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National University of Computer and Emerging Sciences, Lahore Virtuel Elegance Muhammad Hannan Fareed... 21L-5392 BS(CS) Muhammad Saad Kashif..... 21L-1789 BS(CS) Muhammad Tayyab Irfan..... 21L-1859 BS(CS) Supervisor: Dr. Mirza Mubasher Baig Final Year Project April 15, 2025 Anti-Plagiarism Declaration This is to declare that the above publication was produced under the: Title: Virtuel Elegance is the sole contribution of the author(s), and no part hereof has been reproduced as it is the basis (cut and paste) that can be considered Plagiarism. All referenced parts have been used to argue the idea and cited properly. I/We will be responsible and liable for any consequence if a violation of this declaration is determined. Date: 8th December 2024 Name: Muhammad Hannan Fareed Signature: Name: Muhammad Saad Kashif Signature: Name: Muhammad Tayyab Irfan Signature: Author's Declaration This states Authors' declaration that the work presented in the report is their own, and has not been submitted/presented previously to any other institution or organization. Abstract In a fast paced modern world, where trying-on clothes in shopping stores consume a lot of time, Virtuel Elegance streamlines the experience of shopping by providing the platform of virtual try-ons. Using live camera technology, we aim to accurately measure body size that extracts pose, allowing customers to try on clothes virtually from home. The platform of Virtuel Elegance will enable registered brands to upload their articles to facilitate the customer experience of virtual try-on. Executive Summary The desire to look good in clothes and find outfits that perfectly fit and match one's personality sense is a nature instinct throughout the world. The way we dress not only affects how others perceive us, but dressing the way we do also gives us confidence and comfort. However, shopping for clothes in particular sizing can be a tricky experience. With the rise of online shopping, customers quickly ran into problems of arriving at a store and hoping that clothes they ordered would fit them well without ever getting them on. This is where Virtuel Elegance comes in, with an innovative virtual try on solution, users can see how garments will look on them in a new way to shop for clothes. The recent development post COVID years in quarantine opened doors for many brands to incorporate new technologies for online shopping that facilitate customers to buy clothes from home with an idea how they would be fitting on them. The cost of returns while shopping online for clothes have signifi- cantly impacted the marketing costs and minimized profits in garment industry because they do not live up to terms in physical look as they tend to appear online. Hence, the idea to build Virtuel Elegance is driven from the same motivation to enhance the shopping experience and challenge the traditional ap- proaches of shopping. These may include the physical approach of in-store shopping experience where customers will first try-on the selected clothes in the physical try room, look into the mirror and take the decision as well as the online shopping approach to just purchase the article that they happen to like it without even trying-on. Both approaches lead to a customer dissatisfaction and loss as the former is time consuming and tiring process while the latter is unsatisfactory for customer end and cost effective for brands. In circumstances like these, Virtuel Elegance promises to deliver a system that focuses on customer enhancement and satisfactory experience as well as marketing boast for brands. The primary goal of Virtuel Elegance is to facilitate the garment industry by promoting the use of Com- puter Vision (CV). The platform is meant for both at home and in store shoppers, offering virtual fitting functionality which cuts the need to physically try out clothes. Users can see how garments will fit on their bodies, through live image processing and pose estimation. The system provides an interactive and a personal shopping experience, making it possible for users to get satisfied, reduce return rates and improve customer brand relationship. The scope of this project is very wide as it follows sustainable development goals of decent work and economic growth as well as industry, innovation and infrastruc- ture. Virtuel Elegance is both web-based and available as a cross platform mobile app. The application will use live image processing and pose estimation to take accurate body measurements using libraries in python, creating a 3D model of the user using unity. Clothes from a database filled by brands will be applied to this model, allowing users to see how the clothes would fit. Brands can sign up and add their clothes to the database, enabling the virtual try-on feature for their products for realistic visualizations. Many existing work on this idea has been made but Virtuel Elegance stands out on its functionality of wider scope where it fully provides the customer from home, the experience of wider brand integration that makes it diverse options for him or her to choose an article and try-on virtually. The application will be

designed in a modular approach to consider scalability, usability, flexibility, security in both high and low level designs. Separation of concerns while designing front-ends and back-ends will be fully con- sidered. This report includes every aspect of Virtuel Elegance, from the project vision to the software requirement specifications and complete design of the system architecture along with all the relevant diagrams. To put the matter in a nutshell, Virtuel Elegance has the ambitious goal of automating the garment and fashion industry through the creation of an intuitive, virtual try on platform. The system uses the user centric approach and creates a system that can serve both online shoppers and in store shopper in a way that they experience seamless and accurate fitting garment. The platform will like evolving with user satisfaction and reducing the inefficiencies of the traditional shopping experience.

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Skinned Multi-Person Linear Model that uses pose parameters and shape parameters to repre- sent the 3D geometry of a human body. 1.4 Conclusion Chapter one highlights Virtuel Elegance's inspiration and commitment to revolutionizing the garment's industry, describing its aims, vision, technical requirements and objectives. The driving aim to build this application is to achieve the objective set for its stakeholders (customers and brands) that is to revolutionize the in-store clothes try-on experience. It is critical to recognize that the development of this application is the key to automate garment industry in Pakistan. Chapter 2 Project Vision Virtuel Elegance's driving aim is to reduce time by trying-on clothes in real time as it benefits both companies and customers. This chapter will explain the problem domain that was considered to facilitate people using this idea as well as the goals and objectives with respect to the scope of this project. 2.1 Problem Domain Overview Customer satisfaction is a major concern in Pakistan's garment industry. The success of a brand is directly proportional to its profiting sales that boost up the market value by providing reliable quality to customers. But the standard methods for facilitating the customer like physical try-room while choosing the favorite dress are very inefficient and time consuming. In these circumstances, Virtuel Elegance is designed that stands out by addressing customer ease at first through providing a real time virtual try- on. It is aimed specifically to reduce time and enhance profits by minimizing the cost of returns for the brands. The customer is required to register and sign in to the user-friendly interface of mobile and web based application of Virtuel Elegance. The customer is then advanced towards the core functionality of Virtual Try-on once articles are selected on the browse articles page. For brands, they will be registered first and allowed to upload articles on which Virtual try-on functionality will be made active. The ultimate goal of this project is to provide users with a user-friendly mobile and web based application with functionality of virtual try-on to enhance user experience of trying-on clothes virtually in real time. 2.2 Problem Statement The idea to automate garment industry with rapid advancements in Artificial Intelligence (AI) has been a widespread topic but it is also the bone of contention between the companies who operate using the outdated concepts of physical changing room or trying-on room and with those customers who are willing to save time in choosing the dress that fits best upon according to their choice. For events like EID and any special occasion in the nation, companies cannot afford to construct multiple rooms for trying-on and the only one they have requires one person at a time to try-on that piece of article and then proceeds to another. By addressing this concern that targets the customer satisfaction and profits of brands, Virtuel Elegance offers a better user experience by assisting both customers and brands by giving the concept of virtual try-on in real time to see how clothes fit on them on screen without even bothering to put them on in reality. 2.3 Problem Elaboration Customer dissatisfaction, high time consumption and cost of bearing frequent returns for brands are some of the problems faced by customers and branded companies with respect to garment industry. Some brands do not have trying-on room as they have to take customer to the nearby branded shop that has and those that have may get you queued up if peak or festive occasions are going on. This is highly time consuming and this affects the customers' ease as they have to go through the various attempts to try on before finalizing it and it leads to customer inconvenience. And on the business end, brands bear the burden of frequent returns because of multiple exchanges as the article bought online do not carry the same expected perfect fit since it was bought without even tried on. This leads to re-stocking and affects operational costs. The inability to provide customers with a virtual appearance how the clothes fit on them hinders growth and profitability of a brand. These problems are brought into consideration for launching Virtuel Elegance that accommodates both customers and brands by enhancing customer experience by introducing virtual try-on in real time to see how clothes would fit before buying and it also improves the operational efficiency of garment industry. 2.4 Goals and Objectives Since Virtuel Elegance is designed to facilitate both customers and brands, hence the primary goal of this application is to revolutionize the traditional approach of online shopping experience and boosting performance of sales for brands by integrating virtual try-on technology. Our objectives include: • Facilitate the garments industry by promoting the use of Computer Vision (CV). • Design an interface that is easy to use and understand. • Utilize Live Image Processing to capture accurate body measurements for personalized virtual try-on experiences. • Create a 3D model of human body using data from the pose estimation and captured measure- ments. • Map the 3D model of human body with the garment images obtained from database to see how clothing fits in real time on their body virtually. • Allow companies to register to use this platform by populating the database adding their articles and products for virtual try-on. 2.5 Project Scope Virtuel Elegance is

a revolutionary application that is designed to improve the shopping experience by the use of computer vision technology to facilitate users by trying-on clothes virtually both at homes and in shopping outlets. The application is both web-based and available as a cross platform mobile app. The system includes three entities the customer, the brand and the admin with different user roles and permissions. The system will allow users to: • Register and log in to the application. • View and edit profile. • Browse articles to select. • Apply virtual-try on feature of the selected article. • View and upload articles by populating the database. • Have a user-friendly and seamless experience. The application will use live image processing and pose estimation to take accurate body measurements using libraries in Python, creating a 3D model of the user using Unity. Our web-application will be in JavaScript, with the front-end built using its framework, React JS, the back-end built in Express and Node JS, and the Database in Firebase. Our mobile application will be built using react-native for cross platform android and iOS. Our project will be developed using Agile development principles, and project management will be done using SCRUM. At the end of project, we shall be able to deliver: • A mobile and web based application to offer virtual try-on. • A user manual for the application Implementation of a project of this scale will facilitate both customers and markets since it aims to automate the garments' industry. With the passage of time, an idea of enhancing customer experience and driving innovation and garment industry through Virtuel Elegance can be realized by incorporating its style suggestions, expanding brand partnerships and integrating real-time feedback mechanisms. 2.6 Sustainable Development Goal (SDG) As Virtuel Elegance aims to revolutionize and automate the garments' industry by integrating virtual try-ons and promoting the use of computer vision based technology in garment sector, hence its robust digital infrastructure relying on mobile and web based applications will boost economic and industrial growth. Therefore, Virtuel Elegance aligns with Sustainable Development Goal 9: 'Industry, Innovation and Infrastructure' as its primary focus, while also contributing to Goal 8: 'Decent Work and Economic Growth' . 5.3. Figure 2.1: Sustainable Development Goals 2.7 Constraints The following constraints are needed to be stressed upon for the development of Virtuel Elegance: • Work: This project will be developed by 3 members. • Time: This project needs to be completed within 2 semesters. • Camera Quality: The accuracy of pose estimations are heavily relied on the quality and specifi- cations of camera used. • Integration with 3D models: The translation of pose estimations into 3D models to garments' adaption reduces breeds inaccuracy and unrealistic view so to maintain the accuracy of original pose estimations are technically very complex. 2.8 Business Opportunity Virtuel Elegance has the ability to present various business opportunities. Since it is specifically designed to launch into market by utilising virtual try-on technology to completely transform the in-store and online shopping experience, therefore by the use of subscription models, the platform of Virtuel Elegance may partner and collaborate with fashion companies to reduce the cost of returns and physical try rooms, providing a smooth and seamless interaction between businesses and customers. The seeds planted by Virtuel Elegance will blossom into a future where customers reap the fruits of convenience, personalized and eased fashion and an improved shopping experience. 2.9 Stakeholders Description/ User Characteristics The stakeholders of Virtuel Elegance would be customers, branded companies and the admin. • Customers: They will use Virtuel Elegance platform for virtual try-ons. • Brands: They will use Virtuel Elegance platform to populate the database for virtual try-ons on their uploaded article with an aim to boost their sales and profits. • Admin: The official representative of Virtuel Elegance that will be responsible for managing the platform, feedback, approving and removing articles and maintaining database and system integrity. 2.9.1 Stakeholders Summary The intended impact of Virtuel Elegance can be achieved through the cooperation and support of multiple stakeholders. First and foremost, brands will use the application's functionality to register themselves and populate the database to ensure their articles are available for virtual try-on. Secondly, the customers will hit the application's core functionality to browse and select articles for virtual try-on after following the similar flow of sign-up. The application will ensure the availability of both options to try-on clothes virtually both at home and in-store with the difference of limited brands and their clothes that will be reserved for in-store. Lastly, the admin will interact with the application's functionality to make sure the seamless and effective performance of the platform by optimizing Virtuel Elegance continuously to adapt to evolving needs. When all of these stakeholders come to choose Virtuel Elegnace for virtual try-ons, only then the idea to automate garment industry will bring into realization and fulfil its purpose. The coordination of all these entities will help Virtuel Elegance grow to a scale that revolutionizes the traditional shopping experience and enhances customer

satisfaction. 2.9.2 Key High-Level Goals and Problems of Stakeholders The primary objective of developing a platform like Virtuel Elegance is to revolutionize the traditional mindset that requires excessive effort of trying-on clothes one by one to come to a final selection. This platform is capable of not only challenging that mindset but also to automate the garment sector by providing the solution of virtual try-ons to enhance customer experience as well as its ease to reduce un- certainty and increase sales for brands by minimizing return rates. With these high-level goals designed to achieve via Virtuel Elegance, there may be some problems that stakeholders will face. A problem for a customer will be the accurate measurements via live image processing to see whether pose estimation could lead to a realistic 3D model or not. The biggest problem that the stakeholders will face is the introduction of computer vision and pose estimation algorithms in garment industry along with intuitive interface and image mapping tools for a high quality outputs. 2.10 Conclusion The vision of our Virtuel Elegance is to transform the shopping experience from traditional mindset to revolutionary and efficient by automating it through Computer Vision, Pose estimations and 3D model- ing. We aim to facilitate customers to select and choose an article for finalisation in seconds. Our project scope is deliver a mobile and web based application that includes all the objectives already defined. Chapter 3 Related Applications The following chapter extensively elaborates on the applications that are related to our concept of Virtuel Elegance. 3.1 Definitions, Acronyms, and Abbreviations AI: Artificial Intelligence AR: Augmented Reality 3D: Three-Dimensional CV: Computer Vision SDK: Software Development Kit Smart Mirror: A mirror that uses technology to show how clothes will fit on you in real time, even though you're not physically wearing them. Cloth Simulation: makes virtual clothes look like real fabric, showing how they would fit and move on your body. 3.2 Detailed Applications Review The following section provides the summary, critical analysis and the relationship to our project of some related applications. 3.2.1 PICTOFiT 3.2.1.1 Summary PICTOFiT [1] helps fashion stores let customers try on clothes online, without being in the store. It does this by using technology to show how clothes will look and fit. The company provides different tools, like SDK for creating virtual try-ons, smart mirrors for in-store virtual fitting, and a system to turn normal photos into 3D models of clothes. 3.2.1.2 Critical Analysis PICTOFiT [1] is a good solution for making online shopping feel more real. It gives customers a fun way to see how clothes will fit before they buy. However, for it to work well, stores need to easily add it to their websites, and customers need to feel comfortable using virtual try-on technology. 3.2.1.3 Relationship to the project PICTOFiT's [1] virtual try-on system is similar to our project. Both aim to make online shopping better by allowing people to try on clothes virtually using AI. The main difference between our project and this app is that our project has the goal of allowing users to try out outfits in real time, while this app does not have such capabilties. 3.2.2 YourFit by 3DLOOK 3.2.2.1 Summary YourFit by 3DLOOK [2] is a smart and modern tool that uses AI to let people try on clothes virtually. Its mechanism works on the principal to take two photos of the user, creating a 3D model of their body, and showing how clothes will fit. It also recommends the right size and includes exciting features like sharing the snapshots of outfits with friends and voice commands to make shopping easier. 3.2.2.2 Critical Analysis YourFit [2] makes online shopping experience better by creating a 3D model of the customer's body by using two photos, helping the customer to see how their clothes will look on them and find the right style. This reduces returns and makes shopping more enjoyable. However, like other virtual try-on tools, it needs to work well with different websites and to make sure people feel safe sharing their body data. 3.2.2.3 Relationship to the project The working of YourFit [2] is quite different to our project as it aims to take two photos of the user and then it provides a processed image of the user wearing different clothes virtually. Our project intends to create a virtual try-on space for the user in real time. Users can see how a particular outfit looks on them by choosing an outfit and standing in front of the camera. 3.2.3 Dress Try 3.2.3.1 Summary The Dress Try [3] app allows users to virtually try on different clothes before actually buying them. Users can see how different outfits might look on them by just uploading a photo of themselves. This app offers free as well as premium versions with extra features like personalized outfits. It lets users to save and compare outfits. 3.2.3.2 Critical Analysis The app solves the worldwide problem of online shopping by allowing users to see how clothes would look before making a purchase, which helps reduce returns. However, a perfectly accurate fit cannot be provided by the system every time and also, the premium features might be expensive for some users. Despite these challenges, the app's simple user interface and the ability to save outfits for comparison, make it a useful tool for smarter shopping. 3.2.3.3 Relationship to the project The idea of this app is quite similar to our project, however a major difference is

the fact that this application only provides a virtual try-on experience for the upper body of the user. Secondly, it uses a photo of the user's body and then overlays clothes on the body by using image processing. Our system intends to provides a virtual try-on experience for the upper body as well as the lower body of the user, all in real time. 3.2.4 Letsy 3.2.4.1 Summary Letsy [4] is a virtual try-on app that helps users to visualize how clothes will look on them. The app prompts the user to upload a front-facing, clear photo of themselves. It then uses AI to generate realistic images of clothing articles as if the user is actually wearing them. The app can act as a personal fashion assistant by recommending outfits to the user based on their preferences. Users are able to save their favorite outfits, making it easier to refer back to them while shopping. 3.2.4.2 Critical Analysis Letsy [4] is a user-friendly tool for fashion enthusiasts who wants to try on clothes virtually without the hassle of physically trying them in stores. The technology used is particularly beneficial for online shopping, where visualizing fit and style is quite difficult. However, its efficiency can be narrowed by some factors like the quality of the photo or the complexity of clothing styles. Additionally, the app only relies on front-facing images, so it may not handle more dynamic or diverse body positions as effectively. Though the app may not be able to fully replicate the in-store try on experience but is still considered to be useful. 3.2.4.3 Relationship to the project Similar to other apps, the concept of this app is closely tied to the goal of our project. The difference between this app and our project is that this app uses front-facing images of the user, however our project intends to do this in real time. Other than that, this app uses a learning model to recommend different articles to the user based on their preferences, however the goal of our project is solely limited to a virtual try-on experience. 3.2.5 Superlook: AI Outfit Maker 3.2.5.1 Summary Superlook: AI Outfit Maker [5] is an app that uses AI to help users try on different outfits virtually. Users can start by uploading a photo of themselves to see how various styles, colors, and accessories would look on them. The app provides the user the ability to customize outfits and even suggests random styles based on their preferences. It is aimed for anyone who likes fashion, facilitating them to explore different looks without trying on physically. 3.2.5.2 Critical Analysis The AI technology used in the app creates realistic looking outfits, making it easier for users to visualize how clothes will fit and look on them. This reduces the doubt associated with online shopping. However, results can be affected by the quality of the uploaded photos which may not always perfectly recognize clothing details. 3.2.5.3 Relationship to the project Just like other mentioned apps, the goal of this app is similar to our project. This app provides cus- tomization and outfit suggestions which is beyond the scope of our project, where we aim to provide a real time virtual try-on experience to our users. 3.2.6 Virtual Fit Check 3.2.6.1 Summary Virtual Fit Check [6] is an online tool where users can virtually try on clothes via a Chrome extension or iOS app. The platform allows for easy outfit selection, offering the ability to mix and match clothing items and share outfits on social media. Users can purchase credits to access the service instead of subscribing. It aims to enhance the online shopping experience by letting users preview how clothes may look on them. 3.2.6.2 Critical Analysis The platform is convenient and user-friendly, but different body types may hurdle its fir accuracy. The credit-based model provides a flexible experience, as users pay only when they need to use the service. However, this model could become costly for people who frequently use it. Improving body fit exactness or adding customization features could increase its demand. 3.2.6.3 Relationship to the project Just like other virtual fitting room projects, it aims to help customers visualize how clothes will look on them, making it easier to make choices and subsequently reducing returns. It reflects the developing use of AR and AI in the market of fashion to create a more immersive shopping experience. This app also uses images of the user's body instead of making the user to try on different articles in real time. 3.2.7 Arbelle by Visage Technologies 3.2.7.1 Summary Arbelle [7] is an innovative AI-driven platform that focuses on virtual makeup try-on experiences. It allows users to digitally try on different makeup products using Visage Technologies' advanced face AI technology in real time. The shopping experience of users in the beauty sector is enhanced by applying personalized virtual makeup through the app. 3.2.7.2 Critical Analysis Arbelle's amalgamation of face-tracking AI and beauty AR technology provides an immersive, user- friendly experience. It shows the company's extensive expertise in CV and AI, making it a reliable platform to virtually try on makeup. However, like other AR services, a main challenge is to ensure consistent accuracy across the diverse human facial features and camera quality of the device. 3.2.7.3 Relationship to the project This app is alot different to our project as it focuses on the beauty aspect of the virtual try-on experience providing a diverse range of facial beauty products that could be digitally

tried on. However, our project mainly focuses in clothes that could be tried on virtually in real time. This app has one similarity towards our project that it allows the user to try products in real time, just like our goal. 3.3 Related Applications Review Summary Table Table 3.1: Table of Related Applications Review Summary Table Application Features Relevance Limitations PICTOFiT [1] Virtual Try-On of clothes. Provides 3D look of how clothes will appear virtu- ally while navigating the website Limited articles of a single brand available in the app and only processes instead of real time capturing. YourFit 3DLOOK [2] by Virtual fitting of clothes on 3D model and size recommenda- tion. Creates 3D model of a user from the processed image to fit clothes virtu- ally. Limited to processed images only instead of real time and lim- ited population of article catalog of a singular brand for user at home. Dress Try [3] Virtual fitting of a cloth on an image and fit comparison Virtual try-on experience by the use of image pro- cessing and image seg- mentaion to map gar- ments on the processed image Limited to only upper part of the body and it is only for the pro- cessed image not live. Does not allow integration of brands for a wider experience for customer at home. Letsy [4] Virtual platform for try-on and outfit recom- mendation. Provides functionality of Virtual try-on by process- ing a quality image of the user and saves their try-on history Limited to front-face and pro- cessed image of a user only and does not integrate a wider range of brands for multiple catalogs of articles. Superlook: AI Outfit Maker [5] Virtual outfit maker to try-on and style sug- gestion Creates an outfit for the virtual try-on by process- ing an image to give a re- alistic look. Only limited to images and does not provide a real time virtual try-on experience by using pose estimations and 3D modeling. Virtual Fit Check [6] Virtual ex- perience of checking a fit and social media sharing. Provides virtual try-on ex- perience for users by pro- cessing image in a user- friendly interface. Limited to purchasing credits for providing the virtual try-on ex- perience as well as lacks body fit accuracy. Also it does not pro- vide real time live processing of pose estimations. Arbelle by Visage Tech- nologies [7] Virtual makeup experience Provides virtual experi- ence of trying makeup in real time using live cam- era and uses advance CV algorithms. Limited to makeup products only as it does not provide vir- tual try-on experience of clothes in real time. 3.4 Conclusion This chapter discussed the detailed review of applications that are already existing and have done a work, to some extent, similar to what we propose. All the applications and their similarity with respect to algorithms, technologies and approach were reviewed as well as the difference and limitations which makes out project stand out against them to provide accurate, user-friendly and easy to use virtual try- on experience. By incorporating all the limitations present in the existing applications, we propose to unveil a project that leaves no stone unturned by covering all aspects and functionality needed to provide a virtual try-on platform. . Chapter 4 Software Requirement Specifications This chapter provides a detailed overview of the functions that our project will be capable to provide along with functional and non-functional requirements. It also contains images of our Graphical User Interface (GUI) as well as Use cases and database design. 4.1 List of Features Virtuel Elegance will provide the following features to its users: • It can register new users. • It can allow users to view and edit profile. • It can allow companies to add and remove articles. • It can allow customers to browse and select articles. • It can allow customers to try-on articles virtually. • It can allow customers to take snapshots of the virtually tried-on article. 4.2 Functional Requirements Here below we have listed down all the functional requirements of Virtuel Elegance with respect to each stakeholder individually : 4.2.1 Core System Functional Requirements • The system shall create pose estimation of the user from live feed of a camera. • The system shall create a 3D model from pose estimation of the user. • The system shall retrieve clothing article of the brand from the database. • The system shall map the clothing article on the 3D model of the user. 4.2.2 Functional Requirements for Customers • The system shall allow customers to create an account. • The system shall allow customers to log in to their account. • The system shall allow customers to view their profile. • The system shall allow customers to edit their profile. • The system shall allow customers to browse articles for selection. • The system shall allow customers to select an article. • The system shall allow customers to try-on the selected article virtually. • The system shall allow customers to scroll through more articles for virtual try-on. • The system shall allow customers to take snapshots of the virtually tried-on article. • The system shall allow customers to log out their account. 4.2.3 Functional Requirements for Companies • The system shall allow companies to create an account for registration. • The system shall allow companies to log in to their account. • The system shall allow companies to view their profile. • The system shall allow companies to edit their profile. • The system shall allow companies to add an article or articles to the database. • The system shall allow companies to remove an

article or articles from the database. • The system shall allow companies to log out their account. 4.2.4 Functional Requirements for Admin • The system shall allow admin to create an account. • The system shall allow admin to log in to their account. • The system shall allow admin to approve an article. • The system shall allow admin to remove an article. • The system shall allow admin to log out their account. 4.3 Quality Attributes Virtuel Elegance aims to include the following essential quality attributes to guarantee the smooth work- ing of the application: 4.3.1 Performance The system should perform efficiently in order to provide fast response times during image processing and rendering for virtual try-on. 4.3.2 Reliability The system should be consistent to operate without crashes and failures to ensure its users can rely on its functionality. 4.3.3 Security The system should ensure that the data being stored in database must be secured using a irreversible hash function and it must not be accessible to any unauthorized person. All the data stored in database must be protected from any SQL injections or phishing attacks and ensure data confidentiality, integrity and availability. 4.3.4 Maintainability The system should be easy to maintain and update, allowing for supporting the new updates to existing features and adding new features with the passage of time. 4.3.5 Usability The system should provide an intuitive user interface for easy navigation and browsing to use virtual try- on feature without any extensive training and its theme should be consistent across the whole system. 4.3.6 Flexibility The system should be flexible to adjust and adapt to the changed needs such as feature expansion or incorporating new languages according to the needs in future. 4.4 Non-Functional Requirements Virtuel Elegance has the following non-functional requirements : 4.4.1 Usability • The system shall provide users an intuitive interface to use virtual try-on. • The system's theme shall be consistent. 4.4.2 Performance • The system shall provide the rendered virtual try-on final result to the user within a maximum of three seconds. • The system shall accommodate 100 concurrent users without experiencing performance degrada- tion. 4.4.3 Security • The system shall ensure that passwords stored in database are properly encrypted and secured. • The system shall ensure that 3D models and snapshots stored in database are not accessible to any unauthorized person. 4.5 Assumptions Following are the assumptions considered while developing Virtuel Elegance: • It is assumed that the users have a device that can run web and mobile applications. • It is assumed that the users have a stable internet connection throughout using this application. • It is assumed that the users have a basic knowledge of navigating a clothing website and applica- tion. • It is assumed that the users have a mobile and laptop with a good front camera for virtual try-ons. 4.6 Use Cases 4.6.1 Sign Up Name Sign Up Actors User, Company Summary The user creates a new account in the system by providing the required information. Pre-Conditions The user's record must not exist in the database. Post-Conditions The user is registered and asked to verify their email. Special Requirements None Basic Flow Actor Action System Response 1 The user opens the sign up page. 2 The sign up page is displayed asking the user to fill the form. 2 The user fills in the required details. 4 The system stores the information in the database and redirects the user to the login page. Alternative Flow 3 The user skips any required information. 4-A The system responds with an error prompting the user to fill in the necessary information. 4.6.2 Login Name Login Actors User, Company, Admin Summary The user shall provide their credentials (email and password) on the login form, and after verification, redirect the user to the home page. Pre-Conditions The user must be in the database records. The user must be registered and not already be logged in. Post-Conditions The user's session is successfully established and shall be redirected to the home page. Special Requirements None Basic Flow Actor Action System Response 1 The user opens the login page. 2 The login page is displayed asking for email and password. 2 The user enters valid email and password. 4 The system verifies the email and password, establishes a session for the user and redirects the user to the home page. Alternative Flow 3 The user enters invalid email or password. 4-A The system responds with an error message: Incorrect email or password entered. 4.6.3 Logout Name Logout Actors User, Company, Admin Summary The user would be logged out of the system by the click of a button. Pre-Conditions The must already be logged into the system. Post-Conditions The user's session is successfully terminated and shall be redirected to the login page. Special Requirements None Basic Flow Actor Action System Response 1 The user clicks the logout button. 2 The system asks the user if they are sure. 2 The user clicks 'Yes'. 4 The system terminates the user's session. No Alternative Flow 4.6.4 Edit User Profile Name Edit User Profile Actors User, Company Summary The user can edit their personal profile. Pre-Conditions The user must be logged in to the system. Post-Conditions The user's profile is updated with the new information. Special Requirements None Basic Flow Actor Action System Response 1 The user navigates to

the profile settings page. 2 The system allows the user to update their personal information. 2 The user updates any information of their choice. 4 The system updates the user profile in the database and a success message is displayed. Alternative Flow 3 The user enters invalid data or data format. 4-A The system responds with an error message. 4.6.5 Browse Articles Name Browse Articles Actors User Summary The user can browse through all available articles. Pre-Conditions The user is in the browse articles category. Post-Conditions The user successfully browses through the available articles. Special Requirements None Basic Flow Actor Action System Response 1 The user navigates to the browse articles page. 2 The system fetches available articles from the database and displays them in a grid view. 2 The user selects any article of their choice. 4 The system gives the user the option to virtually try the article or view more details. Alternative Flow 3 No articles available. 4-A The system displays an error message indicating no available articles. 4.6.6 Virtual Try-On Feature Name Virtual Try-On Feature Actors User Summary The user gets a real time view of the selected article layered over their body using the mobile camera or a webcam. Pre-Conditions The user initiates the virtual try-on feature and provides access to the camera. Post-Conditions The selected article is overlaid on the user's body in real time, allowing the user to see how it fits. Special Requirements None Basic Flow Actor Action System Response 1 The user clicks the virtual try-on feature button. 2 The systems requests access to the device camera. 3 The user grants permission for the camera access. 4 The systems asks the user to stand within a certain distance from the camera. 5 The user prompts the system after adjusting their position. 6 The system overlays the selected article on the user's body in real time via the camera feed. Alternative Flow 3 User denies camera access. 4-A The system displays message indicating the user to allow access to the camera for virtual try-on feature. 4.6.7 Take Snapshot Name Take Snapshot Actors User Summary The user can take a photo of themselves virtually trying out outfits to save it. Pre-Conditions The user has initiated the virtual try-on feature. Post-Conditions The user successfully takes a photos of their virtual try-on. Special Requirements None Basic Flow Actor Action System Response 1 The user either clicks a button or performs a hand gesture. 2 The system takes a picture and asks the user if they want to keep it or retake it. 3 The user decides to keep the picture. 4 The system saves the picture in the device. Alternative Flow 3 The user decides to retake the picture. 4-A The system opens the camera again in order to retake the picture. 4.6.8 Scroll More Articles Name Scroll More Articles Actors User Summary The user can scroll to find more articles while being on the virtual try-on page. Pre-Conditions The user has initiated the virtual try-on feature. Post-Conditions The user can find more articles by scrolling in real time. Special Requirements None Basic Flow Actor Action System Response 1 The user scrolls left or right to view more articles. 2 The system fetches the next article in real time. 3 The user chooses to tries it on. 4 The system allows the user to try it on. No Alternative Flow 4.6.9 Add Articles Name Add Articles Actors Company Summary Companies and brands can add their articles for users to virtually try them on. Pre-Conditions The user has logged in and is on the add articles page. Post-Conditions The user successfully populates database by their articles. Special Requirements None Basic Flow Actor Action System Response 1 The user clicks the 'add articles' button. 2 The system allows to users to upload images of different clothing articles. 3 The user uploads images to the application. 4 The system stores these clothing article images in the database. Alternative Flow 3 The user does not upload any image. The system prompts the user to either upload 4-A images or cancel the function. 4.6.10 Remove Articles Name Remove Articles Actors Company Summary Companies and brands can remove their articles from the application. Pre-Conditions The user has logged in and is on the remove articles page. Post-Conditions The user successfully removes selected articles from the database. Special Requirements None Basic Flow Actor Action System Response 1 The user clicks the 'remove articles' button. The system allows the users to select articles 2 that are to be removed. 3 The user selects particular articles and clicks the 'remove' button. 4 The system deletes the selected articles from the database. Alternative Flow 3 The user does not select any article to be removed. The system prompts the user to either select 4-A articles or cancel the function. 4.6.11 Approve Articles Name Approve Articles Actors Admin Summary The Admin can approve or reject any article that is going to be listed on the application. Pre-Conditions The admin has logged in and is on the approve articles page. Post-Conditions The admin successfully approves or rejects any particular article. Special Requirements None Basic Flow Actor Action System Response 1 The admin clicks the 'approve articles' button. 2 The system allows the admin to select articles that are to be approved. 3 The admin either approves or rejects particular articles. 4 The system performs the action accordingly. No Alternative Flow 4.7 Hardware and Software Requirements This section

describes the hardware and software requirements of the application Virtuel Elegance. 4.7.1 Hardware Requirements Our hardware requirements for the Virtuel Elegance are as followed: • Users are strongly advised to use a laptop from Intel Core i5 or higher and no less than 8 GB of RAM. • A good quality laptop or mobile camera for live image processing vital for pose estimation is recommended. • A steady internet connection. 4.7.2 Software Requirements Our software requirements for the Virtuel Elegance are as followed: • ReactJS, NodeJS, ExpressJS and Firebase for web based application. • React Native for cross platform (android and iOS) mobile application. • Python libraries like OpenCV, OpenPose and MediaPipe for image processing and pose estima- tions. • C# for 3D modeling. • Visual Studio Code, Android Studio, Jupyter Notebook and Unity Editor for the web based appli- cation, mobile application, pose estimations and 3D modeling respectively as IDEs. 4.8 Graphical User Interface The following are the snapshots of the Graphical User Interface of Virtuel Elegance applications. Figure 4.1: Landing page of the web application of Virtuel Elegance Figure 4.2: Admin dashboard of the web application of Virtuel Elegance Virtuel Elegance Enter Username Enter Password Log In Forgot Password? Figure 4.3: Login page of the mobile application of Virtuel Elegance Browse Browse Figure 4.4: Browse article pages of the mobile application of Virtuel Elegance Try-On Try-On Choose a Fit Choose a Fit Figure 4.5: Real time virtual try-on page of the mobile application of Virtuel Elegance Add Article Upload Image ArticleId Title Category Description Upload Figure 4.6: Add articles page of the web application of Virtuel Elegance 4.9 Database Design 4.9.1 ER Diagram Entity Relationship diagram of Virtuel Elegance is given below. Figure 4.7: Entity Relationship Diagram 4.9.2 Data Dictionary Table 4.1: Data Dictionary Table of entity User Entity Attribute Data Type Nullable Unique Relation- ship to Relation- ship Type Description User UserID Integer No Yes Article Article Virtual Try-On Session Snapshot 1 to N 1 to 1 1 to 1 1 to N Primary Key Name Varchar No No - - User's user- name Email Varchar No No - - User's email address Password Varchar No No - - User's pass- word Table 4.2: Data Dictionary Table of entity Clothing Article Entity Attribute Data Type Nullable Unique Relation- ship to Relation- ship Type Description Article ArticleID Integer No Yes Virtual Try-on Session N to 1 Primary Key Title Varchar No No - - Article's title Category Varchar No No - - Type of a article like jeans, T-shirt or jacket. Description Varchar No No - - Description of the article like brand name, dress color, price and size ImageURL Varchar No No - - Link of an ar- ticle to view Table 4.3: Data Dictionary Table of entity Snapshot Entity Attribute Data Type Nullable Unique Relation- ship to Relation- ship Type Description Snapshot SnapshotID Integer No Yes - - Primary Key UserID Integer No No - - Foreign Key Table 4.4: Data Dictionary Table of entity Company Entity Attribute Data Type Nullable Unique Relation- ship to Relation- ship Type Description Company CompanyID Integer No Yes Article Article 1 to N 1 to N Primary Key Name Varchar No No - - Comapany's username Email Varchar No No - - Company's email ad- dress Password Varchar No No - - Company's password Table 4.5: Data Dictionary Table of entity Admin Entity Attribute Data Type Nullable Unique Relationship to Relationship Type Description Admin AdminID Integer No Yes Article 1 to N Primary Key Name Varchar No No - - Admin's username Email Varchar No No - - Admin's email ad- dress Password Varchar No No - - Admin's password Table 4.6: Data Dictionary Table of entity Virtual Try-on Session Entity Attribute Data Type Nullable Unique Relation- ship to Relation- ship Type Description Virtual Try-on UserID Integer No No - - Composite Primary Session ArticleID Integer No No - - Key 4.10 Risk Analysis Following are the risks that were identified as potential risks to Virtuel Elegance after conducting risk analysis. 4.10.1 Technical Risks • Virtuel Elegance will be used by users that have entered their Personally Identifiable Information (PII), so their personal data may be exposed to any theft in case of phishing and cyber attack. • The web application will be hosted on a server so the speed of server will determine the availability of different services. 4.10.2 Operational Risks • The application involves dependency on third party services and APIs integration so any service outrage can disrupt functionality. • The application will target users to try virtual try-on functionality, so the risk of any inadequate user training for this application may result in poor user experience. 4.10.3 Performance Risks • The application will need a consistent internet for smooth working. Any instability or unavailabil- ity can abort functioning performance of the application. • A high quality camera for pose estimation is required. Bad quality of camera may impact the live image processing that is most important for pose estimations. • The virtual try-on functionality relies on the 3D modeling of pose estimations. So, inaccurate measurements and issues associated with integration of 3D modeling will indicate the risk of application's objective failure. 4.11 Conclusion To summarize briefly, this chapter describes comprehensively all the technical requirements of Virtuel Elegance. It provides all the relevant details of functional and non-functional requirements of our project. All

the quality attributes essential for the success of project along with hardware and software require- ments are discussed in detail as well the analysis, built on certain assumptions, is written in detail with all the technical, business and operational risks attached with our project. Lastly, use cases to facilitate the road map for user interaction with the application with simple yet intuitive Graphical User Interface are provided. Chapter 5 High-Level and Low-Level Design In this chapter, we will discuss both the high level design and low level design of our application. In the high-level design, we will explore the overall architecture, emphasizing the key modules and how they interact with other components. The next level, low level design, is to consider the detailed look at how the specific modules operate by considering the classes and methods that make up a particular module. Both levels of design are essential in developing our application, Virtuel Elegance. 5.1 System Overview Virtuel Elegance is a web and mobile application that is designed with the purpose to facilitate garment industry by providing virtual try-on and ease customer shopping experience. Through its virtually trying- on functionality, it is capable to revolutionize traditional shopping methods of trying clothes in a physical try room. The system incorporates live image processing for pose estimations and integrate 3D modeling to try-on garments virtually. 5.1.1 System Functionality The application offers two primary user environments: • At-home virtual try-on: Users can try-on clothes from various brands and click snapshots. • In-store virtual try-on: Customers can try-on clothes of the specific brand to visualize how it will look. The system also allows brand and companies to register themselves, upload their clothing catalog and use the application core functionality to enable virtual try-on. 5.1.2 System Design The core design of the basic Virtuel Elegance integrates: • Live Image Processing for pose estimations. • 3D modeling for virtual try-on. • Real-time integration with brand catalogs. • Cross-platform compatibility for mobile and desktop applications. 5.1.3 System Modules The system has a modular design, so it divides functions into separate modules based on their services. Key modules include: 5.1.3.1 User Management Module This module handles user authentication, profile management and the storage of body measurements and preferences. This module will also help user to create profile and store their history of all virtual try-ons. 5.1.3.2 Brand Management Module This module enables brands to create their account for the management of articles of cloth and uploading new articles to be virtually worn. 5.1.3.3 Real-time Image Processing Module This module handles OpenCV, a computer vision library as well as OpenPose machine learning models for body pose recognition, image processing and body measurement extraction in real time. 5.1.3.4 Virtual Try-On Module This module is solely responsible for placing the chosen clothes on the 3D model to provide a rather realistic visualization of garments look. 5.1.4 System Workflow The system will follow the followings core steps to reach the desired output: • User Onboarding: The user will sign up the relevant information and then login to the system. The profile information will be stored in database. • Brands Integration: The brands will sign up their registration and sign in to the application to add their clothing catalog. • Image Processing: The logged-in user will then open the camera of his/her laptop or mobile for pose estimations. • Article Selection and Virtual Try-on: The user will then be able to see how the selected article will fit on him/her virtually. 5.2 Design Considerations This section includes the assumptions, general constraints, goals and development methods for Virtuel Elegance while considering its design. These considerations describe many issues that need to be ad-dressed or resolved before attempting to devise a complete design solution of Virtuel Elegance. 5.2.1 Assumptions and Dependencies Virtuel Elegance has the following assumptions and dependencies for design considerations. 5.2.1.1 Hardware Requirements The system assumes that the users of the Virtuel Elegance own or have access to a camera especially for real time image processing through a mobile or a laptop. 5.2.1.2 Operating Systems The use of this application shall be compatible with the Operating Systems such as iOS, Android and Windows. It is designed to be made fully compatible with the operating systems given above. 5.2.1.3 End-user characteristics Users are expected to have proficiency in web navigation and its usage. They are also expected to be familiar with basic smartphone or desktop operations to upload or capture snapshots of the images while connecting to a consistent internet connection. 5.2.1.4 Possible and/or probable changes in functionality The industry of garments is ever evolving with new trends ruling and inspiring the clothing fits. Hence- forth, our application, Virtuel Elegance, will be designed to adapt the changed circumstances and the future updates with advanced AR features especially in field of customer's experience enhancement. 5.2.2 General Constraints Following are the constraints considered while designing Virtuel Elegance that have significant impact on the design of the our software. 5.2.2.1 Hardware or software environment • An Operating System better than

Windows 7 or equal with a RAM no less than 8GB. • Stable and consistent internet connection for smooth functioning of application. • High quality camera whether on a mobile or a laptop to give accurate pose estimation because the accuracy of pose estimation will also be relied on resolution. 5.2.2.2 End-user environment • The user needs to have a good internet connection that ensures the application's functionality and workflow. • The user needs to have an idea of operating mobile application and running web application on a browser that can be Chrome, Firefox and Microsoft Edge etc. These constraints with respect to end-user environment will be necessary to handle in order to make a satisfactory user experience. 5.2.2.3 Availability or volatility of resources • The user needs have an access to a resource like computer, laptop or a mobile to run our applica- tion. • The user needs have a steady internet connection to run our application. 5.2.2.4 Interoperability requirements • The connection between the user and the database should be good. • Virtuel Elegance will be compatible with different operating systems, browsers and devices such as Android or iOS. • Virtuel Elegance will support third party services and integration using Application Programming Interfaces (APIs). 5.2.2.5 Interface/protocol requirements • User interface easy-to-use will be kept for navigating the application. • User interface will be kept responsive for a consistent user experience on different screens. 5.2.2.6 Security requirements • A secure user authentication system should be implemented to ensure protected access, requiring the use of strong passwords. • Privacy is a key interest of Virtuel Elegance with a major focus on personal data like images. Such strategies as encryption of images and their storage will be required for building the trust between its users and application to maintain Confidentiality, Integrity and Availability of data. 5.2.2.7 Performance requirements • The system must efficiently process large images and provide results without noticeable delays to enhance user experience. • The system shall be able provide the rendered virtual try-on final result to the user within a maxi- mum of three seconds. • The system shall accommodate 100 concurrent users without experiencing performance degrada- tion. 5.2.2.8 Network communications • Real-time virtual try-on requires fast internet speeds for uploading images and retrieving clothing data from brand databases. • Any bandwidth delays will affect the communication of user with the application as well as the performance of application. 5.2.2.9 Data Repository and Distribution Requirements • Since database in Virtuel Elegance will be used by brands to populate it with their clothing articles and the system will also save all the relevant information and snapshots of the user in it, hence it will be secure, scalable, and efficient for storing and retrieving data. • The databases (system and user's) must be kept secure to avoid SQL injections, attacks and data leakage. The performance of a smooth and working functionality of Virtuel Elegance lies in dealing with these constraints for a revolutionary and game changing success. 5.2.3 Goals and Guidelines The goals and guidelines which embody the design of the Virtuel Elegance's software are written below in detail. 5.2.3.1 Goals • The KISS principle ("Keep it simple stupid!") Virtuel Elegance will adhere to following the KISS principle to provide an intuitive and user friendly interface without any complications. The interface will be user-centric which means that the interactive interface would be understandable and accessible to all users. • Speed Virtuel Elegance will prioritize speed over memory use for real-time try-ons. Efficient algorithms for pose estimation and image rendering will be essential to provide a realistic virtual try-on without any delays or little latency. • Modifiability Virtuel Elegance will be modular and adaptable so that new market trends and styling in garment industry will be incorporated to enhance user experience. • Consistency We will ensure that the Virtuel Elegance provides a consistent look and feel across mobile and desktop platforms. 5.2.3.2 Guidelines • Users need to ensure that the quality of camera is high for proceeding towards pose estimations. • Brands need to ensure that the products they are uploading are of high quality as well. • Brands need to ensure that the clothing article they have uploaded does not contain any inappro- priate words, slogans and are according to the cultural values. • User must respect the save limits imposed by system for snapshots at a time. 5.2.4 Development Methods The system design follows Agile methodology which will be a Scrum approach. This will allow flex- ibility and iterative progress in adding features and making improvements from time to time. Scrum is an adaptable, iterative and evolutionary incremental approach to the management and control of the development process. Another reason for this choice is the fact that each phase of the project, including image capture and garment display, can be iteratively developed. The organization of the project based on Scrum approach is divided into time-boxed sprints, where each sprint focuses on developing core features like image capture, pose estimation, and virtual try-on using user stories and product backlogs. Since we are a team of 3 members, hence Scrum roles such as Product Owner, Scrum

Master, and the Development Team will not distinctively made. All of us will work and collaborate with daily stand-ups to track progress and identify blockers. At the end of each sprint, a Sprint Review of 30 minutes will be done to gather feedback for continuous improvement. These sprint meetings of 30 minutes will be conducted daily while Sprint Retrospectives help refine the process. This approach enables incremental feature delivery, quick response to feedback, and continuous product refinement. 5.3 System Architecture The system of Virtuel Elegance is designed to segregate front-ends as well as back-ends for mobile and web applications in order to reduce the dependency such that the front-end will be comprised of web based and mobile applications in which general users have access to mobile applications and general users, company and admin will have a separate react app as front-end for web application. The different front-ends of web application will be connected to different back-end servers to ensure if a single server goes down then the remaining all modules receive no effect and work independently to ensure the smooth performance of how various components interact with each other and separation of concerns of the system. The high level design of our system architecture is discussed in detail below: 5.3.1 High-Level Partitioning The system will consist of the 3 layers explained below: 5.3.1.1 Presentation Layer This layer provides all the user interacting components and various interfaces for different types of users like end users, companies and admin. Key components include: • User Mobile App (React Native) • User Web App (React) • Admin Web App (React) • Company Web App (React) 5.3.1.2 Business Logic Layer The business logic layer is the heart of the system that does all the work of data processing, business rules and communication between the presentation layer and the database. This layer also has the Virtual Try- On Server to perform the core functional tasks such as pose estimation and 3D modeling. Key modules include: • Virtual Try-on Server (Python) • User Module (Node.JS and Express) • Company Module (Node.JS and Express) • Admin Module (Node.JS and Express) 5.3.1.3 Data Persistence Layer The Data Persistence Layer stores all the data needed by the system that include user information, articles, virtual try on information, company details, etc. For this, we will choose Firebase database. • Firebase Database Scalability, real time, and integration within Node.JS and Python are the reasons why Firebase is chosen as the database solution for Virtuel Elegance. 5.3.2 Separation of Concerns The modularity, maintainability and scalability of Virtuel Elegance comes from the Separation of Con- cerns, which in previous subsection of high-level partitioning is written in detail, to enable each layer and module in Virtuel Elegance to focus on one distinct part of the whole system. 5.3.3 Component Collaboration Virtuel Elegance has each component working together through defined interface which leads to a smoother communication between the layers. Key interactions include: • The Presentation layer will interact with business logic layer when a user will perform an action. In that case, an HTTP request will be sent by web app or mobile to the user, company or admin module respectively in logic layer. • The Business Logic layer will interact with Persistence database layer for the retrieval and storage of data. • The Business Logic Layer will interact with Virtual Try-On Server through APIs where the server processes user requests for pose estimations and modeling. These results of the user requests are sent back to the user module which returns back to the applications for the final display. 5.3.4 Rationale This decomposition of Virtuel Elegance into distinct layers is supported by many factors that include the system's scalability, extensibility, modularity, performance and security. Henceforth, this architecture was best suited for us and finalized to achieve the development of Virtuel Elegance. 5.3.5 Architecture Diagram Figure 5.1: Architecture Diagram 5.3.6 Subsystem Architecture Our system is divided into 3 main subsystems. • User Subsystem • Company Subsystem • Admin Subsystem These subsystems represent some services or components in the system responsible for different features of the functionality the system provides. Their detail is given below: 5.3.6.1 User Subsystem All the features that are related to user such as user profile, virtual try-ons and snapshots will be dealt by this subsystem. • User Service It is the central service which handles user specific actions and requests. It acts as a centre to the whole user related components as it coordinates with all other components that include: – Profile Management Component It is responsible for the creation of a user profile. Once it is created, it then further authenti- cates and authorizes and then further requests from the user side will be entertained by this component such as managing profile, viewing and updating profile. – Virtual Try-on Component It is solely responsible for the virtual try-on functionality that will be provided to the user to visualize how clothes fit vistually in real time after dealing with backend services of 3D modeling and pose estimations. – Snapshot Component It is responsible for the services of snapshots that the user will be willing to take once virtual try-on component has successfully rendered an image. The snapshot component will

facilitate user to capture, save and delete snapshot. 5.3.6.2 Company Subsystem The Company Subsystem handles the Company's interaction with the system through managing com- pany profile and company product catalog. • Company Service It is the central service which handles company's specific actions and requests. It acts as a centre to the whole company related components as it coordinates with all other components that include: – Profile Management Component It is responsible for the creation of a user profile. Once it is created, it then further authenti- cates and authorizes and then further requests from the user side will be entertained by this component such as managing profile, viewing and updating profile. – Product Catalog Management Component It deals with the companies' product catalogs as it includes uploading, updating, and deleting articles to managing how those articles are available for users to try-on virtually. It's tied to the User Service and Admin Service to sync product data across users. 5.3.6.3 Admin Subsystem The Admin Subsystem gives the administrative functionality that is needed to manage and control users and companies as well as manage articles. • Admin Service It is the central service responsible for working with all admin related operations and for commu- nicating with other subsystems, mostly with company and article management. – Article Management Component It is responsible for handling articles' oversight and regulates articles provided by compa- nies. Products in the product catalog can be approved, rejected or modified by admins for the quality and standards of the virtual try on system. It interacts with company service Product Catalogue Management component to update the product database and make it consistent. 5.3.6.4 Component Diagram The component diagram to represent the internal working of all subsystems of low-level design is at- tached below. Figure 5.2: Component Diagram 5.4 Architectural Strategies Following architecture strategies were considered while making our software: 5.4.1 Programming Languages and Database Python will be used for its extensive support of Computer vision. We will use python libraries such as OpenCV or DensePose for pose estimations. JavaScript is the most important language when it comes to fast rendering and easy maintenance. All the front-end and back-end will be built using frameworks of JavaScript that include ReactJS, ExpressJS and NodeJS. For the development of mobile application, we will use React Native as it supports cross platform development including android and iOS. Virtuel Elegance will use Firebase as the main database; the real-time feature of Firebase will be valuable to achieve the objective of Real-time User Experience of the system. Since the platform is concerned with try-on and interactions with the users, data should be processed in real time, and this is where Firebase comes in handy. Another important aspect is security and as seen, Firebase offers fairly good solutions for users' authentication. 5.4.2 Reuse of existing components Following built-in libraries will be incorporated in our project: • OpenCV (or alternatively DensePose) built-in libraries of python will be used for the processing of image in real time leading us to estimate pose. • Open source library like Keras will be used for the modeling in 3D. • Built-in components in React will be used for the creation of an intuitive and responsive user interface. 5.4.3 Modular Approach and Product Extensibility The system will be designed using modular approach in mind to adapt the evolved and changed needs in marketing and clothing trends without any major rework. This also gives the design flexibility to scale or update individual modules of the overall system, since their dependency is minimum so as to when products are added or improved upon in the future, it can open doors of product enhancement and extensibility. 5.5 Class Diagram Class diagram of Virtuel Elegance is given below. Figure 5.3: Class Diagram 5.6 Policies and Tactics Following factors shall be considered for the project policies. 5.6.1 Coding Guidelines and Conventions Since the project will be developed in two portions as front-end and back-end apart from developing mobile application, henceforth, we will fully adhere to coding conventions i-e PEP 8 for Python and JavaScript ES6 standards to ensure consistency by following standards set by industry. We will also use consistent naming conventions for variables, constants and classes. Proper commenting will be made as well. 5.6.2 Error Handling Proper robust error handling strategies will be used to ensure all the issues that may arise during image processing or rendering final output will be handled using user-friendly error messages displayed to the user. 5.6.3 Testing the System We will implement all types of testing like: • Unit Testing • Integration Testing • End-to-End Testing This is to ensure that all components individually and fully integrated will work as desired to produce the correct output for the user. For this, we will use black box and white box testing techniques. 5.6.4 Maintenance and Improvement Virtuel Elegance is committed to innovation and continuous development. Hence, Virtuel Elegance will incorporate the concept into this view with emphasis on developing and on maintaining the growths and updates so that Virtuel Elegance remains a reliable, resourceful and secure system that can sustain adaptability. For this, corrective and preventive

maintenance strategy will be done. 5.6.5 Algorithm Selection In order to develop an accurate and efficient virtual try-on for the users, the selection of an algorithm will play a crucial role. Algorithms will be selected based on their speed and by ensuring a balance between speed and accuracy as well as scalability. 5.7 Conclusion This chapter thoroughly explained the high and low level design of Virtuel Elegance. All things from system overview and design considerations to strategies vital for designing architectural system sup- ported by diagrams are explained to express the best possible sense of our project. By following these considerations for the proposed design of Virtuel Elegance, we shall be able to deliver an accurate, se- cure, reliable and efficient platform for both users for the virtual try-ons and brands for game-changing marketing performance. Chapter 6 Implementation and Test Cases In this chapter, we highlight the work developed and implemented to bring Virtuel Elegance from a conceptual design and architectural notion to being a real functioning system. This chapter describes the methods through which principal modules like pose estimation, 3D modeling and garment mapping are formulated into one coherent virtual try-on experience. 6.1 Implementation of Pose Estimation Pose Estimation is the base which lays the foundation of an accurate identification of body parts and vir- tual try-on experience in Virtuel Elegance. It is implemented in three phases with continuous refactoring and adaptation with respect to the latest integration and dependencies. Following three approaches, with the passage of time, have been applied to detect accurate body points. 6.1.1 Using openCV Pre trained Model First pose estimation that we carried out was utilizing python library of OpenCV with DNN (Deep Neural Networks) for detecting and identifying human body parts in real time. The neural network model was read using readNetFromTensorflow which allows using the MobileNet-based structure to detect each body part adequately. VideoCapture class of OpenCV was used to capture live frames for smooth real time body parts' detection. Using this model and for each frame, heat map for 19 different parts of the body was computed. Every heatmap corresponds to the confidence score of a body part at certain pixels only. From the heat maps, we derived the coordinates of some main body parts; Nose, Neck, Shoulders, Elbows, Wrists, Hips, Knees and Ankles. From the total number of points for each participant only those points where the confidence score was equal or above threshold thr = 0.2 were included. The recognized key points were linked by defined pose pairs, Neck to Shoulders, Elbow to Wrist, etc., to create a skeleton overlay. Circles on lines were provided on the video frames in real time to show relations and body parts at a revealed stage. 6.1.2 Using Mediapipe 2D landmark detection We then improved our previous pose estimations using openCV library. We applied 2D body pose detection by executing the MediaPipe BlazePose model through the PoseDetector wrapper from CV- Zone. Through this method, we were able to extract 33 full-body landmarks which function in real-time from webcam input to see important body points including shoulders hips wrists and knees thus en- abling virtual clothing try-on functions. This evaluated pixel-based coordinates for these landmarks to determine-shirt sizing with shoulder width measurements and pant dimensions with hip area data along with wrist positions that control user interface elements. We made calculations based on landmark dis- tances such as shoulder width measurements used for shirts and hip-to-knee distances for pants while preserving overlay ratios. The pre-trained model excels at pose detection while offering ready-made functional abilities without autonomous training that utilizes two-dimensional spatial relationships as the key for effective garment positioning fit to live webcam applications. 6.1.3 Using MediaPipe 3D Anatomical BlazePose Model The last technique to improved 2D pose estimation applied is via MediaPipe 3D pose detection. Me- diaPipe's Pose module initializes with optimized parameters for smooth tracking and moderate compu- tation. Each frame is converted from BGR to RGB for landmark detection, identifying 33 key body joints in both pixel and 3D normalized coordinates. Each landmark includes a visibility score, which quantifies detection confidence and influences subsequent alignment calculations. A predefined keypoint mapping dictionary defines a link between MediaPipe detected landmarks (Left shoulder and Right hip) to specific locations on the 3D shirt model. This mapping enables the system to calculate alignment transformations through Procrustes analysis because it optimizes rotation and translation and controls scale. The measurements from detected landmarks of shoulder width and torso height limit scaling fac- tors to prevent abnormal deformations through a smoothing process. Our entire project will be based on this real-time skeletal tracking that ensures dynamic virtual garment adaptation, balancing accuracy and efficiency for seamless try-on experiences. 6.2 Implementation of Modeling Implementation of 3D modeling by extracting pose estimations from live camera of user as well as gar- ments has been successfully analyzed and done. Working on models like SMPL "Skinned Multi-Person

Linear" with python libraries like MediaPipe with initial parameters to optimize pose it using gradient descent has been successfully done for generating a 3D face mesh. Other than that, Blender for 3D model and avatars was explored. It was decided not to incorporate it as it deviates from realistic look of human models which dents our virtual try-on experience. Additionally, after face mesh, we applied the same triangulation for cloth triangular mesh. Different shirts and jeans were given as input to check the dimesnions and rotation of mesh over the three x,y,z axis. It was presented to the evaluators and explained the distortion on the back side of clothing mesh. Because of this inefficiency, we integrated a service API that converts a 2D shirt into a 3D mesh, export- ing it as a `.glb` file which will be used for rendering. 6.3 Algorithm Implementation: Techniques and Approaches Different algorithms have been implemented before coming to final overlaying and mapping of models for the virtual try-on. The final result of real time virtual try-on can only become possible through the combination of these algorithms which utilizes pose estimation for integration with geometric alignment and 3D rendering while robustness maintenance occurs through fallback mechanisms and parameter constraints. Details of these algorithms are written below: 6.3.1 3D Model Preprocessing Within the preprocessing stage of 3D model processing the algorithm performs bounding box analysis while executing uniform scaling operations. The algorithm determines spatial dimensions of models through vertex extreme calculations across all meshes before transforming the meshes to match a de-fined target size using scaling transformation matrices. The normalization step makes the pattern sizes identical across multiple garment models without changing the proportions 6.3.2 Procedural Fallback Garment When the system fails to load defined 3D assets such as due to file corruption or data absence, the procedural fallback garment runs its parametric modeling routine to produce a basic 3D clothing model. The algorithm secures system reliability through its mathematical code that creates T-shirt geometry thus preventing file dependency. 6.3.3 Garment Alignment Core garment alignment performs its operations with a Procrustes algorithm which incorporates biome- chanical constraints. The mapping dictionary first enables body landmarks to be matched with shirt keypoints before the algorithm calculates weighted centroids from both point sets. The calculations pro- cess shoulder widths and torso heights alongside Procrustes analysis through weighted averaging that uses shoulder factors 50 alongside height values 30 percent and general analysis 20 percent. The ro- tation value depends on singular value decomposition of a visibility-weighted covariance matrix which integrates reflection correction for correct alignment. 6.3.4 Motion Stabilization The system performs motion stabilization by using matrix interpolation between successive transforms. The translation components utilize linear interpolation but rotation components use spherical linear inter- polation (slerp) of quaternion representations to sustain valid rotations. Shear distortions are prevented by using this technique to separate each transform scale. The system employs alpha blending between pyrender produced RGBA output and camera frames by applying per-pixel alpha masking for rendering purposes. The technique maintains both competent lighting effects and complete background visibility. 6.4 Implementation of Mobile Application The mobile application of our project solely targets the user where they can virtually try on clothes. This application is created using React Native being the frontend technology while user web application's backend server can act as the backend for this application as well. Users can explore different features such as browsing through articles, saving articles for future use and the core feature of virtual try-on. Each feature is implemented on separate pages to ensure a smooth user experience. 6.5 Test Cases All the test cases performed to ensure proper functionality of our system during the testing phase are elaborated below. Table 6.1: Sign Up Test Case Sign Up TC-001 Test Case ID: 1 QA Test Engineer: Saad Kashif Test case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 10, 2025 Use Case Reference(s): Sign Up Revision History: None Objective: To test whether a new user can register them self successfully on the app. Product/Ver/ Module: User App Module Environment: Internet is connected and the app is running on a compatible mobile phone. The backend of the system is fully operational. Assumptions: User has a valid email and other required credentials. Pre-Requisite: The user is on the sign up screen. Step No. Execution description Procedure result 1 Navigate to sign up screen. Sign up screen is displayed. 2 valid data. Fill all required fields with All fields are filled with valid data. 3 Click "Sign Up" button. Account is created and confirmation mes-sage is displayed. Comments: The test case passed successfully. The system is working as per requirements. Passed Table 6.2: Log In Test Case Login TC-002 Test Case ID: 2 QA Test Engineer: Saad Kashif Test case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 10, 2025 Use Case Reference(s): Login Revision History: None Objective: To

test whether a new user can login them self successfully on the app. Product/Ver/ Module: User App Module Environment: Internet is connected and the app is running on a compatible mobile phone. The backend of the system is fully operational. Assumptions: User has a valid email and other required credentials. Pre-Requisite: The user is on the login screen. Step No. Execution description Procedure result 1 Navigate to log in screen. Login screen is displayed. 2 Fill all required fields with All fields are filled with valid data. valid data. 3 Click ”Login” button. User is successfully logged into the app. Comments: The test case passed successfully. The system is working as per requirements. Passed Table 6.3: Try-On Feature Test Case Try-On Feature TC-003 Test Case ID: 3 QA Test Engineer: Saad Kashif Test case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 12, 2025 Use Case Reference(s): Try-On Virtual Clothes Revision History: None Objective: To test if the user can successfully try on a clothing item using their mobile camera. Product/Ver/ Module: Virtual Try-On / v1.0 / Try Module Environment: Mobile device with working front camera, internet connection active, app installed and running. Backend services are up. Assumptions: User is logged in and has granted camera permissions. Pre-Requisite: User is on the main screen and a clothing item is available. Step No. Execution description Procedure result 1 Open the clothing catalog Clothing item is selected and preview is dis- and select an item. played. 2 Tap on ”Try On” button. Camera is activated and clothing overlays on the user. 3 Move around to test clothing Clothing item adjusts dynamically with alignment. movement. 4 Take a snapshot using the Snapshot is saved or shared successfully. capture button. Comments: Try-on feature works as expected. Clothing overlays correctly and tracks movement. Passed Table 6.4: Edit User Profile Test Case Edit User Profile TC-004 Test Case ID: 4 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 15, 2025 Use Case Reference(s): Edit Profile Revision History: None Objective: To verify that the user can successfully update profile details like name, profile picture, etc. Product/Ver/ Module: User App / v1.0 / Profile Module Environment: Mobile app running on compatible device, connected to internet. Back- end and database are fully functional. Assumptions: User is already logged in. Pre-Requisite: User is on profile screen. Step No. Execution description Procedure result 1 Navigate to Profile screen. Profile screen is shown. 2 Tap on ”Edit Profile”. Edit profile form is displayed. 3 Change name and upload new profile picture. Data entered successfully. 4 Tap ”Save Changes”. Success message is shown. Comments: Profile updated successfully and changes reflected immediately. Passed Table 6.5: Camera Permission Test Case Camera Permission TC-005 Test Case ID: 5 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 13, 2025 Use Case Reference(s): Camera Access Flow Revision History: None Objective: To verify if the application requests and handles camera permission appropriately. Product/Ver/ Module: Virtual Try-On / v1.0 / Permission Module Environment: Mobile device with working front camera, internet connection active, app freshly installed. Backend services are up. Assumptions: App has never been granted camera permission before. Pre-Requisite: App is installed but permissions are not yet granted. Step No. Execution description Procedure result 1 time. Launch the app for the first App launches and navigates to main screen. 2 Tap on a feature requiring App prompts user for camera permission. camera (e.g., Try-On). 3 Tap “Allow” on the permis- Camera permission is granted. Camera sion dialog. opens. 4 Close and relaunch the app. App accesses camera directly without ask- Tap Try-On again. ing again. Comments: Camera permission prompt appears once, functions properly, and persists correctly. Passed Table 6.6: Camera Permission Denied Test Case Camera Permission - Denied Flow TC-006 Test Case ID: 6 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 13, 2025 Use Case Reference(s): Camera Access Flow Revision History: None Objective: To verify that the app handles camera permission denial appropriately and notifies the user. Product/Ver/ Module: Virtual Try-On / v1.0 / Permission Module Environment: Mobile device with front camera, internet connection, and fresh app install. Backend services are up. Assumptions: App is not granted camera permission yet. Pre-Requisite: App is installed. User is not logged in or logged in, doesn’t matter. Step No. Execution description Procedure result 1 Launch the app and navigate App prompts for camera permission. to Try-On. 2 Tap “Deny” on the permis- Camera access is denied. App shows alert sion request. about permission requirement. 3 Try tapping Try-On again. App shows message or guidance to enable permission in settings. Comments: App gracefully handles denied permission by informing the user and preventing crash or blank screens. Passed Table 6.7: Take Snapshot Test Case Take Snapshot Feature TC-007 Test Case ID: 7 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 13, 2025 Use Case Reference(s): Capture Try-On Image Revision History: None

Objective: To ensure that the app takes snapshot and saves the image with the virtual clothing. Product/Ver/ Module: Virtual Try-On / v1.0 / Snapshot Module Environment: Mobile device with camera access granted, try-on feature active, in- ternet available if saving to cloud. Assumptions: User is already trying on a virtual clothing item. Pre-Requisite: User is logged in, camera is on, try-on overlay is active. Step No. Execution description Procedure result 1 Tap on the "Capture" or Snapshot is taken with clothing overlay vis- "Snapshot" button while try- ible. ing on clothing. 2 Check gallery or saved sec- Image is saved in correct format and loca- tion of app. tion. 3 Verify clothing is aligned in Clothing is properly overlaid as seen during the saved image. live try-on. Comments: Snapshot feature successfully saves a visual record of the virtual try-on. Passed Table 6.8: Logout Test Case Logout Feature TC-008 Test Case ID: 8 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 13, 2025 Use Case Reference(s): User Logout Revision History: None Objective: To verify that the user is successfully logged out and redirected to the login screen. Product/Ver/ Module: Virtual Try-On / v1.0 / Authentication Module Environment: Mobile device with app installed, user logged in, internet connection available. Assumptions: User is already logged into the application. Pre-Requisite: User is on the home screen or settings screen. Step No. Execution description Procedure result 1 Navigate to the settings or Settings/profile page is displayed. profile section. 2 Tap the "Logout" button. Confirmation dialog is shown (if applica- ble). 3 Confirm logout. User is logged out and redirected to the lo- gin screen. Session is cleared. Comments: Logout feature successfully ends session and navigates user to login page. Passed Table 6.9: Reset Password Test Case Reset Password Feature TC-009 Test Case ID: 9 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 14, 2025 Use Case Reference(s): Reset Forgotten Password Revision History: None Objective: To verify that a user can successfully reset their password using the 'Forgot Password' flow. Product/Ver/ Module: Virtual Try-On / v1.0 / Authentication Module Environment: Mobile device or web browser, internet connection active, backend services running. Assumptions: User has registered with a valid email address. Pre-Requisite: User is on the login screen. Step No. Execution description Procedure result 1 Tap on "Forgot Password" "Reset Password" screen is displayed. on the login screen. 2 Enter a registered email ad- Email is accepted and reset instructions are dress. sent. 3 Check email and click on re- User is redirected to reset password page. set link. 4 Enter and confirm new pass- Password is updated and user is notified. word. Comments: Password reset was successful, and login is possible using the new password. Passed Table 6.10: Add Clothes Article Test Case Add Clothes Article Feature TC-010 Test Case ID: 10 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 14, 2025 Use Case Reference(s): Add Clothing Item to Cata- log Objective: To verify that a company user can add a new clothing article successfully. Environment: Mobile/web app, authenticated company user, backend services active Assumptions: User has access to admin/company dashboard and clothing image ready. Pre-Requisite: User is logged in as company and navigated to the Add Clothes section. Step No. Execution Description Procedure Result 1 Tap on "Add New Article" New article form is displayed. button. 2 Enter article details (title, Form fields accept valid input. description, category). 3 Upload clothing image. Image is uploaded and preview is shown. 4 Click "Save" or "Add Arti- Article is successfully added to the catalog. cle" button. Comments: Add article feature is functional. Article appears in the list. Passed Table 6.11: Delete Clothes Article Test Case Delete Clothes Article Feature TC-011 Test Case ID: 11 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 14, 2025 Use Case Reference(s): Delete Clothing Item from Catalog Objective: To verify that a company user can delete a clothing article from the catalog. Environment: Mobile/web app, authenticated company user, backend services active Assumptions: At least one article is added and visible in the catalog. Pre-Requisite: User is logged in and viewing the articles list. Step No. Execution Description Procedure Result 1 Locate an article in the list. Article is visible with delete icon/button. 2 Tap on the delete icon/but- Confirmation prompt appears. ton. 3 Confirm deletion. Article is removed from the catalog. Comments: Article deleted successfully. Catalog updates accordingly. Passed Table 6.12: Switch Camera Test Case Switch Between Front and Back Camera Feature TC-012 Test Case ID: 12 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 15, 2025 Use Case Reference(s): Switch between cameras for virtual try-on Objective: To verify that the user can switch between front and back camera successfully. Environment: Mobile app with camera access permissions granted Assumptions: Camera permission is already granted, and app is in virtual try-on mode. Pre-Requisite: User has launched camera and live preview is visible. Step No.

Execution Description Procedure Result 1 Launch camera in virtual Default camera (front or back) is opened with preview. try-on screen. 2 Tap on switch camera Camera switches to the opposite (front/back). icon/button. 3 Confirm camera preview up- User sees real-time view from the newly selected camera. dates accordingly. Comments: Switch camera functionality works correctly and without delay. Passed Table 6.13: Browse Articles Test Case Browse Articles Feature TC-013 Test Case ID: 13 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 15, 2025 Use Case Reference(s): Browse clothing articles in catalog Objective: To verify that the user can view and scroll through the list of available clothing arti- cles. Environment: Mobile app with active internet and logged-in user Assumptions: Clothing data is available in the backend and synced properly. Pre-Requisite: User is logged in and on the home/catalog screen. Step No. Execution Description Procedure Result 1 Open the clothing catalog Catalog screen is loaded with list of articles. section of the app. 2 Scroll through the articles More articles load as user scrolls down. list. 3 Tap on any article to view Details screen opens for selected article. details. Comments: Browsing functionality works smoothly, and articles load dynamically as expected. Passed Table 6.14: Pose Estimation Test Case Pose Estimation Feature TC-014 Test Case ID: 14 QA Test Engineer: Saad Kashif Test Case Version: 1.0 Reviewed By: Hannan Fareed Test Date: April 15, 2025 Use Case Reference(s): Pose Estimation for Virtual Try-On Objective: To verify that the app can detect and estimate the user's pose for accurate clothing overlay. Environment: Mobile app with active internet, working camera, and logged-in user. Assumptions: User is in a well-lit environment and camera permissions are granted. Pre-Requisite: User is on the main screen and has selected a clothing item for the try-on. Step No. Execution description Procedure result 1 and select an item. Open the clothing catalog the screen. Clothing item is selected and displayed on 2 Tap on the "Try-On" button. Camera is activated, and pose estimation begins. 3 Position yourself in front of the camera and adjust for a full-body view. Pose is estimated, and clothing aligns with the user's body. 4 Move around to test real-time pose adjustment. Clothing adjusts dynamically according to user's pose and movement. 5 Check for accurate clothing fit and alignment. Clothing overlays properly and tracks movement correctly. Comments: Pose estimation works accurately, with clothing aligning correctly to the user's body and dynamic adjustments made. Passed 6.6 Test Metrics Table 6.15: Test Case Metrics Metric Value Number of Test Cases 14 Number of Test Cases Passed 14 Number of Test Cases Failed 0 Test Case Defect Density 0 Test Case Effectiveness 100% (All defects were detected using test cases) Traceability Matrix Traceability is maintained between requirements and test cases through unique IDs. 6.7 Conclusion As it can be seen from the implementation written above, our project has gained significant progress towards building a smooth real time virtual try-on experience. Mobile application is getting ready with both frontend and backend as it awaits for the final successfull rendering of virtual try on. As for the core Virtual try-on experience, two most important components including the base foundational aspect of accurate pose estimations has been implemented as well as 3D modeling has also been also accomplished. Different algorithms have been designed and implemented which now brings us very closer to finally render the 3D shirt on live feed. The aforementioned implementations exemplify the ability of computer vision and 3D modeling in transforming the online and offline shopping experience to be precise, time efficient and engaging. CHAPTER 7. USER MANUAL Chapter 7 User Manual 7.1 Introduction Welcome to Virtuel Elegance – a personalized fitting room powered by augmented reality and pose estimation. This app allows users to select clothing items, try them on virtually using their device's camera, and experience real-time fit and motion alignment. 7.2 Account Creation & Login To get started with Virtuel Elegance, follow these steps: • Navigate it to the website homepage of Virtuel Elegance or open the mobile app. • Choose "Sign Up" and fill in: – Full Name – Email Address – Password • Tap "Sign Up" to create your account. • After registration, click on "Log In" button on to enter your credentials. • Note: You can also log in with Google or Apple ID. 7.3 Granting Permissions The app requires access to the following: • Camera – for pose tracking and virtual try-on. • Storage – to save snapshots. • Internet – to fetch latest outfits and sync data. Upon first use, the app will prompt you to allow permissions. Tap "Allow" to proceed. 7.4 Navigating the Home Screen The home screen contains: • Catalog: Browse clothing items. CHAPTER 7. USER MANUAL • Profile: View or update personal info. • Try-On: Start virtual fitting. • Saved Items: View your favorites. 7.5 Trying On Clothes Step-by-step instructions: 1. Browse Catalog: Scroll or use filters (category, color, size, brand). Tap on an item to view it in detail as a selection. 2. Start Try-On: Tap the "Try-On" button. The camera will open. Align your body within the screen as guided. The item will overlay on your body using pose estimation. 3. Move Naturally: Walk, turn, raise

arms — the outfit will adjust in real time. 4. Take a Snapshot: Tap the camera icon to save your look. You can share it on social media or save it locally. 7.6 Managing Your Profile To manage your profile, follow these steps: • Go to Profile from the home screen. • Update your: – Profile picture – Body measurements (optional for better fitting) – Preferences (gender, style, size) • Click on Update button after updating the relevant details. 7.7 Saved Looks & Favorites To save an article and add it to favorites, follow these steps: • While viewing an item or after try-on, tap the "Heart" icon to save it. • Go to the Saved Items tab to view your favorites. • Tap to re-try or delete saved looks. CHAPTER 7. USER MANUAL 7.8 Adding or Removing Articles The app allows clothing brands to upload their catalog or update it with new article. To do it, follow these steps: • The brands or companies can go to their "Profile section" and click on "Manage Articles". • From there, they can select "Add" option to upload a new article by adding pictures and relevant information or "Remove" option to delete an existing article. • The company can also click on Update option below every article to update its existing picture with a new picture. 7.9 Troubleshooting Issue Solution Camera not opening Check permissions in device settings. App crashing on try-on Restart the app or update to the latest version. Clothing not aligning Ensure proper lighting and full-body visibility. Slow performance Close background apps or check your internet connection. 7.10 Tips for Best Experience • Use the app in a well-lit area. • Stand 1–2 meters away from the camera for full-body detection. • Wear fitted clothes for better overlay precision. • Update your body profile for realistic try-ons. CHAPTER 8. CONCLUSION Chapter 8 Conclusion The garments industry functions as one of the largest industrial sectors worldwide because of its fast expansion and broad consumer adoption of essential goods together with lifestyle products. Technology needs to advance to create friendly customized online shopping services that meet the growing demands of consumers seeking fashion trends in electronic stores. Our platform, Virtuel Elegance, offers a live virtual try-on system which links physical fashion encounters to digital platforms. Development of a prototype that covers all the major functionalities of our web application as well as mobile application highlighting its utility, has brought us towards a successful completion and fully functional end product. The application development incorporated essential user features including account setup and image acquisition alongside size selector functionality and trial assembly screens alongside virtual try-on capabilities. React Native enabled the development of mobile application. Web appli- cations are built through the FERN stack that combined React frontend with Firebase real-time data functions and Node.js API implementation. Through its design the architecture delivered seamless user- system communication between different platforms. On the technical side, our platform integrated modules starting with OpenCV for pose estimation frame- works and improved by incorporating OpenPose and DensePose to obtain correct body measurements from live images. The collected body measurements enabled the creation of human models which de- velopers used with third party services for mapping garment images. Each clothing article exists in an organized database structure on Firebase which links brands together so users obtain precise filtering results and recommendations based on size information. The system testing process validated major parts of our system while verifying seamless frontend- backend-image processing interaction. The system ensures data security through Firebase Authenti- cation while Firestore rules provide structured protection for safe information handling. Due to its modular system architecture, our platform can be rescaled and refactored in future adapting to the user feedback and needs. Overall, the Virtual Elegance platform provides users with a full solution which turns conventional clothing buying into an individualized digital encounter. BIBLIOGRAPHY Bibliography [1] "Pictofit, shopify virtual try-on." https://www.reactivereality.com/pictofit. [Accessed October 09, 2024]. [2] "Yourfit by 3dlook." https://3dlook.ai/technology/. [Accessed October 09, 2024]. [3] "Dresstry." https://play.google.com/store/apps/details?id=com.dresstry. [Accessed October 09, 2024]. [4] "Letsy." https://play.google.com/store/apps/details?id=com.metacortext.letsy. 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