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# **ABSTRACT**

This project entitled “Body Tracking Software” has been fulfilled as a requirement for the completion of Master of Technology (Business Analytics and Enterprise Systems) and Master of Technology (Software Engineering). The project is about creating a fully functioning mobile application using augmented reality for a body tracking software. It is virtual clothes try on app, to enable the user to try on clothes virtually anytime and anywhere. Through the app, users are going to be updated by the latest trends on clothing with the help of AR and share it to their friends on social media.

For developing this platform, the team has used different tools and technologies such as Viromedia, Viro React cli, Blender. The project client is Trigensoft Lty Ltd., which is based in India. They have entrusted us their project requirements, goals, methodologies, project implementation and project deliverables-which we have all achieved efficiently. Moreover, we have utilised agile methodology and scrum framework throughout the whole duration of the project and for the team to achieve our project milestones. The Body Tracking software project has been completed within the specified time frame and all the expectations and respected outcomes have been fulfilled.

Key words:

Body Tracking Software, Agile Methodology, Scrum Framework

**Table of** **Content**

[**ACKNOWLEDGEMENT** 1](#_Toc74860448)

[**ABSTRACT** 2](#_Toc74860449)

[List of Tables and Figures 5](#_Toc74860450)

[**1.** **INTRODUCTION** 6](#_Toc74860451)

[1.1 Background Information 6](#_Toc74860452)

[1.2 Problem Statement 7](#_Toc74860453)

[1.3 Project vision 7](#_Toc74860454)

[1.4 Project Objectives 7](#_Toc74860455)

[1.5 Significance/Impact of the Project 8](#_Toc74860456)

[1.6 User Stories 9](#_Toc74860457)

[1.7 Stakeholders Involved. 15](#_Toc74860458)

[1.7 Report organization 16](#_Toc74860459)

[**2.** **RELATED ACADEMIC RESEARCH** 17](#_Toc74860460)

[2.1 Literature review 17](#_Toc74860461)

[2.2 Conclusion drawn from the literature review. 19](#_Toc74860462)

[2.3 Justification of the Proposed product 19](#_Toc74860463)

[**3.** **SYSTEM DESIGN** 20](#_Toc74860464)

[3.1 System Overview 20](#_Toc74860465)

[3.1.1 System Flow Diagram 20](#_Toc74860466)

[3.1.3 Use-Case Diagram 21](#_Toc74860467)

[3.1.4 Human Body Detection/ Coordinates 22](#_Toc74860468)

[23](#_Toc74860469)

[3.2 System Architecture Design 24](#_Toc74860470)

[3.3 Features 24](#_Toc74860471)

[ Try on Shirt and Pants 24](#_Toc74860472)

[ Take screenshots. 24](#_Toc74860473)

[ Share in social media platforms. 24](#_Toc74860474)

[**4.** **SYSTEM IMPLEMENTATION** 25](#_Toc74860475)

[4.1 Design specification 25](#_Toc74860476)

[4.1.1. Methodology 25](#_Toc74860477)

[4.1.2 Tools Used 26](#_Toc74860478)

[4.1.3 Functional and Non-functional requirements 28](#_Toc74860479)

[4.2 Coding and Implementation 29](#_Toc74860480)

[4.2 Interface 40](#_Toc74860481)

[**5.** **TESTING** 41](#_Toc74860482)

[5.1 Functional Testing 41](#_Toc74860483)

[5.2 Non-Functional Testing 42](#_Toc74860484)

[**6.** **CONCLUSION** 42](#_Toc74860485)

[6.1 Application of the product 43](#_Toc74860486)

[6.2 Limitation of the Product 43](#_Toc74860487)

[6.3 Future work 44](#_Toc74860488)

[References 45](#_Toc74860489)

# List of Tables and Figures

[Table 1.1 User Stories 15](#_Toc74860800)

[Table 1.2 Stakeholders involved with roles and responsibilities. 17](#_Toc74860801)

[Figure 3.1 Flow Diagram 21](#_Toc74860802)

[Figure 3.2 Use-Case Diagram 22](#_Toc74860803)

[Figure 3.3 Human Body Coordinates 24](#_Toc74860804)

[Figure 3.4 System Architecture Design 25](#_Toc74860805)

[Figure 4.1 SDLC Cycle 26](#_Toc74860806)

[Table 4.1 Laptop Hardware Specification 29](#_Toc74860807)

[Table 4.2 Mobile Hardware specifications 29](#_Toc74860808)

[Figure 4.2 App front preview 31](#_Toc74860809)

[Figure 4.3 ArKit 32](#_Toc74860810)

[Figure 4.4 App Camera Preview with Shirts in AR andPants in AR 41](#_Toc74860811)

[Figure 5.1 Use Case Testing for Viewing model 42](#_Toc74860812)

[Figure 5.2 Use case Testing for detecting body positions. 42](#_Toc74860813)

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# **INTRODUCTION**

## Background Information

Augmented reality (AR) is now a widely used technology which lets computer generated virtual images to precisely overlay physical objects in real time (Feng Zhou, 2008). Therefore, augmented reality lets the users to allow the interaction between virtual images and real objects. AR technology is one of the fastest growing technologies in different sectors such as engineering, entertainment, health, education, and retail. Moreover, AR is indeed rapidly affecting the software industry nowadays; commonly used applications are utilising AR technology to create camera filters, make up and background effects. According to (Lee, 2021), building an AR application from scratch is never easy. The developers should have an advanced knowledge of algorithms especially for motion tracking, image processing, machine learning and even spatial analysis. However, Apple and Android made AR software development kits which includes the necessary algorithms to make the AR application more manageable.

The Body Tracking Software utilizes AR to track the body of a user, so they can try on clothes virtually anytime and anywhere. The virtual try on clothes app gives outfit options to the users from their mobile phones for the users to discover trendy and stylish clothes with the help of augmented reality. The virtual try-on experience will help the users to try the clothes in detail which can enhance their experience. According to (Arzilla), the idea of tracking a person’s whole body came from VR when it was utilized in gaming purposes. It is fulfilled through using sensors which are called outside-in tracking. However, we are using AR for smartphones. The user will not be wearing trackers but will be relying on the phone’s hardware which is called inside-out tracking. The smartphone needs to have and is not limited to have the phone camera, accelerometer, and gyroscope.

Operating systems such as Android and IOS are now creating advanced AR features available to developers during these times. However, IOS is leading the way between the two operating systems. At present, smartphones can now detect human body which works best if there is correct lighting, with 1 person or 2 people within the frame and when they are facing the camera. According to (AR Tech You Can Use in Your App Today, 2020) body tracking was just a recent addition to Apple and Android’s AR SDK’s so it is still not perfected and basic features are still light. Therefore, body tracking still faces new and various issues at present as it is in its early days of technology, but it will improve in the future.

In this project, a virtual try on clothes app is developed that supports IOS platform. It displays the user wearing the shirt or pant on a smartphone by reflecting the clothes on the user’s body in real-time. The technologies involved in the development of this app includes AR, human body detection as well as motion tracking. The different body coordinates are captured and then the movement of the body is tracked that helps to fit the clothes on the body perfectly. The users are able to screenshot the real-time virtual try on clothes images and share it to the social media or different channels to get feedback from them. The body tracking software enables the user to see the outfits from the different angles. The virtual try-on clothes app can be integrated into different retail business app and thus shoppers can enhance their shopping experience without going to the physical store and wasting time. As online shopping is getting popular nowadays, this app can help to decrease the returns of online shopping and also users can visualize different personalization options. Hence, the body tracking software is an effective app to the shoppers to experience a new feature while doing online shopping as it enables users to try the clothes virtually without stepping foot to the store. It benefits the retailers by increasing the sales and building relationship with customers. Thus, in this project a body tracking software is developed where the camera detects the body coordinates and images of clothes can be overlayed in the body of the person in real-time.

## Problem Statement

The online shopping is growing so fast globally especially in this pandemic situation as people could not travel anywhere physically. It has increased the need of digital transformation. A high-quality digital experience is essential for retailers to improve their business and building brands.

Online shopping has lots of benefits as customers can purchase their items without going out of the home, it saves time as they do not have to travel far from shopping as well as they do not have to stand in the long queue for payment. But it has some disadvantages too. Especially for clothing, the customers are unable to know how the clothes fit in their body. It limits the idea of how the clothes will looks like. Most of the consumers feels that finding the perfect fit of the cloth is very difficult and it results in returning of the products. It results in greater loss of the retailer as well as customer will be switching brands due to unfit clothing. It will be great difficult for retail business to offer return policies and as well as free shipping if the size is inadequate. Also, the fitting rooms may take space which can be utilize fully for other purposes.

Thus, these limitations have encouraged to develop the body tracking software, where the users can try and choose different clothes fitted in their body in real-time. By integrating the app, the retailers can earn huge revenues. This app built with Unity and ARKit helps in trying the clothes without physically putting step to the store that helps to save time, efficiency and improve the image of the store.

## Project vision

The vision of the project is to develop IOS platform-based application for tracking the body so that clothes can be worn in the real-time. The main theme is to develop an AR project for 3D virtual clothes that a user can try on without taking off actual clothes. The accessibility of the clothes can be improved due to this app. The vision goes beyond than developing the platform. The users are able to do the screenshot of the outfits and can send to their loved ones through various social media. Through this app, it is envisioned that the users can experience the convenience of trying out 3D clothes whenever and wherever, thus, providing a great user experience.

## Project Objectives

The project objectives are the deliverables that are needed to be achieved at the end of the project. A well written objectives are needed for planning and to meet at the end. They are the short-term goals.

The objectives of our project are:

* To make a fully functioning mobile application using augmented reality (AR) for a body tracking software. This is clothes try on app, wherein the user can try on clothes virtually anytime and anywhere.
* To provide convenience to users wherein they can try out whenever and wherever clothes without the hassle of going to physical stores.
* To detect the human body positions and body movements using smartphone cameras.
* To let the users, take a screenshot when they are trying the 3D cloth or pants and save it to their gallery.
* To let the users, share their saved photos of them trying the 3D clothes and share to their family and friends through social media such as Instagram, Facebook, WhatsApp and so on.
* To let users, share their saved photos on Air Drop, assign saved photos to their contacts or create Apple Watch face with the saved photo as well as save the photos in Apple’s Files app.

## Significance/Impact of the Project

There are several positive impacts of the proposed product.

* As online shopping faced the problem of large number of returns of the clothing, AR body tracking system solve that problem by trying clothes on the body without physically trying on the body by going to physical stores.
* It is very tedious job to take off and put on the clothes which is very time-consuming activity. So, by using this software integrated with ecommerce applications the customers can save time and build up confidence in buying the clothes.
* The cloth retailers can utilize their space by not building fitting rooms thus can save cost, increase satisfaction, and improve image of the store.
* The more personalized shopping experience can be experienced by the online shoppers and retailers can improve the brand image of the product.
* Convenience is provided to the users through this app as they can try on 3D clothes anytime and anywhere as well as they can share the photos to their friends and family on social media as well as Air Drop the photos or even share their photos on their photo editing app.

## User Stories

The user stories describe the perspective of user for the software development. It gives description of the types of users and what they want. They are the requirements needed for the development of the software.

The user stories of the project are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| User Stories | Acceptance criteria | Priority | Student role | Time estimation |
| US1: As a user, I want the app to be user-friendly | When the app is simpler to use. | Medium | Make the interface simpler. | 2 days |
| US 2: As a user, I want to try the shirts on AR | When the shirt is successfully overlayed on the user’s body. | Critical | Create rigged shirt 3D model and used bone controller to pinpoint the joint points of human body. | 4 days |
| US 3: As a user I want to try the pants on AR | When the pant is successfully overlayed on the user’s body. | High | Create rigged Pant 3D model and used bone controller to pinpoint the joint points of human body. | 4 days |
| US 4: As a user I want my body to be tracked constantly | When the user moves the 3D outfit also moves according to the body points. | Critical | Used motion tracking code which gives the refreshed coordinates of the body catches from bone controller program. | 4 days |
| US 5: As a user I want to take a screenshot of my outfit | When the user is able to take screenshot. | High | Used the screenshot feature of mobile phone and catch it using the program. | 1 day |
| US 6: As a user I want to share my outfits to my friends | When the screenshots are shared with friends. | High | Wrote a program to share the screenshot. | 1 day |
| US 7: As a user I want to fit clothes perfectly on my body while viewing in AR | When the application detects the user’s body an overlay outfit on top of it. | High | Used human body tracker and bone controller. | 3 days |
| US-8: As a user I want my screenshot image to be not saved elsewhere. | When the image is not visible elsewhere in the application after exiting. | Critical | Used function only to share screenshots and application has no database linked to it. | 1 day |
| US-9: As a user I want to view 3D outfit from different angles and sides. | When the dress fits and appears in AR view from different angles and sides. | High | Used human body tracker and bone controller. | 1 day |
| US-10: As a user, I want the UI design to be simpler so it will be easy to use and understand. | Suitable to IOS 13.0 and above. | Medium | Created simple functions. Made the app easy to use. | 3 days. |
| US-11: As a user, I want to use all the navigation in the application so that I can access all the functions of the app. | Navigation bar must be easier to understand. | Medium | Created only essential menus and created a clear hierarchical structure. | 1 day |
| US-12: As a user, once in the dashboard, I need to see all the functionalities of the app. | Dashboard menu is easy to understand. | Medium | Created a dashboard that is easy to understand. | 2 days |
| US-13: As a user, I want my photos to be saved in my gallery | Screenshots can be downloaded from app to user’s gallery. | High | Wrote a program to let user save the photos to gallery. | 2 days |
| US-14: As a user, I want my screenshots to be shared on my social media platforms | Screenshots can be shared via Instagram, Facebook, Whatsapp & etc. | High | Wrote a program to enable the user share their photos in social media | 3 days |
| US-15: As a user, I want my photos to be shared on Instagram with having options how to share it | When users can pick how to share photos either as a story, post or message. | Medium | Wrote a program for users to have choices how to share in Instagram. | 1 day |
| US-16: As a user, I want to access the app without any lag/error free so that I don’t have to wait too long | The user should experience the page to load at least 2 seconds or below 2 seconds. | High | Continually did testing and constantly checks the run-time. | 3 days |
| US-17: As a user, I want the application fonts to be the right size so that it is easier to navigate. | The apps font should be at least 12 px on and at least 60% of the text on the page. | Medium | Ensured to pick the right font and size. | 1 day |
| US-18: As a user, I want the navigation buttons to be the right size so that it is more convenient to navigate. | There is ensured balanced information, density and usability. | Medium | Created navigation buttons which is 48x 48dp, with at least 8dp (or more) between them. | 1 day |
| US-19: As a user, I want the landing page to be distinguished so that the user will be keen to use the app. | The landing page should describe the functions of the mobile app. | Medium | Created a landing page just showing the choice of trying on a shirt or pants. | 1 day |
| US-20: As a user, I want the camera button to be simple as possible | The camera button should be between 42-72 pixels. | Medium | Found a simple camera button design and added it to the code. | Half day |
| US-21: As a user, I want to share photos on social media without logging in again | When clicking to share on social media, the app already connects to the account of the user. | Medium | Created a code to integrate app with the social media accounts of the user. | 2 days |
| US-22: As a user, I want my integrated social media apps and photo gallery’s privacy be maintained. | Session should be maintained. | Critical | Session option in the backend is explored and ensured user’s privacy and security. | 1 day |
| US-23: As a user, when I am not using the body tracking app, I want my credentials in the integrated social media apps still secured | Session should be maintained | Critical | Session option in the backend is explored and ensured user’s privacy and security. | 1 day |
| US-24: As a client, I want video report of work done to verify equal work done within the team. | Division of roles and responsibilities during the Master’s Project. | High | Make Power Point showcasing every team members work and other essential documents. | 2 days |
| US-25: As a client, I hope the team still continually improves the app in the future. | More improvement and features can be added. | Medium | Meet the client expectations. | 3 days |
| US-26: As a client, I want the app to be able to adapt to some requested requirements in the future. | More improvement and features can be added. | Medium | Client requirement should be met. | 3 days |
| US-27: As a client, I want all the test cases to meet the requirements | Client requirements should not fail. | Critical | Use case testing, performance and usability testing. | Continuous testing during the sprints |
| US-28: As a client and application manager, I want to see the entity relationship designs so that I can view if the flow of the application is well-defined or not. | The entity, attribute and relationship should be shown some elements as well such as weak entity, multi value attribute, derived attribute, recursive relationship and weak relationship. | High | Created effective entity relationship designs. | 1 day |
| US-29: As a client and application manager, I want to see the control flow diagram so that I  can view if the flow of the application is well-defined or not | The control flow diagram should show where the control starts and where it ends and where it may branch off to another direction with given circumstances. | High | Created an effective control flow diagram. | 1 day |
| US-30: As a client and application manager, I want to view the user schema so that I can view if the project flow is properly defined or not. | The schema should include the set of objects such as tables and views that belongs to the database. | High | Created an efficient user schema. | 1 day |
| US-31: As an application manager, I want all access in order to manage all data and information in the application. | There should be full access given to the application manager in order to manage problems and issues as they arise and to improve the app where it’s possible. | High | Given full rights for accessing the data and information of the app. | 1 day |
| US-32: As a user, I want to share my photos in suggested groups or contacts in my phone which I frequently contact. | Frequently contacted group chats or contacts are shown in the sharing option in the app. | Medium | Created a code to show suggested contacts and groups which user contacts. | 1 day |
| US-33: As a user, I want my photo to be shared via AirDrop. | Shares to Iphone users instantly without social media platforms. | Medium | Created a code to enable AirDrop sharing. | 1 day. |
| US-34: As a user, I want the taken screenshot photo to be saved as my contact photo. | Users can assign the photo to a specific contact. | Medium | Created a code to enable assigning the photo to a contact. | 1 day |
| US-35: As a user, I want to share my photo in Facebook as a private message. | Photo can be shared on Facebook in a private message either to a group chat or a single friend. | Medium | Created a code to enable sharing in Facebook as a private message. | 1 day |
| US-36: As a user, I want the option to have the photo to be printed. | App can connect to printer. | Medium | Created a code to integrate app to print photo when connected to a feasible printer. | 1 day |
| US-37: As a user, I want the option to connect to a photo editing app in my phone. (i.e. Photoshop Express) | Photo can be shared to a photo editing app user’s phone. | Medium | Created a code to integrated app to a photo editing app. | 1 day |
| US-38: As a user, I want the the option to share my photo in DropBox or Files in Iphone. | Photo can be accessed in DropBox and Files. | Medium | Created a code to integrate app to Files app in Iphone and Dropbox. | 1 day |
| US-39: As a user, I want the option to use photo to create Apple Watch Face. | Photo can be accessed to create Apple Watch Face. | Medium | Created a code to integrated app to Apple Watch Face. | 1 day |
| US-40: As a user, I want the option to copy image to any other platform. | Photo can especially be copied to Mail or Gmail app. | Medium | Created a code to enable copying the image to other apps. | 1 day |

Table 1.1 User Stories

## 1.7 Stakeholders Involved.

Stakeholders are those who are interested in the project or who are directly and indirectly involved in the project. They are the members of the project team. They can be customers, project managers, team members, supervisors, project managers etc. There can be internal and external stakeholders of the project. They have interest in the project, and they can affect the outcome of the business project. The requirements can be altered by them time to time during the different phases of the project. They provide clear results based on experience and identify different constraints of the project. During the whole duration of our Master’s project, the stakeholders played an important role in providing an impact or is impacted by the fulfillment of the team’s objectives. The stakeholders also evaluates the requirements and ensures to fulfill them. (Benn, Abratt & O’Leary, 2016).

The stakeholders associated with this project are:

|  |  |  |
| --- | --- | --- |
| **Name** | **Email-ID** | **Roles and Responsibilities** |
| Parimal Kumar (Trigensoft Solutions Pvt. Ltd. | [parimal@trigensoft.com](mailto:parimal@trigensoft.com) | Client  - Making important decisions regarding the project.  - Keeping track of the progress of the project  - Provides a clear project assignment  - Attends in a regular meeting for discussing about the requirements  - Performs acceptance testing  - Approving the project. |
| Vishal Saha | [Vishal.Saha@atmc.edu.au](mailto:Vishal.Saha@atmc.edu.au) | Supervisor  - Evaluating performance  - Providing feedback  - Helping to resolve different issues  - Ensuring the tasks have been performed on time |
| Kathleen Mediavillo | [30376525@students.atmc.edu.au](mailto:30376525@students.atmc.edu.au) | Project Manager  - Organizing team  - Monitoring the progress  - Knowledge in developing app and analytics  - Timely communication with supervisor and client  - Controlling project management  - Active involvement in other project activities |
| Rachita Awal | [30377003@students.atmc.edu.au](mailto:30377003@students.atmc.edu.au)) | Business Analyst and Researcher  - Identifying the problems  - Research designs  - Research existing business systems  - Document the requirements of business  - Active involvement in other project activities |
| Bibek Adhikari | [30376204@students.atmc.edu.au](mailto:30376204@students.atmc.edu.au) | **Back-end developer**  - Proficiency in programming  - Knowledge of app development  - Experience in version control system  - Proficiency in HTML/CSS, JavaScript, UI/UX design  - Proficiency in Unity & ARkit |
| Pratik Maharjan | [30376695@students.atmc.edu.au](mailto:30376695@students.atmc.edu.au) | **Front-end developer**  - Proficiency in graphic design  - Proficiency in HTML/CSS  - JavaScript  - Creativity in UI/UX design  - Proficiency in Unity & ARkit |

Table 1.2 Stakeholders involved with roles and responsibilities.

## Report organization

The report is organized into six chapters. The each of the chapters provides content that are related to each other. The first chapter includes the introduction of the project. It provides the brief explanation of the project, its background information, the stakeholders involved, the project objectives, project vision and the user stories involved to complete the project.

The chapter 2 reviews the existing system related to the body tracking software based on AR. Different existing system are studied with their pros and cons. Each of the case studies are reviewed properly that have been implemented with the similar solution as the proposed project. They are all related to tracking the body and virtually trying the clothes without going to the store physically. The different research is critically evaluated and summarised in this chapter. Also, the justification of the proposed product from the existing research has been included.

The chapter three describes the system design that includes the flow diagram, activity diagram, use case diagram of the system. The feature of the system is described with the camera model as well as detecting human body movements and positions by overlaying the image of clothes to the image of the body.

The chapter four explains about the work procedures used in the system, types of methodology used, functional requirement of the system as well as coding and implementation of the system. Here, design specifications are mentioned with its tools and technology used.

The chapter five includes the testing of the product. The testing can be functional testing and non-functional testing. The verification plans are developed to test the product to locate any bugs or errors. Different test cases were developed to evaluate the product.

At last, the chapter six includes the conclusion of the report. It includes the summarization of the report including application of the product and limitation of the product. The future work and improvement to be done is also mentioned in this chapter.

# **RELATED ACADEMIC RESEARCH**

## 2.1 Literature review

Augmented reality is an experience of overlaying the digital information into the real-world objects. There are many apps that are currently using augmented reality. It makes it seem like the content is there in the physical world. It allows people to add different digital elements into their actual environment. The application of augmented reality has gone beyond the video games, television, navigation to human body detection and tracking, healthcare, logistics and so on. The one-to-one customer interactions is possible through augmented reality. (Overby, 2019) There are many companies who are taking advantage of the AR feature. The furniture company Wayfair has incorporated an AR app to let the customer experience how the piece of furniture would look like in their home before buying it. The human body tracking system is possible by body mapping and object tracking done through implementation of the AR concept that can have future scope on online shopping through virtual trying on clothes.

An augmented reality for body tracking can eventually change the shopping experience of the customers by trying on clothes without physically wearing the clothes as per (Hirschfeld, 2020). The Hirschfeld also mentioned that almost 100 million people tried the augmented reality technology for shopping due to the COVID situation that has gained the popularity towards this technological trend. The use of the AR app has helped the retailers to analyse the patterns of shopping and can know what styles are popular so that they can keep stock in their physical stores accordingly. The virtual try-on clothes can enhance the personal experience of the shoppers due to new features such as comparing the avatars or checking it from different angles without physically trying the clothes. (Miaolong Yuan, 2014). The user study proposed by them evaluates the user’s perception of how the experiences of using the virtual images and how it affects in the purchase decision of the customers. The three different case studies related to the same proposed solution are reviewed as below:

**Case Study 1: Virtual Fitting Room by Zeekit**

Zeekit has developed a virtual fitting room with the combination of fashion and technology that let customers to try the clothes found online. It revolutionizes the way people do shopping by giving chance to the shoppers to try every clothes of the catalogue which are personally modified with the size of the customers. Shoppers can see how the outfit looks from different sides and as well as get the recommendation of friends. As inspired by military related technology, it has been able to map a person’s image into thousands of segments through rendering 3D images over 2D images. The deep learning techniques used by the team scans the online catalogue and analyses each item by letting it to divide more into other smaller segments. Virtually dressing and seeing how the outfit looks, has enhanced new world of personal shopping experiences and encourage customers to become their own model which has reduced the online returns of the packages. This application estimates different body measurements and see whether the outfits fit them or not. (Xu, 2019)

**Case study 2: The DressingRoom by Gap Mobile App**

The Gap mobile application uses the augmented reality that enables the shoppers to try the outfits by choosing avatar of various sizes. The phones must support Google’s tango technology for this app to be installed in the smartphones. It uses the phone’s camera and sensors to map the room and overlay the virtual objects into real-world environment. It lets to place different virtual mannequins around the room which are dressed up in the different outfits which gives the idea to the fit of the outfit and how it looks. A detail looks of the fabric, the embroidery, the designs of the dress. It lets customers try the clothes without setting foot to the physical store. It creates 3D renders for fashion brands. It overlays virtual images such as clothing on the top of the real-life images and the customers will have the ability to move around the avatar to see how the clothing looks from different angles. It currently offers five different body types. They are constantly exploring new ways of adding value to the experience of the customers. They are trying to satisfy the customers by giving the exact fit of the fabrics they see while doing online shopping as it has become very popular nowadays.(Liz Nunan, 2017)

**Case study 3: Webcam Social shopper**

Webcam Social Shopper is a virtual dressing room software where the webcam turns into the digital mirror. With the wave of the hand the user can try various tops and pants. It is the app developed by Zugara. The motion capture app allows to select different items and styles. Also, the users can take pictures of their outfits and send it to their friends. It is available as a SaaS software. It scans our whole body and track our movement and gestures using the camera. The WSS software lets the user to use the hand motions to try the outfits and change the outfit colour as well as size. It is the customizable software that are integrated now on different social sites. It is the product visualization tool that has been embedded by different retailers for enhancing the personal shopping experience of the people. (Kale, 2011)

The real-time interactive mirror is available on the website [www.webcamsocialshopper.com](http://www.webcamsocialshopper.com). And users need permission to download it. In this software, the user have to stand some feet apart from the camera and the software can detect the position of the body. Then, users can browse different option and choose the outfit accordingly. As it offers full integration, it became very popular for ecommerce platform. (Ling, January 2020)

## 2.2 Conclusion drawn from the literature review.

From the literature review, it can be known that there are certain strengths and weakness of the existing product. The Zeekit virtual fitting room has certain advantages like the 3D outfit fit to the body perfectly, but as the image is static it cannot be viewed from the different angles. The webcam social shopper capture the motion of the body and it was developed almost like 12 years ago due to which new features has not been added. It is less efficient in detecting the body. Nowadays, 3D images are popular, but the WSS software generates 2D images. The 2nd case study, the DressingRoom by the Gap helps to fit the garment in the avatar. The main pitfall of the app is as it generates the avatar, there can be differences between actual body and the avatar that can results in purchasing inappropriate size of the outfit.

## 2.3 Justification of the Proposed product

The proposed product is the need of a user-friendly platform. It is based on a IOS platform using augmented reality that helps to detect and monitor the body movements in real-time by overlaying the images. As per the research (Papagiannis, 2020), 51% of the people are willing to use this technology to assess the products. Using AR for online shopping has 94% higher conversion rates. Different retail business has adopted the AR software in their business for online shopping for the convenience of the customers and decrease the chances of returns. During New York Fashion Week of 2018, AR technology was used by Moschino and H & M’s retail and the people were able to purchase the clothes on the spot without trying physically but through the augmented reality.

The proposed product is simpler to use, and smartphone camera is utilized to detect the human body movement and tracking. The virtual 3D clothes are properly overlayed on the body of the person in real-time. Moreover, as the retail business is one of the most innovative and rapidly changing industry, the key players are moving towards AR in order to provide users a seamless experience. Through our virtual try on clothes app, the users can experience a more enhanced customer shopping experience. A bonus to that is they can also share it to their friends through social media. Due to the recent Covid-19 pandemic, more and more people also preferred to shop online. The pandemic can lead the consumers to be more likely to be hesitant about going to physical stores especially on hardly hit countries, therefore leading them to shop online. Therefore, our virtual try on clothes app through AR will be effective and efficient in the Covid-19 situation. In addition to that, according to analysts, if shoppers can also see the genuine representation of themselves, they are more likely to purchase the product and have a lower chance of making a product return.

# **SYSTEM DESIGN**

## System Overview

### 3.1.1 System Flow Diagram

Diagram

Description automatically generated

Figure 3.1 Flow Diagram

In the above flow diagram, it shows the basic concept of how our program works. As our program is a mobile application, when the application first opens and it gives the user a choice between 2 scenes i.e., shirt scene and pants scene. Then, the user can select either of the scenes. When the section is made, the mobile camera is then opened, and after pointing the mobile camera at the user’s body, the application starts to track the human body. Our application is equipped with a bone controller program which lets the application pinpoint various joint points of the human body. After the application starts to pinpoint the points on the user’s body, the 3D model of the outfit is displayed, and according to the points that the application has gathered; the 3D shirt also gets those points which then helps the 3D object to be mapped with that of the user’s body. Till this process, the 3D outfit is overlayed in the user’s body via the mobile camera. Now comes the motion tracking wherein the application tracks the movement of the human body and passes the points for the joints of the user’s body accordingly, which then is mapped with the 3D model of the outfit and the 3D outfit is overlayed to the user’s body as the user moves.

### 3.1.3 Use-Case Diagram

Diagram

Description automatically generated

Figure 3.2 Use-Case Diagram

This is a use-case of the application where it shows the functions the user can access while using the application.

### 3.1.4 Human Body Detection/ Coordinates

Diagram

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### Diagram Description automatically generated

Diagram

Description automatically generated

Figure 3.3 Human Body Coordinates

There are 3 different figures where the first figure shows the human body coordinates related to the upper body part to overlay the image of shirt, second figure shows the human body coordinates related to arms and shoulders whereas the third figure shoes the human body coordinates related to lower body part to overlay the image of pants. The model is transformed as per the frame to track the body in real-time. The scaling and transformation parameters have been produced to draw the model in the live video as per the skeleton joint points of the body.

## Diagram Description automatically generatedSystem Architecture Design

Figure 3.4 System Architecture Design

## Features

Our application has met all the required functions which we provided in the product description. Features as requested by the clients are:

## Try on Shirt and Pants

The user can select to choose among shirt or pants to try it in virtually through Augmented Reality.

## Take screenshots.

The user can take a screenshot while trying outfits with the use of Augmented Reality.

## Share in social media platforms.

Upon taking a screenshot of the user with overlayed 3D outfit, it can be shared among various social media platforms such as Instagram, Facebook, email, WhatsApp, Multimedia message and many more.

# **SYSTEM IMPLEMENTATION**

## Design specification

### Methodology

The software development life cycle is followed in the completion of the project. It involves a series of steps to be followed for the completion of the project. The process involves the identification of requirements, definition of requirements, design of the product, implementation of the product and the evaluation. The right SDLC process can affect in the success of the business project.

Diagram

Description automatically generated

Figure 4.1 SDLC Cycle

Figure 4.1 shows the Software development life cycle which is followed to complete this project. First the requirement analysis of the project is done. The requirements were mentioned by the client which were studied through different research and literature review. As per the requirement identification, the system design is done. In this phase, the architecture, user interface, types of programming language, platforms for development are discussed and demonstrated. The flow diagrams, use case diagrams, activity diagrams and sequence diagrams were designed. Then, the implementation is done. After that, testing of the app is done with its deployment. It is the never-ending cycle. SDLC helps to improve the process of development that maximizes the efficiency at each of the stage (Jevtic, 2019). Through SDLC cycle, the team was able to lessen the difficult of developing an app from scratch within a framework of structured phases that helped in shaping the virtual try on clothes app and manage it efficiently. According to Svitla (2019), a SDLC is essential as it helps in transforming an idea project into a fully functional operating system. The cycle covers important aspects such as processes, procedure development, user experience, change management and etc. Through SDLC, the team was able to provide goals and deliverables, make decisions and improve the quality in each phase of the life cycle.

**Agile research methodology**

The proposed project follows the agile methodology for the software development. This iterative approach has helped us to deliver the value to the customer in time and regular feedback of customer has made the project to become successful. It focuses on collaborative effort of cross-functional teams. It is highly flexible than the other methodologies. A project storyboard was developed which describes the outline of the project, the vision of the project, the scope of the project as well as the project approach. It helps the team to know what to do next in the project. A project roadmap was prepared that includes the project schedule, product backlog, user stories and so on, that specifies the full list of requirements needed for the project and when to complete the project is specified. A total of three sprints was included which was needed to be completed in two weeks respectively. The scrum, which is an agile framework- was involved for the software development. The sprint backlogs were prepared in each of the sprints that visualizes the progress of the tasks involved. (Muslihat, 2018). Based on iterative approach, agile methodology breaks the task into smaller tasks where the no of iterations, the duration as well as scope of the project is mentioned. Regular communications with the client is possible with the agile methodology. According to Peitl & Baptista (2017), agile methodology produces empowered teams. This type of methodology tackles the problems which are found through traditional work as well as providing answers to challenges in the upcoming future which are the increasing rate of change and the amount of difficulty in the project that the team developed. Therefore, the agile methodology aims on achieving positive results. It aims to be not complex, responsive, provide technical excellence and highlights collaborative practices.

Agile development aims at both

tackling the problems identified with traditional work, and also

answering to challenges of the future such as the increasing rate of

change and the amount of complexity in products we develop [5]. An

agile methodology focuses on results: It is simple, it is responsive and

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### Tools Used

#### Software:

* **Unity**:

Unity is a real-time 3D development platform. It can also be called cross-platform engine. Unity is one of the most popular engines for creating games in various platforms including consoles, virtual reality, mobile and desktops. It is the technology used for creating real-time interactive content. It is used in animation projects for faster production. The reason for using Unity by most of the developers is because it provides various built-in features that can help the developers work easier and efficient. Unity is one of the most popular 3D rendering tools as well. It is compatible with Windows, Mac, Linux. The advantages of unity are high flexibility and high performance for end-to-end development. (Unity Technologies)

* **Blender:**

Blender is the software that creates 3D pipeline like rigging, modelling, motion tracking, composition, rendering and simulation as well. Blender can also be used for video editing and even in game creation. Basically, Blender is a 3D modelling software or a 3D creation suite. It is an open-source software which are free to download. Blender gives power to the people to build anything from their imagination. It is compatible with cross-platforms due to which it is perfectly compactable with Unity. It has plenty of useful tools and can be used from beginners to advanced level users. (Hartmann, 2020). There are other tools like blender in the market too. For example, Maya is one of the most hyped and most popular 3D modelling software available in the world. But unlike blender Maya is not as open source as we thought it would be. Maya is better fit for larger productions and projects, in contrast Blender is the best choice for small projects.

* **Viro Media:**

Viro Media is a platform by which VR/AR applications can be developed**.** The viro media is used to support ARKit which are useful for the AR development in iOS applications whereas it also supports ARCore which is needed for AR development for android applications. It offers powerful performance for high-level scene descriptions for rendering images in real-time. It is very quick to iterate and see the changes using Viromedia. (Viromedia)

Some of the best features of Viro media are like Real world 3D tracing, Plane/surface detection, Image/Marker recognition, powerful renderer and real-world effects. The best thing about Viro media is that it provides so many APIs which can be implemented by the developers easily. Due to its large set of APIs and its capability to work in AR and 3D both, our team decided to use this technology for our project. At the initial phase it was going well and we were progressing quite well. We even completed image recognition using viro react as we were developing our application for android at first. But due to the technological blockage i.e. viro react was not still compactable to create object tracking for android we had to switch the whole project to ios development and used unity instead. The switching was possible and easier than expected because of the agile development framework that we had been using in this project.

* **Jupyter:**

Jupyter notebook is an application which lets the users to create and share various documents which includes visualizations, live codes, narrative text or even equations. Jupyter is also an open-source application. Jupyter provides the user with a simple interactive data environment across various programming languages which not only works as an IDE, but also works as a presentation tool. Jupyter provides with various of functions like data visualization, numeric simulation, Data cleaning and transformation, machine learning etc. We used jupyter in the attempt to create a machine learning code using open CV and python script for our application. It did work but the android development was stopped and focused more on iso due to the limitation of viro media.

* **Tensorflow:**

Tensorflow is known for its end-to-end open-source platform for machine. A platform with comprehensive and flexible ecosystem of tools, libraries and resources that lets users push the state-of-the-art in Machine learning and can also easily build and use those Machine learning applications. We used Tensorflow library in this project in order to get the real time body points in the attempt to track human body.

#### Hardware:

1. Laptop

|  |  |
| --- | --- |
| OS | MacOS 10.15+ |
| Processor | Any |
| Memory | Any |
| Hard Drive | Any |

Table 4.1 Laptop Hardware Specification

1. **Mobile**

|  |  |
| --- | --- |
| **Model** | **Iphone XS or above** |
| **ARKit** | **13 and above** |
| **IOS** | **13.0 and above** |
| **Rear Camera** | **LiDAR sensor** |

Table 4.2 Mobile Hardware specifications

### Functional and Non-functional requirements

**Functional requirements**

* The system shall display the try on button for trying shirts or pants in AR view.
* The system shall click the button “pants on AR”.
* The system shall open the camera of the smartphone screen.
* The system shall scan and detects the human body positions.
* The system shall overlay the image of pants on the human body in real-time.
* The system shall take screenshot of the AR image.
* The system shall send the favourite screenshot of the outfit across various social media platforms.

**Non-functional requirements**

* The system shall be efficient.
* The system shall be deployed easily.
* The system shall be easy to use.
* The system must be accurate.
* The system shall be able to scan and detect the human body within 5 seconds.

## 4.2 Coding and Implementation

Text

Description automatically generated This part of unity code deals with the selection of scenes using index i.e. 0, 1, 2. By default the scene will be on 0 which is named as “selection.unity”. From where we can enter the shirt scene or pant scene.

Logo, company name

Description automatically generated

Graphical user interface

Description automatically generated with medium confidence

Figure 4.2 App front preview

On choosing the shirt scene we enter index 1 and 2 for pant scene. Both scenes are similar, the only thing different between them are the pant and shirt in the scene. On entering any scene, the object looks for the body to be overlayed. The position of the body is given by HumanBodyTracker script, and the camera detects the frame of human skeleton and gives the position of rig joints co-ordinates so that 3D object can be mapped onto it.

Arkit

Diagram

Description automatically generated

Figure 4.3 ArKit

Arkit uses device camera and motion features to produce AR experience in application or a game. Motion features includes motion tracking, scene capture, scene processing, and display to ease the task of creating an Augmented Reality experiences.

Arkit tracks body in a specific format. Any models not matching the expected format may not work correctly. While verifying scene co-ordinate system and orientation match the expectations of Arkit. The skeleton should match Arkit expected joint names and hierarchy for motion capture.

The model should use a scene coordinate system which uses +Y for up, +X for right and +z for forward where the model must face.

The outfits should have joints in correct hierarchy but there is not necessary to bind every vertex unless it is required. Then Arkit recognizes and tracks person’s movement using an iOS device’s rear camera. Reality kit applies the detected motion to a 3D outfit model in real time, allowing the person on camera to control the movement of 3D model. The 3D model was imported with custom mesh model to use with motion captured by Arkit in T-pose as given in fig.

A picture containing text

Description automatically generated

The outfit was rigged in T-pose. No more than four joints should contribute to move any one vertex and no animation keyframes should be added.

Match Torso Joints

The lower part should contain eight vertices with hip joint as root of the joint heirarchy followed by and seven spine joints. The hip joint and first spine joint overlap when the character is in the T-pose position.

Diagram

Description automatically generated

| Joint name | Parent joint |
| --- | --- |
| hips\_joint | root |
| Spine\_1\_ Joint | hips\_ Joint |
| Spine\_2\_ Joint | Spine\_1\_ Joint |
| Spine\_3\_ Joint | Spine\_2\_ Joint |
| Spine\_4\_ Joint | Spine\_3\_ Joint |
| Spine\_5\_ Joint | Spine\_4\_ Joint |
| Spine\_6\_ Joint | Spine\_5\_ Joint |
| Spine\_7\_ Joint | Spine\_6\_ Joint |

Arm and shoulder joints

Arm comes from spine 7 and have shoulder, elbow and wrist.

Leg and Foot Joints

The leg and foot joints consists hips, with joints for moving the upper legs, lower legs, feet, and toes.

Diagram

Description automatically generated

| Joint name | Parent joint |
| --- | --- |
| right\_shoulder\_1\_joint | spine\_7\_joint |
| right\_arm\_joint | right\_shoulder\_1\_joint |
| right\_forearm\_joint | right\_arm\_joint |
| left\_shoulder\_1\_joint | spine\_7\_joint |
| left\_arm\_joint | left\_shoulder\_1\_joint |
| left\_forearm\_joint | left\_arm\_joint |

Diagram

Description automatically generated

| Joint name | Parent joint |
| --- | --- |
| left\_upLeg\_joint | hips\_joint |
| left\_leg\_joint | left\_upLeg\_joint |
| left\_foot\_joint | left\_leg\_joint |
| left\_toes\_joint | left\_foot\_joint |
| left\_toesEnd\_joint | left\_toes\_joint |
| right\_upLeg\_joint | hips\_joint |
| right\_leg\_joint | right\_upLeg\_joint |
| right\_foot\_joint | right\_leg\_joint |
| right\_toes\_joint | right\_foot\_joint |
| right\_toesEnd\_joint | right\_toes\_joint |

Text

Description automatically generated

The given co-ordinates are the reference point of the Arkit where the rigged coordinated joints should perfectly match. The camera should detect the whole body starting from head to toe. After that Arkit gets the position and co-ordinates of human body reality kit places the outfits according to points such that human body mimics the movement of 3d model.

Text

Description automatically generated

This boneContoller script plays key role in mapping.Arkit give 92 reference coordinate points to the rig. The node starts from root in 3D model and walks through all child joints in the skeleton and store at the corresponding index in the m\_BoneMapping array. In order to save the vertices in 3D space, it needs to be transformed into co ordinates in terms of x,y,z co-ordinates. The coordinates are saved as integer value corresponding to JointIndices enum values and passed as a string. The bone controller script bind rig with prefab as the script is added to shirt and pant prefab.

Table

Description automatically generated

This human body tracker script will produce body tracking events. It looks for the skeleton prefab get the position of the prefab so that it will change accordingly when the human body position is changed. The skeleton with 92 indices mimics rig in the 3D model which acts as a bone in reality kit. For that it is important to identify head, toes and hand position. Moreover, it is a wrapper script that is used to know the position of human body in AR scene.

The prefab model is exported 3D model with a game object script attached to it where the animator will be also added. In simple, prefab is a script with attached game objects to a 3D model in a hierarchy.

Text

Description automatically generated

This script is related to capture the screen and save it. Here the function store 2D image by reading pixels in rectangle of given width and height. Sharing is done using a share payload where object ss is added and committed. Besides that, there are many libraries used and plugins for iOS and android as well.

## A person standing in a room Description automatically generated with medium confidenceInterface

A person standing in a room

Description automatically generated with low confidence

Figure 4.4 App Camera Preview with Shirts in AR andPants in AR

Graphical user interface, application

Description automatically generated

# **TESTING**

Testing is the process in the software development to check if the software is developed as per requirement or not. It is the evaluation process to check the results is as expected as per the user requirements or not. There are basically two types of testing as functional and non-functional for the software development. Functional testing describes the functionality of the software whereas non-functional testing describes the behaviors of the system. According to Uk (2017), testing plays an important role in developing a software product. Thus, it ensures the quality of the software. Moreover, it is also suggested that testing should be started as early as possible to manage time properly. It is also needed that testing should be performed in every step of the SDLC.

## 5.1 Functional Testing

In functional testing each of the function is tested where input is given to get the expected result. Here, overall system flow is checked to validate with the requirements of the user. It is done to ensure that the functions of the app are working regarding fulfilling the app requirements. In functional testing, the tester should identify first the test input and compute the expected outcomes with the selected test input values. After that, the tester then tests the cases and compare the data with the expected result (Dubey, 2020).

The use case testing is done for testing the functionality of the system. The test case done in the project are as follows:

|  |  |  |
| --- | --- | --- |
| Specifications | Steps to Execute | Expected Result |
| View the System model | 1. Open the app. 2. View the Shirt in AR 3. View Pant in AR | System shows the front of the app with shirt and pants to go to the next button |
|  |

Figure 5.1 Use Case Testing for Viewing model

|  |  |  |
| --- | --- | --- |
| Specifications | Steps to Execute | Expected Result |
| Detect the body positions and overlay clothes over body | 1. User selects either “pants in AR” or “shirts in AR 2. System opens the camera. 3. Detects the body in real-time. 4. Overlay clothes over body | System displays the overlaid clothes images over human body in real-time. |

Figure 5.2 Use case Testing for detecting body positions.

# 5.2 Non-Functional Testing

According to Samra (2005), non-functional testing focuses on the software performance that includes specific requirements such as reliability and scalability. In our Masters’ Project, we utilized usability testing wherein we ensured that the users of the app can experience efficiency, effectiveness, and satisfaction. We have used walkthrough in our Body Tracking Software. During the walkthrough, we provided feedback regarding the change in UI or any functionality change or in the logic. Therefore, the developers in our team tried to make our app as good looking as possible and tried to fit the required functionality of the system. Through this non-functional testing, the developer got to know the aspects of the app that can get errors and aspects of the app that can be continually improved.

# **CONCLUSION**

Developing the body tracking software was a challenging task for us. During the start of the Masters’ Project, we did not have any experience in developing an app with AR function, which we thought was complicated. However, with the collaboration among the team members and the support of supervisors and the client, we were able to develop the required product on time. The proposed application has achieved the objective and the requirements as mentioned by the clients. By reviewing different research articles, blogs, papers, artifacts, we were successful in developing the project objectives. The issues, the needs of the development of the product were raised by studying different case studies related to the body tracking software app through AR. Thus, the project requirements were identified, and the project structure was developed by discussing with the team members.

## 6.1 Application of the product

There are different applications of the product. They are as follows:

* While online shopping has been gaining so much popularity nowadays, the proposed project can reduce the returns of the product which was main disadvantages of the online shopping.
* The AR body tracking software aims to track the human body positions and overlays the clothes 3D images over the body in real time.
* The user can take screenshot of the favourite outfits they like and as well as share with their friends through different social media platforms.
* The app is user-friendly, and user can experience AR by installing the mobile application in their iOS phones.
* It has great system performance as such they can try the clothes anywhere, they want without physically going to the stores.

## 6.2 Limitation of the Product

While we tried to develop the product with full functional requirements, there are certain drawbacks of the product. They are:

* ARkit supports full body tracking. Camera needs to detect whole body even for specific tracking like hand, foot, leg only is required to be tracked.
* This application works only with IPhone XS or above which camera have LiDAR sensors.
* The application coding for body tracking software can be done in MacOS 10.15 and above only.
* The process of generating a 3D model is a tedious process which is the most time-consuming process.
* There are only two outfit to try on in our product. The numbers can be increased with a backend and a database.
* Occlusion culling and body tracking feature is not supported simultaneously as it needs high computing power. This results in rendering the part of object which are not visible to camera in Augmented Reality.
* While designing 3D model the upper body model must be in T-Pose.
* No more than four joints should contribute to movement of any single vertex.
* 3D file like .fbx and .usdz are only supported. Any other format beside these shows error.
* The code may not work properly or not work at all if the joint hierarchy is not followed.

## 6.3 Future work

This application has lots of future possibilities as the digital transformation is the requirement of the latest online shopping retailers and the customers. This application can be integrated with different ecommerce applications, and they can add different outfits as per their requirement for the customers for wider selection of the products. This software can be developed in android platforms so that larger group of people can use this type of applications. The better version of the application can be developed with a better UI, accuracy, and relevancy.

For future, besides a single shirt and pants, different types of clothing can be selected with appropriate size and colors. The varieties of clothes model can help users select the best among different clothes. Dresses, jackets, gloves, caps can be added to be fitted in the model. Likewise, jewelry, shoes can be added to be fitted in the model. Users will be able to try a lot of clothes by sitting at home without physically going to the store.

Furthermore, the UI design can be made more specific and more interface and elements. It can be made more attractive and let the users to easily navigate through the interface. The accessible interface with visually attractive colors can impress the users and improve the product accessibility. Moreover, favorite list can be added in the system where the users can add their favorite outfits.

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