problem statement. While a lot of information was gathered it stands broadly and imprecise as it has not been filtered in to stay focused at the primary problem.

Motion capture has many benefits but it also comes with its own difficulties and drawbacks. The benefits are not only in that it makes the animation process fast and puts the work into more hands as animators can work on animation while a team of motion capture technicians capture performances that are then send on in the pipeline to the animators which gives them some groundwork to move on from. Some of the drawback of motion capture of course includes the technical issues that might be encountered while using it but more over its a huge undertaking planning and management wise. Its also a new way to work with performances for the actors in motion capture. Another drawback is the cost and potential risk of using motion capture and putting resources into it if the system used is not robust enough. As experienced with the Rokoko smart suit some of these motion capture solutions are still experimental and so produces varied results in terms of data quality. Still there are many benefits to using motion capture including potential saving time and so also money that should have been invested in more animator work. Motion capture in many cases also produces more real results. When animating something stylised then hand animation is probably the best way to go. However, for realism motion capture produces faster and better results in that it actually captures the real rather than animators having to recreate it by hand (Cooper, 2019).

Physical motion capture and the traditional four motion capture types might be on the way out. The big advances in machine learning and computer vision will without a doubt change how motion capture works in the future. At the time of writing it is still a very new development and so it will still be a few years before the full scope of what these changes will mean. For now there still is a place for traditional motion capture and it is highly relevant in the current climate of film productions and game development where fictive characters are being pushed to become more and more believable or realistic.

This study could have focused more on these new motion capture techniques and explored the problems that novices would be likely to encounter with them. This would mean the study would have a clear current relevance and this would not exclude the study from them potentially compare it to the problems from traditional motion capture and see how different they are.

On their own problems found from this study might not have much meaning. It is in their collection and use that they find relevance. They become obstacles to be aware of and to potentially solve. Some of these problems are relatively deeply rooted in how motion capture works and so some of these problems might be solved with these new motion capture systems. Some of these motion capture problems could potentially be the foundation for new studies where there is a bigger focus on solutions to these problems rather than finding them in practice.

With the findings and the project discussed the study comes to an end, but before making conclusions, there will be a chapter discussing the potential use of this study and how it could be expanded in the future.

## Chapter 11

### Future works

To further the understanding of the motion capture that is available in the same budget range, testing other systems would be necessary. During the action research, some experience was gathered using the Ikinema Orion (see field work with Vizarts on page 27). It displayed a high precision in the motion capture recorded and seemed surprisingly easy to use. It could be beneficial to compare the usability of Rokoko against Orion and potentially other similar systems using the test setup from the user test. There is also the variable of the quality of the data. While a system can be easier to use, it can on the off side maybe be less advanced in its features or produce inferior quality data in the motion capture recordings.

As suggested earlier another direction could be to test other aspects of the project. Test on different target groups, as in different kinds of novices. This would include specifying the target group more and maybe make better targeted tests. Continuing the action research would also still be part of the project but with a much more rigorous procedure for data collection and documentation. There would be more focus engaging scientifically with the productions and the partners. There would need to be clear validated processes for gathering information and triangulating tendencies while in the field. Whether it be from questionnaires, interviews or other methods, the procedure of this study has made it clear the importance of gathering better information while working with a partner as part of an academic project.

Future studies could also expand to explore other aspects of motion capture, potentially expanding to performance capture setups. Studying performance capture would mean, including exploring the difficulties for facial capture systems and hand motion capture. With the current development and changes in motion capture using machine learning and only needing smartphones for meaningful capture, there could potentially be considerable changes in the expectations, both technically but also for the usability. These new expectations can either force the phys-

ical systems to adapt with features that set them apart from the new motion capture technologies or to find ways to create the same kind of universal and easy to use motion capture but with their own systems. As things change is there even a place for traditional physical motion capture or will it fade away with the surge of new systems that do not need equipment or the limitations that the different systems impose? There are still much to be explored as a continuation of this study.

So with the potential future of the project presented, the project comes to an end. Here follows a conclusion wrapping up the project, a bibliography and appendices relevant for the study.

## Chapter 12

# Conclusion

"Sync, hug, moclap and action!" were the words used for the title of this thesis. They describe the special and kind of unorthodox techniques used as part of preparing motion capture. While not necessarily relevant to a new user, they invoke the kind of whimsical nature of acting and becoming another character while still being grounded in the technical necessities of motion capture. Synchronising or synching, as in calibrating the suit and data, whether that be recordings or real-time previews of the characters. Hug, as in the technique used during the U C ME project to compare and evaluate the placement and interactions between multiple actors in motion capture. Moclap, an emerged step to motion capture as part of a production to better sync sound and other external elements in post. The last expression, action, refers to the use of the word to signal the start of a scene at a movie set. The project set out with an initial problem that then shaped the final problem statement that became the focus of this project:

### **Initial Problem Statement**

How to make low-budget motion capture solutions more available to users?

### **Final Problem Statement**

What usability and technical difficulties occur for motion capture novices when learning how to use Rokoko smart suit and HTC Vive tracking?

After having read about, worked with and discussed the problem it can be concluded that the difficulties that occur with Rokoko smart suits are mostly external problem. While problems like planning and working with the technology can both alleviate and produce problem, what throughout the study stood out was the problem of inconsistency. The inconsistency of systems made them risky to use for productions and gave novice users little to work with as some of these problems were not even problems that they could have avoided. Sometimes the problem

came down to random WiFi problems and errors in the suits. Other times it just came down to persistence in continuing to try the same procedure with the system and with enough tries the problem would seemingly resolve itself. So while there is a lot to learn and motion capture is not necessarily easy to learn, for motion capture novices the most hindering difficulties relate to external problems that were out of their hand. As mentioned in future works, further study into more reliable alternatives or how to improve these problems stands as extremely relevant endeavours in the pursuit of making motion capture even more available and allowing people to better tell their stories or become fantastical characters in the virtual world.

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## Appendix A

# Virtual production process - U C ME

## **Pre-shoot**

1. Scripts, shot list and character information is sent out to performers.
2. All props are found, build and packed for easy access during the shoot.
3. Stage pieces are found and packed for easy access during the shoot.
4. Technical team and director set up the Virtual Capture Volume, and tests equipment. Audio equipment is tested and everything is set to charge.

## **During shoot**

1. Meet and greet with actors, technical staff and director. The team is introduced, technical roles are pointed out and explained. Performers can ask any questions about the process, their characters, the scenes and previsualization, concept art etc. is shown.
2. Performers suit up with the help of technical staff that tests everything is coming through clearly.
3. Performers take turns doing any Range of Motion necessary with technicians.
4. The scene is built, props and trackers are placed and markers are set for any interactions that require it. If you have any wishes for markers, tell the crew now.
5. The director breaks down the scene - Feel free to ask any questions. The director should focus on what he wants rather than how he wants it.
6. The technical crew does their final tweaks and fixes - performers can feel free to start rehearsing and getting into character - ideally with the director if time permits.
7. One or two rehearsals of the scene are done. Data will be captured, but mainly to ensure that everything is recording correctly. The director will clearly communicate whether the shoot is a rehearsal or a take. Performers should focus on "walking through the scene," and save their creative energy for the first take.
8. Performers feel free to ask for additional rehearsals if you are unsure of the scene. But don't overdo it - go for nailing the feeling rather than a perfect performance.
9. Final questions about motivation or specific elements of the scene at hand. If you plan on trying something different, communicate it to the director.
10. Director does a ready call for:
  - a. Mocap technicians
  - b. Sound technicians
  - c. Camera operators
11. Mocap technician calls for straight poses from actors.
12. Crew calls "rolling" when their equipment is recording. Actors clap in front of their face and blink simultaneously to sync.
13. Director calls first position and actors get into their respective starting positions.
14. Director call "action" and the scene starts.
15. Director calls cut to notify the end of a take to performers and crew. Ease into a resting position, and try to stay in place.
16. The crew notifies director if there were any technical issues during the take.
17. The director gives notes on the next takes and an assistant notes them down in the shotlist.
18. Either a new scene is set up (start from 4.) or another take is done (start from 10.)

## **Language and terms**

### **The Virtual Capture Volume**

The space in which a scene takes place. With the Rokoko system, it is constrained to the area between the four “base stations” that make up the space in which a scene can be captured. With Rokoko we are limited to a 5x5 meter space with a buffer of a few meters outside of the four base station towers.

### **Range of motion**

A preset series of movements that help the translation from real to virtual world. You will have to do 50 expressions to help the computer recognise your face and walk around the capture volume to help mark out how far you can go outside of the volume before interrupting the recording.



## **Appendix B**

### **Motion Capture Workflow - Ibbermand**

# Motion Capture Workflow

## Opsætning

**Opstilling af Basestations (Light houses)** - De skal stå som en diagonal (2 stations), trekant (3 stations) eller en firkant (4 stations). Stationerne skal pege ind mod arbejdsområdet i en 24 graders vinkel ned fra horizontal mod arbejdsområdet. Tårnene skal tilkobles til strøm og lyse blå eller tyrkist. Hvis de blinker rødt/orange betyder det at der er et problem med dem. Stationerne skal stå godt 2 - 2.5 meter oppe.

**Forberedelse af Rokoko suit** - Dragten skal have sensorerne i sig og alt bortset fra de midterste lynlåse i fronten og i ryggen skal være lynet til. Der skal sættes et batteri i ryggen i den nederste lomme og den skal kobles sammen med sensor hub'en med USB. Efter batteri er koblet op og sensor hub'en lyser op kan ryggen lynes op. Husk at tage pandebåndet ud først så den ikke bliver lukket inde i dragten. Hvis der skal bruges Vive tracking, så husk at pladsere trackeren i sin ramme i den øverste lomme så den sidder øverst på ryggen af dragten.

Hvis dragten ikke automatisk tilslutter Rokoko Studio skal dragten formentlig have sine Wifi indstillinger opdateret. Tilslut sensor hub'en til computeren med det røde kabel som ligger i dragt tasken. Når Rokoko studio genkender at dragten er tilsluttet kan de nye wifi indstillinger blive oploadet. Der skal måske flere forsøg til før den successfuldt uploader, men den viser et grønt flueben når uploaden har virket. Dragten kan nu frakobles fra computeren og skulle kort tid efter dukke op i studio.

**Opsætning af SteamVR** - Sørg for at basestations er sat op først og at de nødvendige trackers er fundet frem. Sørg for at det nummer af Vive trackers der skal bruges svare til det nummer af Vive senderer som er koblet til computeren. Tænd trackerne og sørg for at de er paret op med senderne. Trackers lyser grønt når de er paret og aktive, blå når de er tændt men ikke paret op, og orange når de er ved at løbe tør for strøm. Der skal trykkes og holdes nede på den midterste knap på vive trackerne for at få dem til at søge en forbindelse og gøres klar til paring. De blinker blå når de søger efter en sender.

Når alt materiale er sat op så sørg for at steamVR er tændt og køre et "room setup". Vælg det stationære setup og tryk næste gennem resten af installationen uden at ændre i tallene. Hvis den ikke kan finde headsettet er det nok fordi null-driveren ikke er slået til i rokoko studio. Den kan findes under indstillingerne for virtual production.

Når alt er sat op så start steamvr gennem rokoko studio's virtual production.

Rokoko og SteamVR skulle nu være koblet sammen. Det kan ske at programmet crasher på dette sted også skal Rokoko studio bare genstartes. Når alt er tændt og koblet sammen så start med at have en tracker på gulvet og tryk define floor i rokoko studio's virtual production. Dette skulle gerne gøre at alle basestations kan ses i Rokoko studio og det samme skulle gøre sig gældende for trackerne.



**Klargørelse af Rokoko Studio** - Rokoko Studio skal startes op også skal programmets licens godkendes. Sørg for at være på nettet for denne del. Log ind i programmet med en bruger og vælg Enterpraise versionen. Når du ser programmet er åbent er internet ikke længere nødvendigt. Lav en nye session og navngiv den meningsfuldt for det der skal optages. Sørg for at få skuespillerens størrelsesmål for at få bedre data. Lav en profil til dem eller rediger et af de eksisterende profiler.

**Skuespiller i Rokoko dragt** - sørg for at vælge en dragt der passer skuespilleren. Den skal side tæt men stadig tillade bevægelse. Lynlåsen som åbne op til dragten skal side i fronten, så skuespilleren lukker dragten ved at lyne op i maven. Sørg for at alle stropper er lukket og sidder tæt uden at være så skramme at de lukker for blodcirkulationen eller gør ondt på skuespilleren. Sørg for at spørge skuespilleren om dragten sidder komfortabelt og hvordan temperaturen er. Det skal der helst spørges om flere gange i løbet af processen. Dragten kan blive rigtig varm at have på så der skal måske åbnes et vindue for skuespilleren.

**Kalibrering** - Det er altid en god ide at "define floor" før man begynder at kalibrerer og efter man har rykket på stationerne. For at kalibrer dragten skal skuespilleren stå med ret ryg, fødderne lige ned fra hoften og begge fødder liggende parallelt fremad for hinanden. Hold armene ned af siden og hold hovedet lige frem og kig ligeud. Når skuespilleren stå korrekt kan kalibreringen begyndes. Knappen er øverst i værktøjsbaren i Rokoko studio yderst til venstre. Efter kalibreringen er gennemført kan det være en god ide at bede skuespilleren om at gå lidt rundt for at teste kvaliteten af dataen. Ser man Y-jumps eller spontan drifting er det nok resonans i Basestationerne. Ser man choppy bevægelser er det formentligt computeren som dropper frames, dårlig forbindelse mellem dragt og wifi eller interferans fra metal på settet.

**Lave projekter, gemme filer og eksportere** - Når rokoko studio er startet op bliver du bedt om at vælge et projekt eller at lave et nyt projekt. Projektet og dens første scene skal navngives. Sørg for at navngive projektet så det er nemt at genkende. Navngiv gerne projektet efter hvad det skal bruges til også tilføj en dato til slut på navnet. Datoen skal være den fulde dato med dag, måned og år. Så et eksempel kunne være Ibbermand\_Optagelse5\_01052019.

Efter hver optagelse skal filen navngives efter de konventioner som er aftalt. Det kan for eksempel være Test\_SC01\_T01 for testoptagelser, scene 1, først take.

Optagelsesnavngivningen skal aftales med resten af holdet.

Når optagelserne er færdige kan hele scenen eller specificerede optagelser blive mærkeret og eksporteret. Det gøres ved at højre-klikke på det ønskede materiale og vælge export funktionen.

Filerne skal eksporteres som FBX format, i ASCII som fbx setting, den nyeste version FBX2016000 og som Mixamo skeleton. Når alle filerne er eksporteret skal de uploades til google drive eller lægges på en harddisk og lægges op så snart som muligt. Lad ikke dataen kun ligge på den brugte computer. Der kan være massere af situationer hvor man har brug for at tjekke dataen og så er det problematisk hvis computeren er pakket sammen eller ikke er tilgængelig.

# Arbejdsprocess

## Forberedelse

1. Opsæt Basestations
2. Start og sæt op SteamVR og Rokoko Studio
3. Tjek forbindelse mellem dragt, vive trackers og computer
4. Påfør Rokoko dragt og sæt skuespiller profil
5. Kalibrer
6. Test kvalitet af bevægelser i dragten og fra trackers

## Ny Optagelse

1. Opsæt scene og optagelses struktur
2. Kalibrer
3. Test kvalitet af bevægelser i dragten og fra trackers
4. Tryk "optag/record" på holdets signal
5. Lav "moclap" for synch
6. Hold øje med real-time data
7. Stop optagelsen på holdets signal
8. Navngiv optagelse
9. Vurder data
10. Gå tilbage til punkt 1 for næste optagelse

## Appendix C

### Analogue Rokoko User Guidelines + Tasks - Design Test

# Guidance and tasks

## Tasks

1. Setup the lighthouses
2. Prepare the Rokoko suit
3. Connect the Rokoko suit
4. Startup SteamVR
5. Connect the trackers
6. Put tracker onto suit
7. Put on suit
8. Define floor
9. Calibrate suit
10. Record Walking
11. Record Waving
12. Record Sitting
13. Record Jumping
14. Take suit off

## Workflow Guide

Follow this guide to complete the provided tasks. If any problems are encountered check out the troubleshooting segment at the end of the guide. If you still have problems you can ask the test conductor. Using the guide to solve problems is part of the test so be sure to check the troubleshooting segment before asking for help. Sometimes connection information does not reset properly so sometimes things might already be connected when you get to a step. If you have problems determining what steps have been skipped and where you got to you, then you are welcome to contact the test conductor to ask.

Equipment and suit overview:

This setup contains one motion capture suit, one computer, two lighthouses, two tripods and two VIVE trackers. For the suit follows a red suit-to-USB cable and one of the VIVE trackers has already been attached to frame to make it fit with the suit. Receivers for the VIVE trackers have already been connected to the computer. A paper with the name and password for the router will also be included with the setup.

## 1. Setup the lighthouses



- Place the lighthouses diagonal to each other looking toward the space between them. Angle the lighthouses about 24 degree down from horizontal still looking down on the workspace between the two lighthouses.
- Connect power to the lighthouses. The power cable connects on the left side of the back of the lighthouses.
- Raise the lighthouses on the tripods so that they are about 2-2,5 m up.



## 2. Prepare the Rokoko suit

- a. Layout the Rokoko suit on a table or the floor with the backside up.
- b. Open the suit in the middle back vertical zipper.



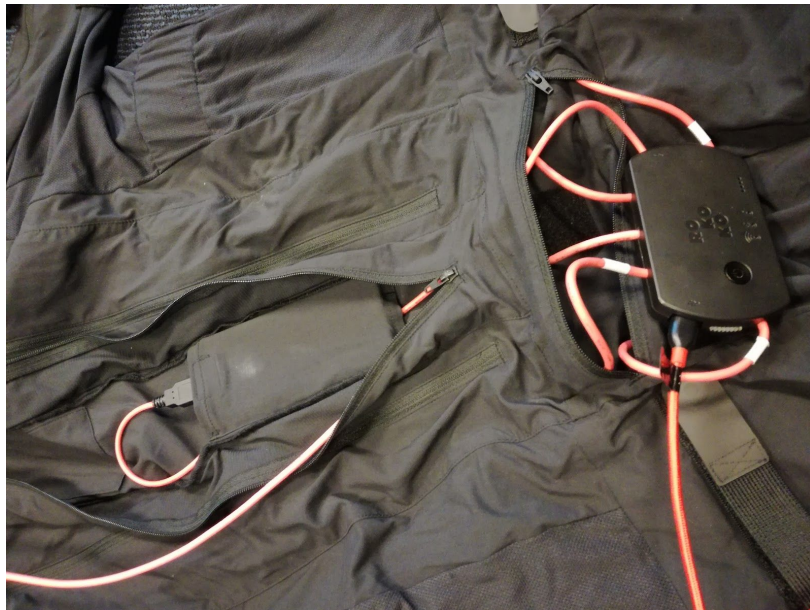
- c. Insert the battery in the lower pocket in the back of the suit and connect it with the usb cable.



- d. Check that the suit hub lights up by opening the horizontal zipper pocket located on the lower back of the suit.
- e. Take out the headband from the back of the suit.

### 3. Connect the Rokoko suit

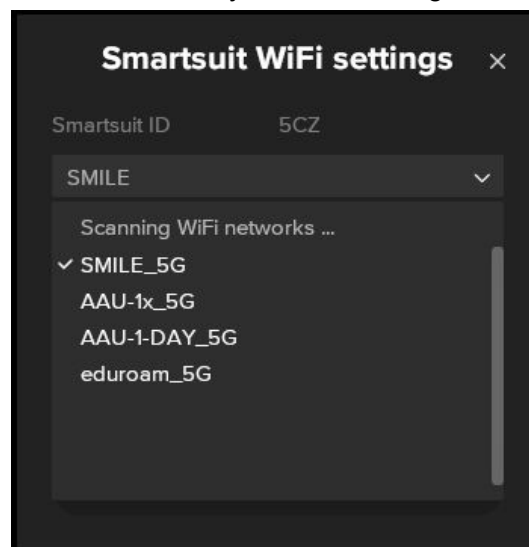
- a. Take the red suit-to-USB cable and attach it to the suit hub on the left side of the hub.



- b. Then connect the USB end of the red cable to an available USB port.
- c. The computer will give a notification that the connection has been made. Click this notification or click on the wifi icon in the upper right part of Rokoko Studio.

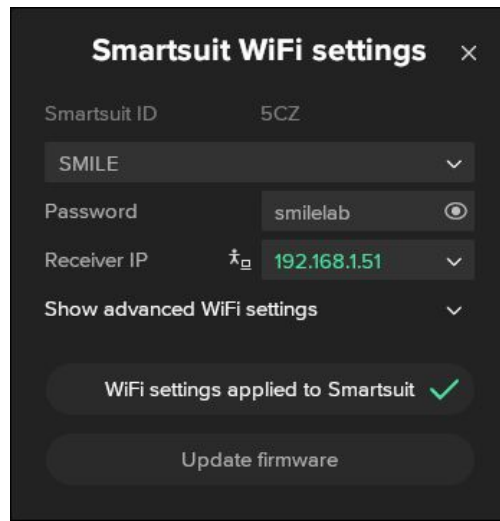


- d. A window will come up. Here you chose the wifi that you will be using for the motion capture session by clicking the drop down menu at the top of the window and choose the wifi you will be using.



- e. Type in the password for the used router. Then click the drop down menu for Receiver IP and choose the top IP that starts with 192. It IP address should be green. Now press "Apply WiFi settings to smartsuit".

- f. When the green checkmark appears on the “apply to suit” button the connection has been uploaded to the suit.



- g. Now disconnect the suit and the computer by removing the red suit-to-USB cable from the suit.
- h. Put the hub into its pocket and close it.

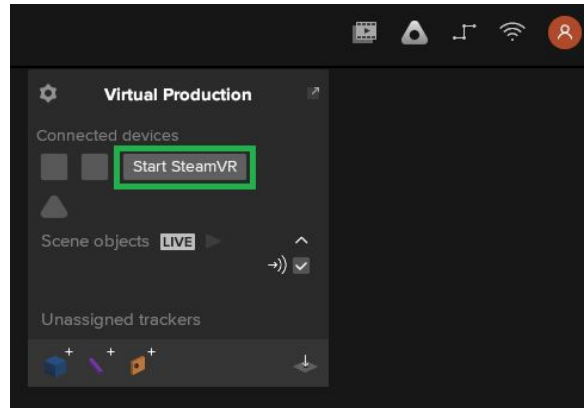


#### 4. Startup SteamVR

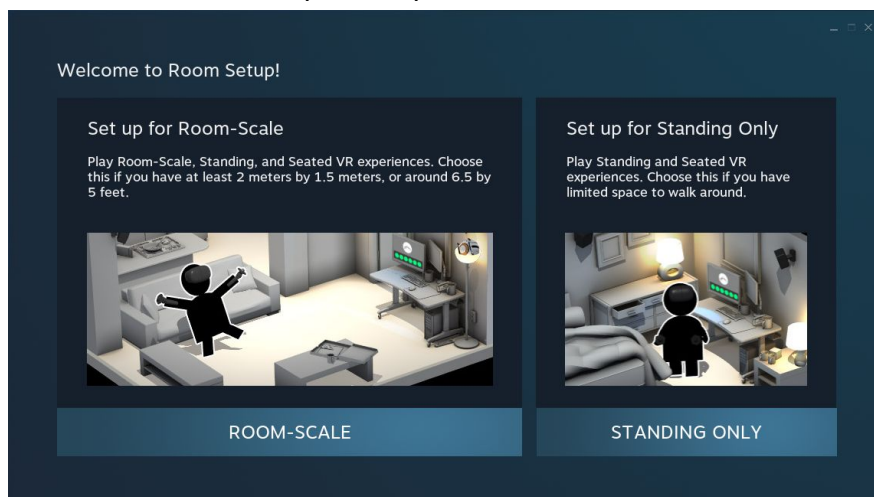
- a. Press the Virtual production icon in the upper right part of Rokoko studio.



- b. Press “Start SteamVR”



- c. As you start SteamVR you might be asked to complete a room setup. If not continue to the task: **5. Connect the trackers**
  - i. If SteamVR welcomes you to room setup start by pressing Standing Only. For this room setup you don't need to change anything just press the buttons directed below.
  - ii. For “establish tracking”, press Next
  - iii. Then for “calibrate your space”, press calibrate center, and after its done loading press Next.
  - iv. Then for “locate the floor”, press calibrate floor, and after its done loading press Next.
  - v. Now the setup is complete. Press done

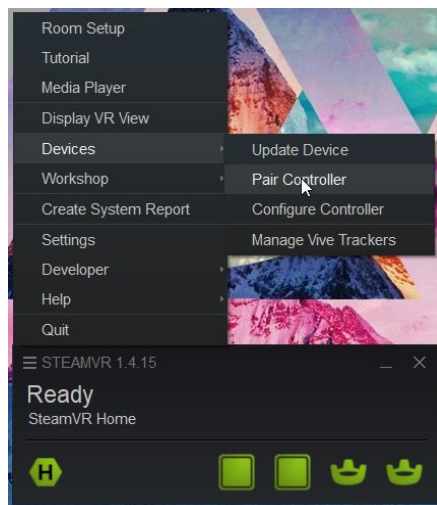


## 5. Connect the trackers

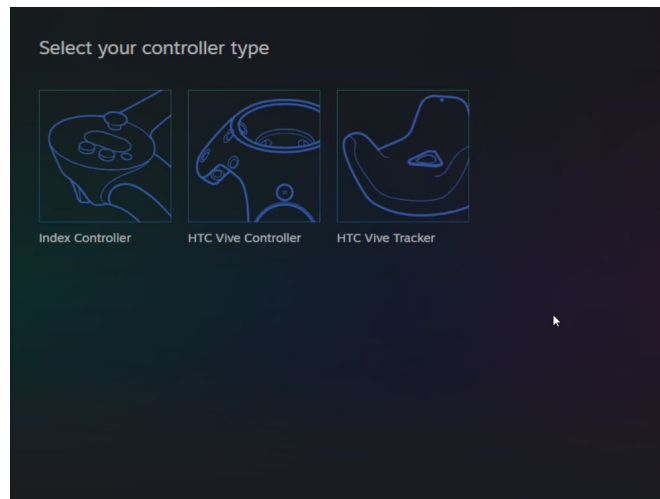
- a. Turn on the two trackers by pressing and holding the middle button on the top of the VIVE trackers until a small light turns on, on one of the legs.



- b. If the tracker light turns green it is paired and ready for use
  - i. If the light is blue, it needs to be paired:
    1. To pair a tracker, go to the steamVR window and click on STEAMVR 1.4.15. Then go into “devices” and press “pair controller”



## 2. Select the HTC Vive Tracker



3. Hold down the middle button on the VIVE tracker until it starts blinking.
  4. The light on the tracker should turn green and the window on the screen should say that the controller got paired.
- ii. If the light is orange, it needs to be charged.
1. (Contact the test conductor and they will provide you with another tracker)

## 6. Put a tracker onto the suit

- a. Take the tracker that is attached to a plastic frame and place it in the upper pocket in the back of the suit.



## 7. Put on suit

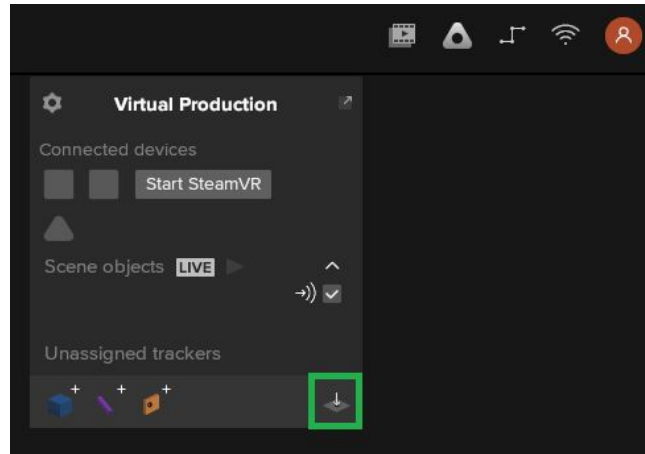
- a. Before starting putting on the suit take off belts and empty your pocket for metallic and electronic objects.
- b. Be sure the headband is outside of the suit. Close all of the zippers except the one in the front. The middle zipper in the back just needs to close up to the tracker over the pocket with the frame.



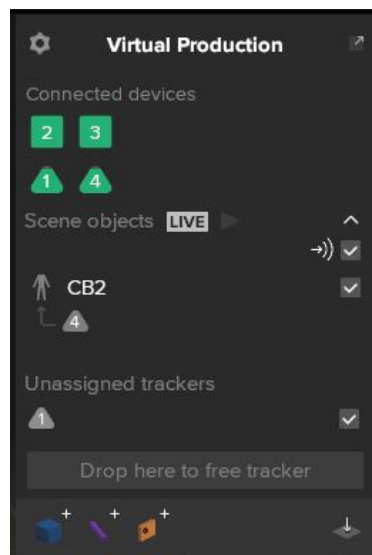
- c. Put on the suit. Put on the headband so that the sensor is in the centre of the back of your head.
- d. Adjust the straps around the suit so that it sits tight but not uncomfortable or painful. Here is a checklist of all the straps
  - i. Torso sides
  - ii. Thighs
  - iii. Shins
  - iv. Feet (sensor should be in the centre of the foot, not out on the toes)
  - v. Upper arms
  - vi. Forearms
- e. Now close the suit in the front

## 8. Define floor

- Place the other tracker on the floor in the middle of the workspace between the lighthouses.
- Go into the virtual production tab.
- Press the define floor button.



- Try to move around a bit in the suit. On the screen you should be able to see one of the trackers move around. Hold the mouse pointer over it and it should say "tracker" and a number. In the virtual production tab go to unassigned trackers and drag and drop the tracker with the number you just saw on the suit under scene object. The tracker should now virtually be attached to the suit.



- If the lighthouses and the trackers appear in the scene in the program as they do in real life they have been connected correctly.

## 9. Calibrate suit

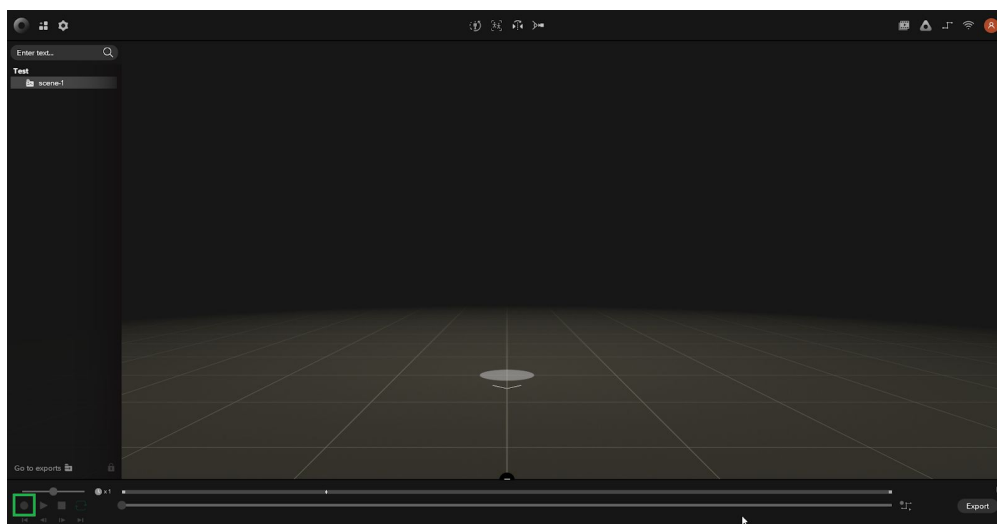
- a. For the calibration, you need to take a particular stance.
  - i. Feet parallel forward. Legs straight. Arms straight down your sides. Straight back. Looking straight forward.
- b. When you feel you are ready to calibrate press the calibrate button on the left of the toolbar at the top of the software.



- c. Press the calibration button and immediately take the calibration stance, you only have a few seconds to assume the pose. Stand still until the screen says Ready.
- d. If the calibration was successful, you should see the avatar on the screen move exactly like you. If this is not the case you can try to recalibrate. If the problem persists check 9.d in troubleshooting

## 10. Recording

- a. You can now record motion capture, by clicking the record button in the lower left corner of the software.



- b. You end the recording by clicking the button again.

**(Now tell the test conductor that you are done setting up and they will document the setup and give you the last instructions for the practical experiment)**

## Troubleshooting

3.b - The suit does not connect to the program; Try to take out the red suit-to-USB cable wait a few seconds and connect the cable again. **(If it continues to not work after two attempts contact the test conductor.)**

3.c - The wifi that I need to use does not appear on the wifi list; Try to take out the red suit-to-USB cable wait a few seconds and connect the cable again.

If this does not work then try to disconnect the battery and while keeping it disconnected from the battery try to close down the wifi tab and then open it again. **(If both attempts fail, contact the test conductor.)**

3.e - An error appears when I try to apply the wifi settings to the suit; First make sure that the password that you have written for the wifi is correct and then try again. If it still is unable to connect, try a couple more times. Sometimes the system is buggy when it comes to the upload and so takes multiple attempts without it being the fault of the user. **(If the problem prevails contact the test conductor.)**

4.b - Rokoko studio crashed when I tried to start steamVR; This sometimes happens. Usually this only happens once and the solution is to just start the program again. **(Contact the test conductor and they will start it up again for you. You have not lost any of your prior progress in the test.)**

5.b.i.3 - SteamVR says it can only facilitate two controllers; This is not true, but there might be a problem with the VIVE receivers attached to the computer. Either there are too few or there is a signal error. **(Contact the test conductor)**

8.e - The lighthouses and trackers all seem to be gathered in the middle of the workspace; Make sure that SteamVR displays the two lighthouses and the two trackers in the steamvr window. All four needs to be visible and be green in the display line with the addition of an icon with an H at the start. If the H icon is missing, make sure that the null-driver is activated. **(Contact the test conductor)**

Then try to take a VIVE tracker and shake it in front of the lighthouses. Try defining floor again and if it still does the same thing despite all elements being green, try to do a room setup. Follow the instructions in the window. **(If problems occur during the room setup contact the test conductor)**

When the room setup process is complete try to define the floor again. **(If the problem persist contact the test conductor)**

9.d - The avatar is not moving like me; try to run a recalibration and make sure you stand like described in the guide or use the avatar's straight pose on the screen as a reference of how to stand. If it still does not work try to ask someone else to press the calibration button so you can focus on standing correctly. **(contact the test conductor so that they can help you with the pose and maybe start the calibration for you)**





## Appendix D

### Questionnaire answers - Design test

# Motion capture experiment

5 svar

Demographic Questions

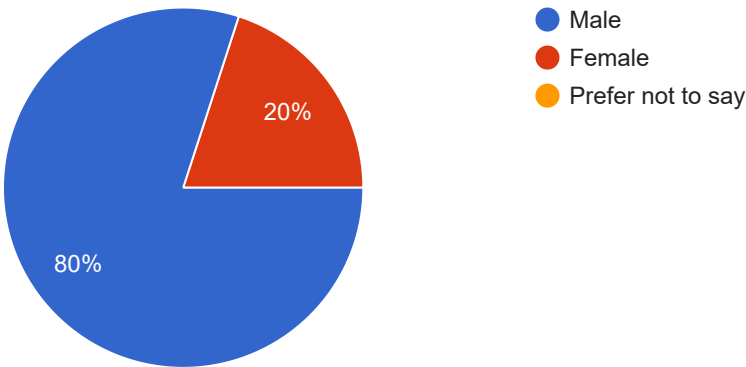
## Participant number

5 svar

- 1
- 2
- 3
- 4
- 5

## Gender

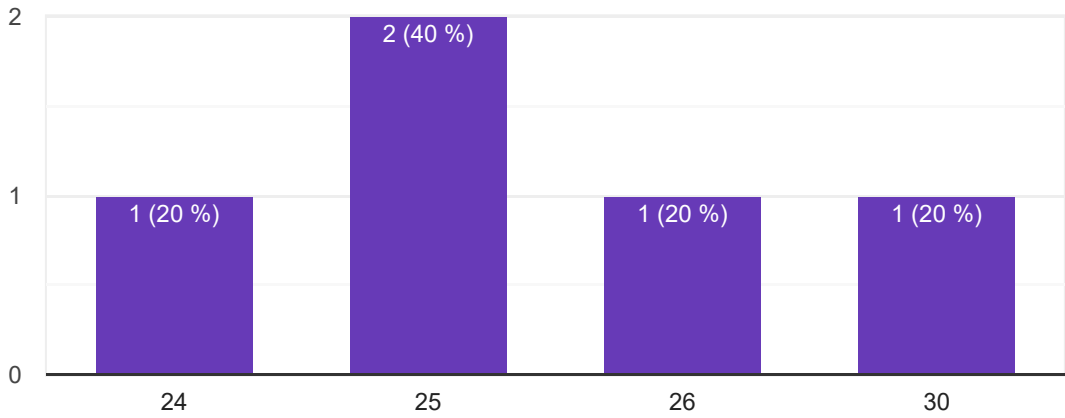
5 svar



84

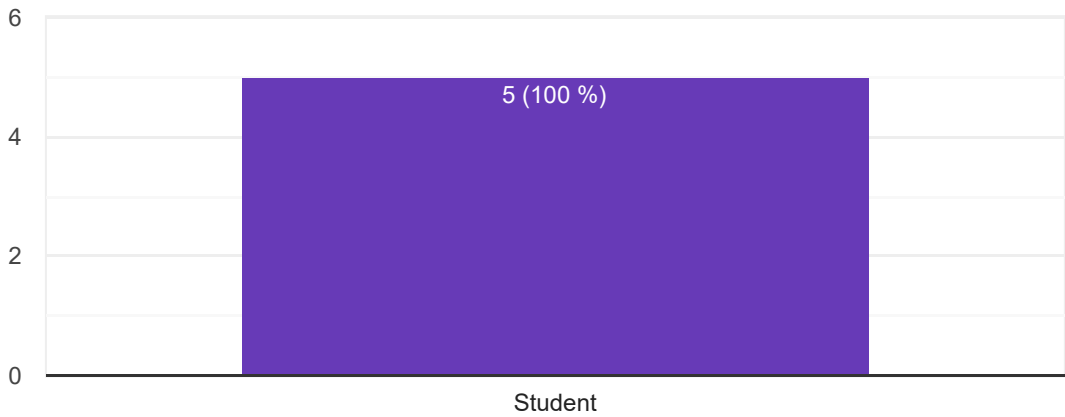
## Age

5 svar



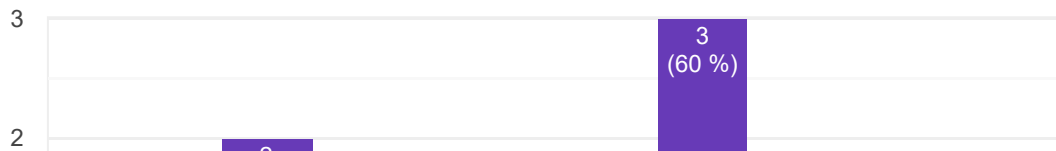
Profession

5 svar



How much experience would you say you have with motion capture?

5 svar



What is your expectations for working with motion capture as part of the test?

5 svar

I expect it will be fun.

I currently have no expectations :D

I expect it to give me a lot of issues

No idea

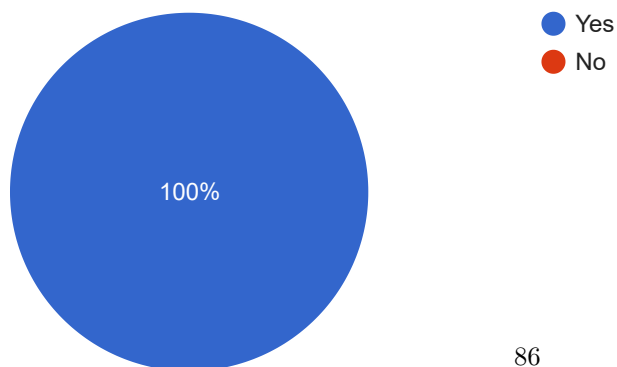
none

## Practical Part

## Post-Experiment Questionnaire

Had you heard about Rokoko motion capture before the test?

5 svar



## If yes, then from where?

5 svar

In relation to my internship at the Danish Film school.

Through my education

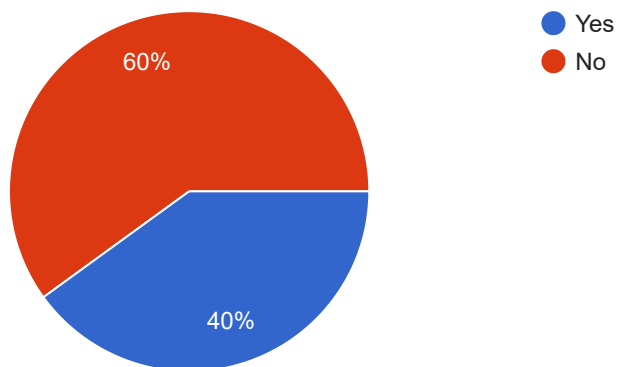
from school

Introduced through friends making projects with it

university / Vizarts

## Have you worked with Rokoko motion capture before?

5 svar



## If yes, then in which capacity?

2 svar

I both acted in the suit myself and worked with the animation after it had been exported to a rig.

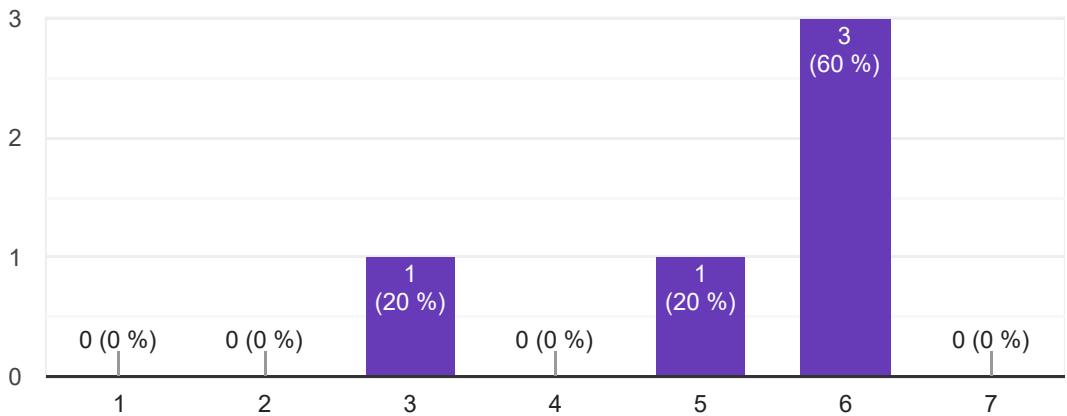
I have worked with quite a few times, for personal projects, internship as well as in regards to work. So a lot!

87



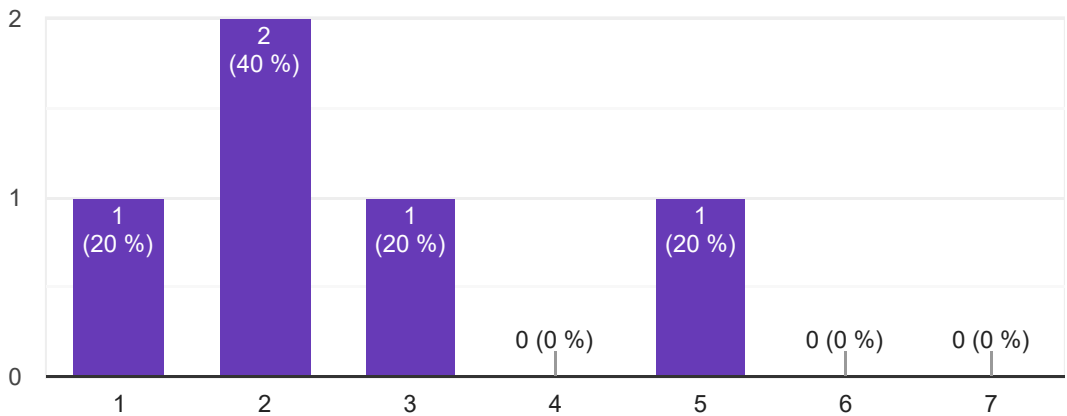
I found the guide easy to use

5 svar



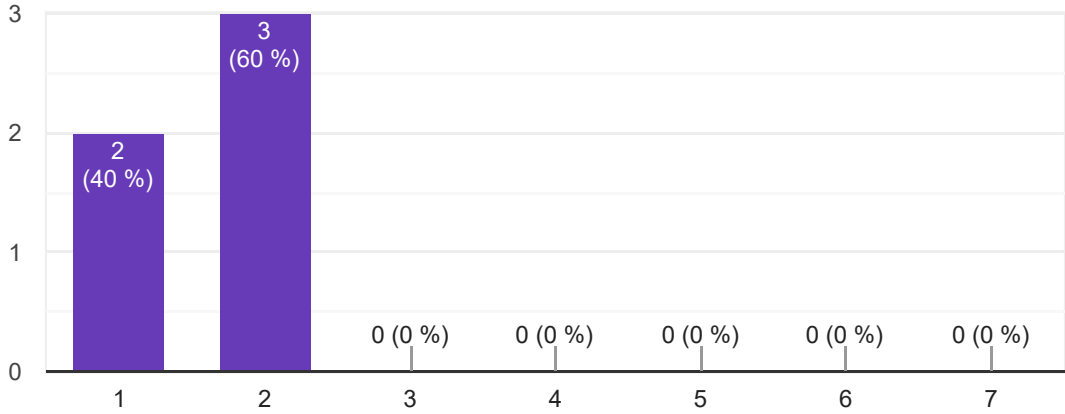
The guide did not make it clear enough what I had to do

5 svar



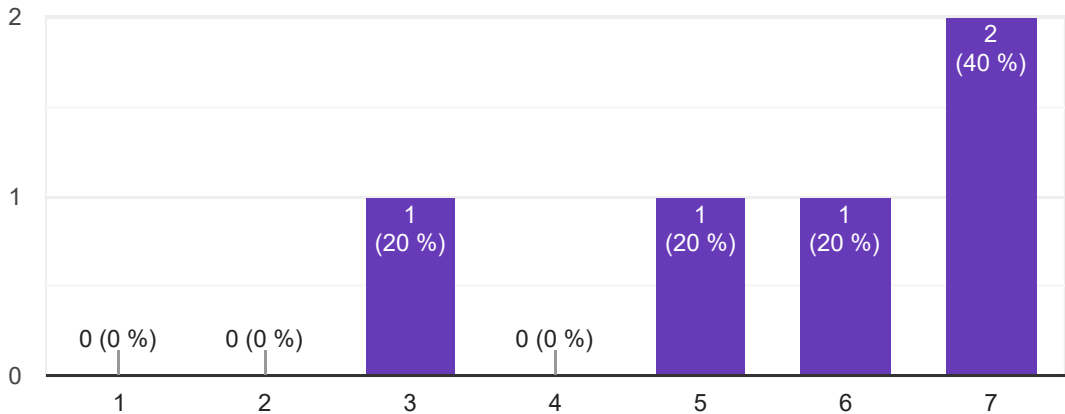
The guide went into too much detail when explaining the procedure

5 svar



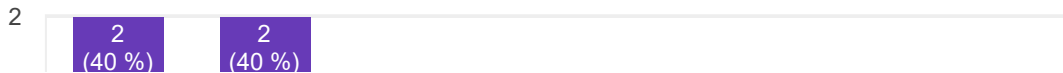
I found the language in the guide easy to understand

5 svar



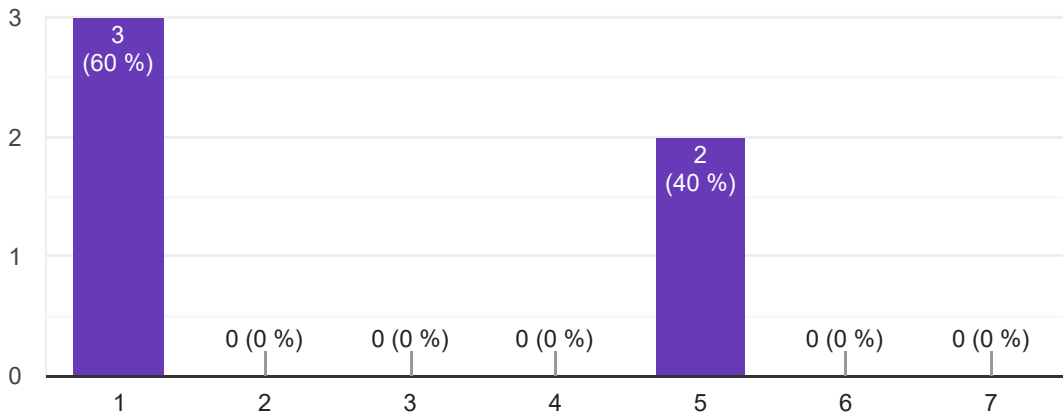
I found the equipment difficult to operate

5 svar



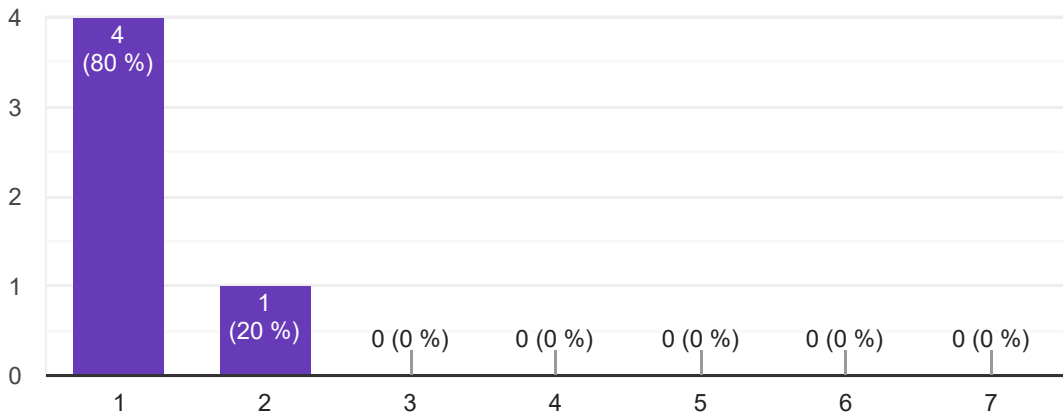
I found the guidelines complicated to follow

5 svar



There were terms in the guide that I did not understand

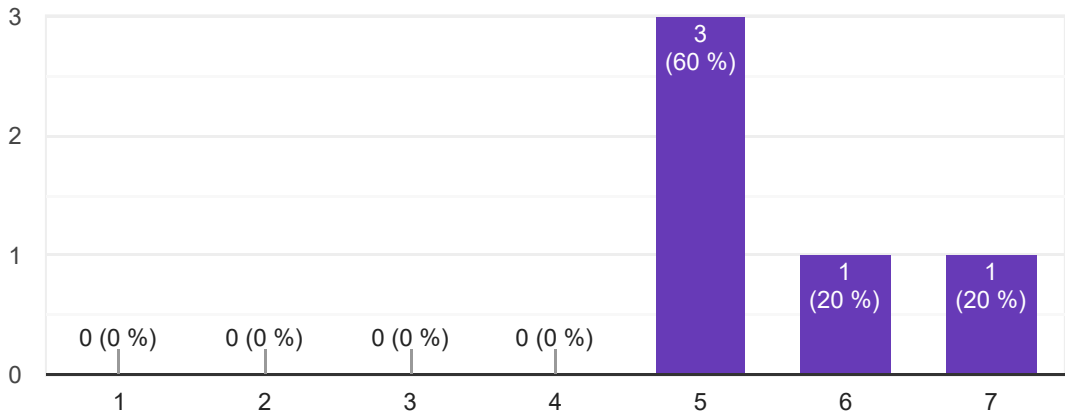
5 svar



I had a good experience using Rokoko smartsuit

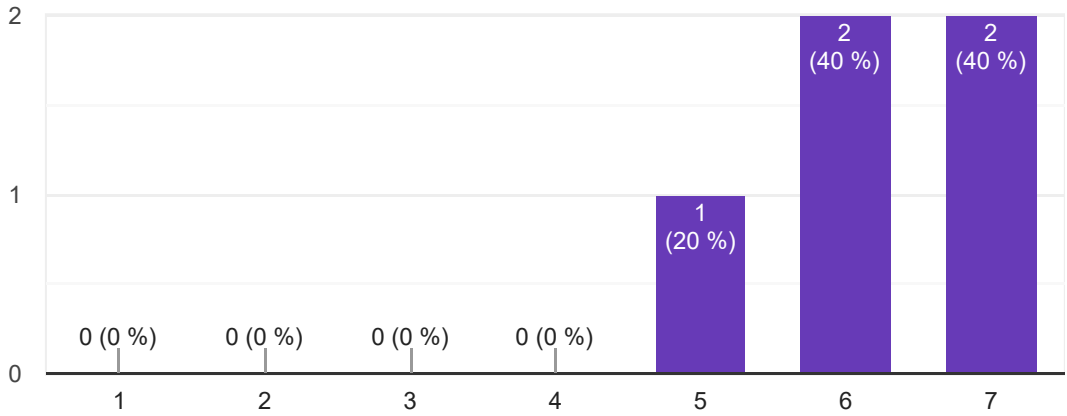


5 svar



If I needed to do motion capture in the future I would like to use Rokoko smartsuit again

5 svar



Last questions of the Questionnaire

What did you think of the guide?

5 svar

91

It could have used more elaboration on most of the things mentioned. With these types of guides I kind of want to be told what to do as if I am 5 years old. Could use some more picture, or even video to

demonstrate what the different parts of the suit were.

It was quite intuitive and easy to follow. I haven't really got any critique.

I liked the guide a lot. Though some of the sentences were too long and even though I had read them all I did not get all the steps. Maybe create smaller sentences or event bulletpoints for a quick understanding.

Many detailed steps inside, which made it a bit overwhelming

seemed nice and informative

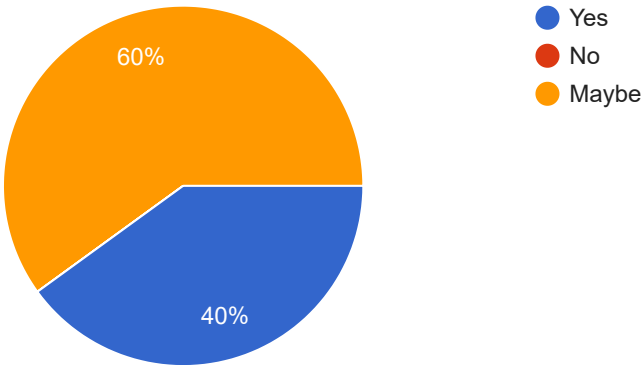
How long do you think you spend on the test since it started?

5 svar

- 20 minutes
- 30 minutes
- 20
- 20 minutes
- 25 min

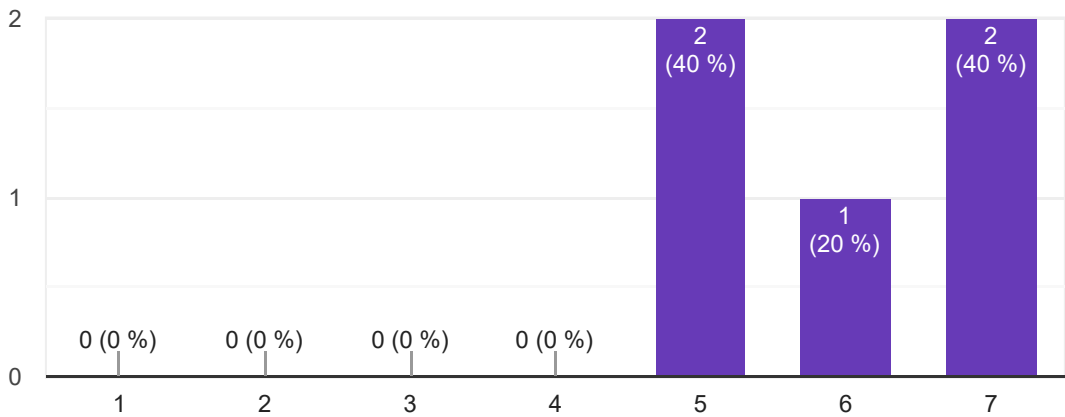
Is motion capture relevant to you professionally or in a hobbyist capacity?

5 svar



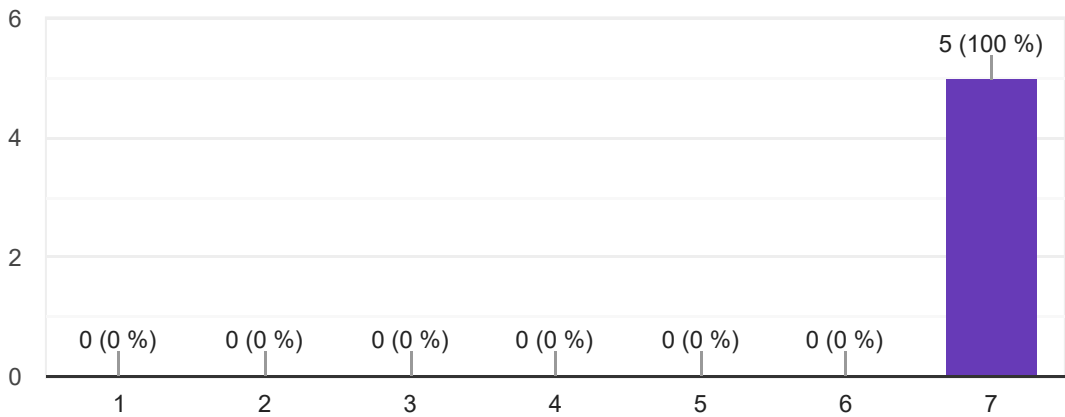
How confident would you be if you had to set up motion capture again in a week without the guide?

5 svar



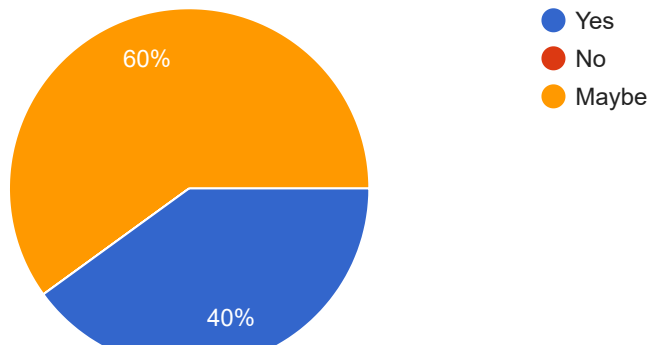
How confident would you be if you had to set up motion capture again in a week with the guide?

5 svar



Would you like to work with motion capture again?

5 svar



## Why?

5 svar

I think motion capture is awesome!

I might/might not stay in the world of game development, and I could definitely see its uses here.

Because of the many doors it opens up in regards to animation and previz

Well its a cool piece of hardware, but i would need an interesting project which involves it first

It has some nice possibilities that would otherwise take a long time

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