Virtual Online Shopping

CS39440 Major Project Report

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Declaration of originality

I confirm that:

* This submission is my own work, except where clearly indicated.
* I understand that there are severe penalties for Unacceptable Academic Practice, which can lead to loss of marks or even the withholding of a degree.
* I have read the regulations on Unacceptable Academic Practice from the University’s Academic Registry (AR) and the relevant sections of the current Student Handbook of the Department of Computer Science.
* In submitting this work, I understand and agree to abide by the University’s regulations governing these issues.

Name …………………………………………

Date ……………………………………………

Consent to share this work

By including my name below, I hereby agree to this project's report and technical work being made available to other students and academic staff of the Aberystwyth Computer Science Department.

Name …………………………………………

Date ……………………………………………

Acknowledgements

I am grateful to a lot of people, starting with the staff at Aberystwyth – who have motivated me and let me achieve my potential as a programmer. I also want to say thanks to my friends who have been there through this project – helping me visualise and think through ideas, debug when issues were out of my scope and for dragging me away from my PC when I become hyper focused.

I’d like to thank…

Abstract

During COVID19, online retail is as strong as ever. I will be exploring the use of Virtual Reality to support both retail stores and customers. The use of real-time simulation of clothing can contribute to this – customers are more likely to buy items if they can examine the goods. This will include identifying the fit and colour of selected clothing items. My aim is to simulate high street shopping but from the comfort of the customer’s home.

The data set will be from ASOS, I will be displaying a small selection of clothing items. A feature I will be implementing is a save feature. This will allow the user to take away the outcome of the application to then purchase the items if they so wish on the website.

The key features of this application are to have the ability to view clothing items in Virtual Reality. The application is going to be developed with the HTC Vive – though the application will be available on any headset compatible with SteamVR.

The application will have a specific area to filter down the clothing choices and an interactive area to view both the clothes and the model. The user can customise the model to match their measurements to see how the clothing looks using sliders. There is also a range of pre-set models to quickly choose from. Pre-sets are based on a range of body types and popular options, such as curvy, petite, and maternity.

With this application, I hope to validate Virtual Reality in this use case and produce a functional prototype to promote the use of VR in the retail sector.

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# Background, Analysis & Process

## Background

**Background preparation:**

Many images posted by online retail companies do not accurately represent the fit of an item. This has been an increasingly more problematic as Covid restrictions limit in-person interactions – decreasing shopping reliability. During this project, I wanted to explore other options and technologies to create a more reliable shopping experience.

**Similar systems assessed:**

According to background research, Mixed Reality has been explored in a similar context before by companies such as Zara and Topshop.

Zara used augmented reality app to bring virtual models to life. This was done in 120 stores for a two-week window during April. It worked with outfit and window displays, as well as AR enabled packaging and promotional materials. The main purpose of it was to display real models showing of clothes in short video bursts, between 7-10 seconds. These features are also available online by hovering their mobile over a package delivery. Overall, it increased sales by 2% that year.

Topshop used a virtual fitting room in Moscow, with a Microsoft Kinect and AR. Users could switch clothes using gestures and display them virtually on themselves. This was on May 10, 2011.

They have also used virtual reality to host a 360-degree catwalk. The hardware used was the Oculus Rift. It was hosted in London during Fashion Week 2014 and the experience feedback was overwhelmingly positive as it won several awards. The awards are:

* “Project of the year” at BT Retail Week Technology awards in 2014.
* “Best Hybrid Event/Virtual Event” at the 2014 Event Tech awards.

According to the “Add journal name” the AR approach could fit several use cases. It was the most successful when used to convey visual attributes such as coordination and style. The findings of the study indicated that AR is proficient at providing a base level of detail and made purchase intentions more favourable.

**Motivation and Interest:**

My motivation for suggesting this specific project and topic is rooted towards my passion for Virtual Reality. I worked with VR hardware during my industrial year and have decided to continue with it as a career. I also understand the frustrations of having to send back items of clothing when they are ill fitting.

## Analysis

**Taking into account the problem and what you learned from the background work, what was your analysis of the problem?**

The problem was that previous AR solutions were only viable on the base level and didn’t have enough detail to be reliable. With this in mind, I took aspects from many applications and games, to design an application that is both intuitive and informative.

**How did your analysis help to decompose the problem into the main tasks that you would undertake?**

The research I did opened the application up into several parts:

* Displaying clothes on a mannequin.
* Filtering clothing.
* User Interface to change the model dimensions.

**Were there alternative approaches?**

Developing an application AR was a valid route, as other approaches had done the same. The examples I found were from 2014, the technology has progressed from then. However, the core issues are still apparent as it does rely on external hardware for reliability.

**Why did you choose one approach compared to the alternatives?**

**There should be a clear statement of the objectives of the work, which you will evaluate at the end of the work.**

I will use VR to simulate clothes shopping – using a virtual dressing room. It fits in with the current political climate during this pandemic as people cannot physically visit stores. It will help online shopping as it can simulate the accuracy of trying on clothing items. The aim is to prove that this concept could work and be used by the public at sometime in the future.

**In most cases, the agreed objectives or requirements will be the result of a compromise between what would ideally have been produced and what was determined to be possible in the time available.**

**A discussion of the process of arriving at the final list is usually appropriate.**

There are minor security challenges expected as the application will be offline based, any saved preferences of clothing will be on the local system and the main data pull from the ASOS API must only be done once.

## Process

**You need to describe briefly the life cycle model or research method that you used. Focus on the process model that you have used. It is possible that you needed to adapt an existing process model to suit your project; clearly identify what you used and how you adapted it for your needs.**

For the project, I used a Kanban board hosted on GitHub. This will take full advantage of milestones by cross referencing notes from the weekly group meetings, ensuring I hit my minimum weekly goals. Weekly goals are agreed upon and documented in my blog.

The blog link is: https://lwilkinson.dev/vosBlog.html

In my process, I break down features into multiple components – Research, Implementation, and Testing. After all these parts are committed, then the pull request is closed and merged. When designing new features, I draw them out visually along with alternate designs. These are photographed and added into the project.

Github action - Mark stale issues and pull requests.

An example of this is:

# Design

**You should concentrate on the more important aspects of the design. It is essential that an overview is presented before going into detail. As well as describing the design adopted it must also explain what other designs were considered and why they were rejected.**

**The design should describe what you expected to do and might also explain areas that you had to revise after some investigation.**

**The use made of reusable components should be described and their source referenced.**

**Particularly important decisions concerning data structures usually affect the architecture of a system and so should be described here.**

* Blender
* Gimp

## Overall Architecture

The software for the project is Unity and the IDE for C# is Rider. The software which supports VR is SteamVR.

### Model Adjustment Levers

The Model Adjustment Levers control the dimensions of the body parts including waist, hip, neck, shoulders and bust. The script is simple as it uses an algorithm to calculate the levers range and assigns appropriate values from only the minimum and maximum. This object is referenced in the model to have a similar algorithm which assigns and scales the model.

I made the script attached to the model sliders as re-usable as possible, by reducing the amount public dependencies and iterating through a hardcoded list of strings instead to find the game objects. That both reduces de-referencing issues when it comes to game objects during development and makes the code clearer to any future developers.

**Graphical user interface, application

Description automatically generated**

### Model

The base model mesh’s have been took from a site online and I edited them for my use – the link for them are included in references. This was for a few reasons – the main being prioritisation of the other key components of the application. The models are royalty free and open source – to avoid any copyright issues.

The model works in tandem with the Model Adjustment Levers, the individual body parts are scaled according to the relative position of the lever. However, through research and finding implementation issues – I adapted the transform of the shoulders by changing the x value instead. The outcome of scaling them up is deforming the model in an inhumane way.

The scene detects the active model on the podium and enables the abstractModel script.

Diagram

Description automatically generated

Female and male model are different classes because the meshes have a different armature structure. The dictionary stores the name of the bones and that is given to the abstractModel class. The bones are found and set to be used in the ModelController script.



Both are added to the Model component within Unity.

### Information Filtering

Approaches

Flow diagrams

Sketches

Final Product

Add separate class diagram.

### Clothes

Approaches

Flow diagrams

Sketches

Add separate class diagram.

Final Product

#### 3D Modelling

The software I used to create the clothes was Blender 2.91.0 – the process was time consuming but returned good results. I started by selecting the faces of the mesh off the first model and then using the sculpt tool for the fine details.

Show images

### ASOS API Data

For the ASOS data pull, I used a third-party link called RapidAPI. I used this because it was free for my level of usage and simple to understand. It also allows data pulls to be done from the browser.

However, my software of choice for testing the API was postman. I have previously used this whilst on my Industrial year. It has a simple UI which allows you to change queries and clearly see the data.

I decided to write the pull in python in PyCharm 2020.2.3. I made it as an internal file for ease of use of other developers. This also future proofs the data pull so you get the data that fits and limits the errors within the main Virtual Online Shopping. This uses two end points to fill the data requirements, so the script must be custom.

Add separate class diagram for python.

Add separate class diagram to link to Unity project.

## Detailed Design

## User Interface Design

My aim is to utilise as many VR design aspects as possible, making sure all controls and UI are intuitive and clear to use.

This includes certain interactions:

* Sliders
* Physical push buttons
* Scroll Bars
* Click buttons
* Teleportation

### Teleportation

I put teleportation in the most active spots, the visuals showing when the teleport button is pressed. There is also a plane which is a teleport area – to give users more freedom when travelling around.

### Clothes

Clothes user interface – which shows errors when the items of clothing don’t fit. The UI for the clothing has a small tag attached as both a way of expanding on details and aesthetically. These are physically distanced from the model as to not cause any interaction conflicts.

### Clothes Spawning

![A picture containing text

Description automatically generated]()

### Model Adjustment Levers

A picture containing text, whiteboard

Description automatically generated ![A picture containing text

Description automatically generated]()

**explain what other designs were considered and why they were rejected.**

The UI on the model slider panel has multiple images attached via planes – which show the body part that would be affected. The sketches show the original design.

I decided against adding highlights on the physical 3D model for multiple reasons. The player should have a minimum number of concentration points, because that increases the complexity of the task – making it more complicated for first time users.

### Information Filtering

**Add sketch of filtering.**

To filter information, I have created a scrolling panel on the wall next to the clothing items. This can open another scrolling panel which shows a more detailed list of options.

## Other Relevant Sections

# Implementation

### 3D Modelling

I got the base models of the male and female from a website called put name here.

#### Rigging

A picture containing indoor

Description automatically generated

The model has two types of armature – one is to pose the model, the other is to change the model’s dimensions.

#### Scaling

#### Model Transformations:

Transformations of armature were done on a case-by-case basis as there were many small issues that I had to fix. One of those was scaling all the different body parts. They worked in different ways as some body parts – the shoulders for example, had to be moved along the X axis rather than scaling the bone up. This is because it had child components – which made up the arm. Unity scales all components which are children – resulting in unwanted model distortion.

**A picture containing white

Description automatically generated**

**Talk about global space and local space issues when moving the arms.**

### Clothes

I used a new package (EZ soft bones) to implement the cloth instead of using the inbuilt cloth component within Unity. I decided to use a new package for a few reasons.

The internal package uses a system of weighting points, in which you can edit how the cloth reacts in certain physics situations. It also needs to be pinned to an object – to keep it anchored. The issue with this is that I needed the clothing objects to be dynamic in scaling and to recognise the model collider mesh component as a rigid body collider. This component is limited as it only accepts capsule and circular colliders. I am also not pinning meshes to the models as it needs to display many clothes and it is difficult/computationally expensive to do on runtime.

The new package accepts a mesh body and simulates physics by using armature. This fits in better with the project architecture as I can dynamically scale the bones in the armature without distorting the mesh too much. The only downside is that there was limited documentation, this meant it took longer than anticipated to implement.

# Testing

## Overall Approach to Testing

Tested the features as I was going using debug statements and the Rider Debugger in Unity. I tested in both 2D and VR because the hardware needed specific inputs in the scripts. Also cannot test hand poses and check scale in 2D.

## Automated Testing

### Unit Tests

### User Interface Testing

### Stress Testing

### Other Types of Testing

## Integration Testing

## User Testing

# Critical Evaluation

* Were the requirements correctly identified?

**The scope was too big – many features didn’t get done because of time constraints. The requirements that were**

* Were the design decisions correct?

**The aestic and UI designs could have been more complex but there was a time constraint.**

* Could a more suitable set of tools have been chosen?

**For texturing, I would have liked to use TexturePainter however that is paid software. However, all the tools were proficient in creating the software.**

* How well did the software meet the needs of those who were expecting to use it?

**It could be more accurate.**

* How well were any other project aims achieved?
* If you were starting again, what would you do differently?

Other questions can be addressed as appropriate for a project.

identify and discuss the parts of the work that went well and also consider ways in which the work could be improved.

**Good things:**

* **Project management**

**Bad things:**

* **Overestimated the timeline in relation to the scope.**
* **Clothes and scaling aren’t as good as I wanted.**

**How to Improve?**

# Annotated Bibliography

This final section should list all relevant resources that you have consulted in researching your project. Each reference should also include a brief annotation.

1. Sylvia Duckworth. A picture of a kitten at Hellifield Peel. <http://www.geograph.org.uk/photo/640959>, 2007. Copyright Sylvia Duckworth and licensed for reuse under a Creative Commons Attribution-Share Alike 2.0 Generic Licence. Accessed August 2011.

This is my annotation. I should add in a description here.

1. Mark Neal, Jan Feyereisl, Rosario Rascunà, and Xiaolei Wang. Don’t touch me, I’m fine: Robot autonomy using an artificial innate immune system. In *Proceedings of the 5th International Conference on Artificial Immune Systems*, pages 349–361. Springer, 2006.

This paper…

1. W.H. Press et al. *Numerical recipes in C*. Cambridge University Press Cambridge, 1992.

This is my annotation. I can add in comments that are in **bold** and *italics*and then further content.

1. Various. Fail blog. <http://www.failblog.org/>, August 2011. Accessed August 2011.  
     
   This is my annotation. I should add in a description here.
2. Apache Software Foundation (2014) “*Apache POI - the Java API for Microsoft Documents*” (Online) Available at: <http://poi.apache.org> Accessed: 14th March 2014.

This is my annotation. I should add in a description here.

1. Apache Software Foundation (2004) “Apache License, Version 2.0” (Online) Available at: <http://www.apache.org/licenses/LICENSE-2.0> Accessed: 14th March 2014.

This is my annotation. I should add in a description here.

1. Neil Taylor, “MMP\_S08 Project Report and Technical Work”, 2019 (Online) Available at: <http://blackboard.aber.ac.uk/> Accessed 19th February 2019.

A document that outlines information about the marking guide for the Project Report and Technical Work. This is published in the Resources folder on Blackboard.

# Appendices

The appendices are for additional content that is useful to support the discussion in the report. It is material that is not necessarily needed in the body of the report, but its inclusion in the appendices makes it easy to access.

For example, if you have developed a Design Specification document as part of a plan-driven approach for the project, then it would be appropriate to include that document as an appendix. In the body of your report you would highlight the most interesting aspects of the design, referring your reader to the full specification for further detail.

If you have taken an agile approach to developing the project, then you may be less likely to have developed a full requirements specification. Perhaps you use stories to keep track of the functionality and the ’future conversations’. It might not be relevant to include all of those in the body of your report. Instead, you might include those in an appendix.

There is a balance to be struck between what is relevant to include in the body of your report and whether additional supporting evidence is appropriate in the appendices. Speak to your supervisor or the module coordinator if you have questions about this.

* 1. Third-Party Code and Libraries

If you have made use of any third-party code or software libraries, i.e. any code that you have not designed and written yourself, then you must include this appendix.

As has been said in lectures, it is acceptable and likely that you will make use of third-party code and software libraries. If third-party code or libraries are used, your work will build on that to produce notable new work. The key requirement is that we understand what your original work is and what work is based on that of other people.

Therefore, you need to clearly state what you have used and where the original material can be found. Also, if you have made any changes to the original versions, you must explain what you have changed.

The following is an example of what you might say.

**Apache POI library** – The project has been used to read and write Microsoft Excel files (XLS) as part of the interaction with the client’s existing system for processing data. Version 3.10-FINAL was used. The library is open source and it is available from the Apache Software Foundation [5]. The library is released using the Apache License [6]. This library was used without modification.

Include as many declarations as appropriate for your work. The specific wording is less important than the fact that you are declaring the relevant work.

* 1. Ethics Submission

This appendix includes a copy of the ethics submission for the project. After you have completed your Ethics submission, you will receive a PDF with a summary of the comments. That document should be embedded in this report, either as images, an embedded PDF or as copied text. The content should also include the Ethics Application Number that you receive.

* 1. Code Samples

This is an example appendix. Include as many appendices as you need. The appendices do not count towards the overall word count for the report.

For some projects, it might be relevant to include some code extracts in an appendix. You are not expected to put all of your code here - the correct place for all of your code is in the technical submission that is made in addition to the Project Report. However, if there are some notable aspects of the code that you discuss, including that in an appendix might be useful to make it easier for your readers to access.

As a general guide, if you are discussing short extracts of code then you are advised to include such code in the body of the report. If there is a longer extract that is relevant, then you might include it as shown in the following section.

Only include code in the appendix if that code is discussed and referred to in the body of the report.

Random Number Generator

The Bayes Durham Shuffle ensures that the pseudo random numbers used in the simulation are further shuffled, ensuring minimal correlation between subsequent random outputs.

// Some example code here…