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Kinect-Based Virtual Dressing Room: A Study

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Abstract— A significant number of businesses and organizations need customers to wait for an extended period of time before they may use trial rooms to try out products in real time. This technique utilizes real-time technologies to process clothing in real-time. First, a human clone is made using real-time simulation, and the subject's height and skin tone are used to give the skeleton a genuine appearance. Hardware sensors like cameras, lights, and motion detectors are used in conjunction with GUI (Graphical User Interface) software. Using the Unity SDK and the most recent Kinect Sensing element depth camera with an operating system that communicates with user-friendly applications, we'll be able to manipulate the controllers with ease. The user interface that arises from this method might be appealing to customers and businesses. Increased marketing activity should follow from using this new, more user-friendly strategy. The suggested method should address problems faced by both the retailer and the end user in addition to providing a suitable clothing option. When most people think of it, they image themselves making a purchase at a conventional brick and mortar store. If there aren't enough trial rooms, customers may try items on in real time. There is a ton of opportunities when trying on clothes and looking through new ones in a virtual mirror. Customers can digitally try on a wide range of items thanks to the "Virtual Reality" idea. Numerous research teams have investigated the idea of a virtual courtroom and have produced various solutions. It is possible to perform customer fittings on a humanoid mannequin by using humanoids that mimic the user's movements. Option two: show a static image of the clothing on the screen and ask the user to move to match where the clothing is. In real time, "Virtual Mirror" recognizes and superimposes the wearer's clothing on a virtual trial room. Before employing the Kinect Sensor, the system collects data. Unity makes advantage of the skeletal data for the user's character to generate new data. Then, using skeletal data, a costume is made in Unity and applied to the wearer in-game in real-time. The user's attire is overlaid over the video and is visible on the screen. The benefit of this approach is that it takes less time and effort to dress. To purchase the clothes, customers must scan the QR code that shows on the display screen. By eliminating the need for customers to try on every item of clothing, this project aids in market management. As a result, retailers save time and space by having less inventory on hand. To improve this concept, gesture recognition for selecting clothing might be utilized in place of a separate device.

Keywords—3D Depth Cameras, Kinect Sensor, Augmented reality, Virtual Dressing Room

1. INTRODUCTION

A lot of data is produced by e-commerce, which is the sale of goods and services via the Internet. The entire value of online goods and services increased by USD 1,336 trillion between 2014 and 2018[1]. The growing ratio of online e-commerce sales to overall sales is another sign of e-commerce growth (online and offline). Online sales made up 10.2% of all global sales in 2017, an increase from the previous year. The tendency of Internet users to buy clothing is one of the most important elements that have contributed to this. According to statistics from commerce, apparel is the most popular online category in every country and generates significant revenue [2]. Due to their many benefits, clothes make a great online buying option. This means that if you want a large selection, you must be able to quickly compare offers from various suppliers, quickly modify your offer in response to shifting fashion trends (including discounts) and simplify the purchase process. You have a special set of difficulties as a vendor because the customer wants to alter the product to fit his or her body type or skin tone. Compared to other e-commerce sectors, this one has a greater percentage of returns. Returns might make up as much as 60% of total sales, which is a big issue for online businesses. Utilizing a virtual changing room could be one remedy (hereinafter VFR). Using the VFR, anyone may virtually try on clothes before buying them. The ability to compare things like size, fit, style, and colour is made possible through this. This allows the online customer to get an idea of how it will appear in other things before making a purchase. Customers gain from VFR since it serves as a "virtual mirror" to guide their purchasing decisions. This study focuses on Generation Y's propensity to use VFRs when making purchasing decisions. Since VFR is still a relatively new option for online shops, it is having trouble getting popularity. This implies that VFR is a concept that Internet users, particularly those from generation Y who are proficient with ICT, are unaware of. Thus, preliminary investigation is required to determine whether VFR may be used. An in-depth analysis of attitudes about and readiness for using this form of application will be provided by this study [4]. As one type of VFR, clothing imitation on a three-dimensional form based on the customer's dimensions and clothing imitation on a two-dimensional likeness/photograph of a client were both examined (the so-called 3D mannequin).

From the perspective of the consumer, purchasing clothing online enables the realization of the following advantages: a wide selection of assortment due to access to many sellers outside of the local market, quick response of online sellers to seasonal changes, fashion factor, promotions, and sales, convenient selection and ordering from the comfort of home, simplicity of comparing the offers of various sellers, and the ability to return an item without providing a reason (in most markets).

However, shopping from a distance is not always as evident. First, the main criterion for selecting for this product category is that purchasing online prevents you from trying on a specific item of apparel. In a conventional store, a customer evaluates a product's fit, considers colour coordination, and contrasts sizes. The buyer at the eshop does not have this option, but she or he still wants to appear stylish and alluring. Second, when buying from a distance, you can't touch the fabric the item is made of [6] . Due of these two

issues, there are a lot of returns for apparel purchases made online. Additionally, there has been a change in consumer behaviour, which has increased returns even more. More and more purchases are being made spontaneously, without giving it much thought, on mobile devices, which results in increased streams of returned clothing.

Considering the e-tailers are engaging in a variety of actions targeted at lowering the expenses and labor required for the product return procedure. Better product labelling or descriptions, the placement of size-specific tables, and the launch of stationary points are among these initiatives (the so-called showroom). A flexible reimbursement policy has been a staple of certain companies' competitive strategy. One of the biggest online clothes shops, Zalando, has extended the return window to 100 days and given a free goods return. Another suggestion is to include VFRs with store software to prevent the primary cause of returns—a mismatch between a particular item of apparel and the actual size of the client body.

2. Idea and types of the virtual fitting rooms

The goal of the VFR is to accurately reflect a particular article of clothing's appearance and alter it to the customer's preferences, body type, and skin tone on a computer or smartphone screen. VFRs are essentially specifically created IT programmes that enable the superimposition of the modelled apparel on the client's body. Therefore, two different types of variables are required: data on the size of the customer's body (height, neck, bust, waist, hips, and arm measurements) and data on the size of the chosen article of clothing, which should also consider the degree of elasticity of the material used to make the clothing in addition to the sizes [7]. Whether we are working with 2D or 3D modelling, the process for adapting the garment to the client's figure will be different.

The primary factor used to categorize VFRs is the number of mapping dimensions. The foundation of two-dimensional VFR is augmented reality (AR) technologies. Like artificial images that are implanted in real range, augmented reality (AR) allows real-world images to be blended with computer-generated images. A webcam is necessary to collect real-world data for AR solutions for them to function successfully [10]. Advanced study on the application of augmented reality for sales has been carried out since the start of the twenty-first century. Two-dimensional VFRs are one of the conceivable options in this regard. Fig. A two-dimensional VFR example is shown in Figure 1. (also referred to as a 2D overlay in the text).

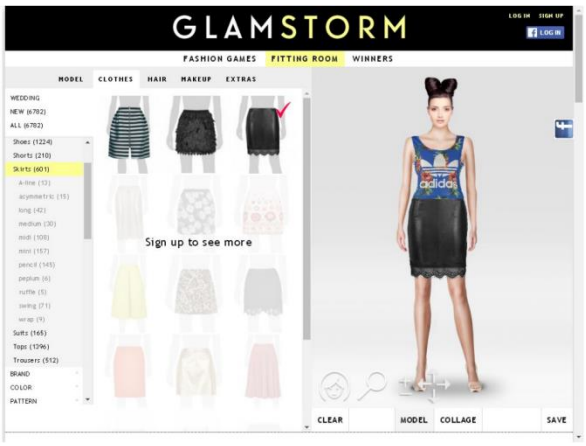

Figure 1. Example of a two-dimensional virtual fitting room (2D overlay VFR)

This sort of VFR's essence is depicted in Figure 1. The client's actual face and silhouette are captured by the camera, and computer-generated and algorithmically fitted clothing pieces are placed on those images. The buyer can view how they seem in the garment after donning it. Because the created image only has two dimensions, it can only be zoomed in and out.

The second primary variety of VFR is three-dimensional. The depth shows next to the breadth and height, allowing the user to spin the body and view how the dress appears on the virtual avatars (mannequins). These remedies rely on 3D modelling. The application algorithm needs manual body size data entry to build an avatar. Therefore, a unique mannequin that can be seen from many perspectives is created. A three-dimensional VFR is demonstrated in figures 2 and 3. (also referred to as a 3D mannequin in the text).

Modeling a chosen piece of clothing is feasible after entering the body measurements. A mannequin is used to display the garment; tight and slack areas can be seen. On this one, you can effortlessly fit your clothing in its ideal size. You can zoom in and out to examine the clothing from several perspectives in addition to zooming in and out to view the garment directly. Skin or facial features cannot be seen.

There are more sorts of VFRs than those covered above. The literature still contains references to the following methods for putting the VFR into practice:

- size recommendation services,
- 3D body scanners,
- photo-accurate VFRs,
- virtual reality fitting rooms.

Regardless of their variations and similarities, VFR versions ultimately fall into one of two categories: 2D or 3D mapping.

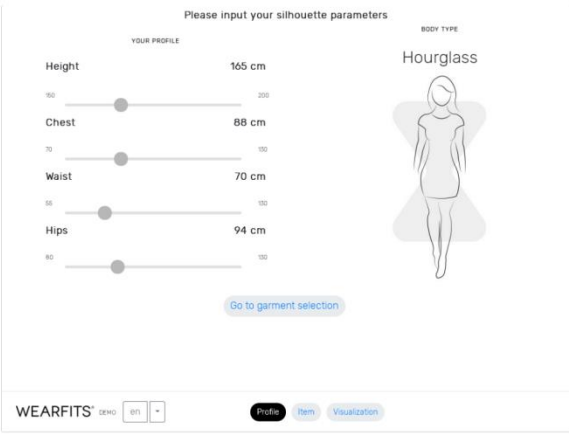

Figure 2. An example of a three-dimensional virtual fitting room (3D mannequin), entering the size

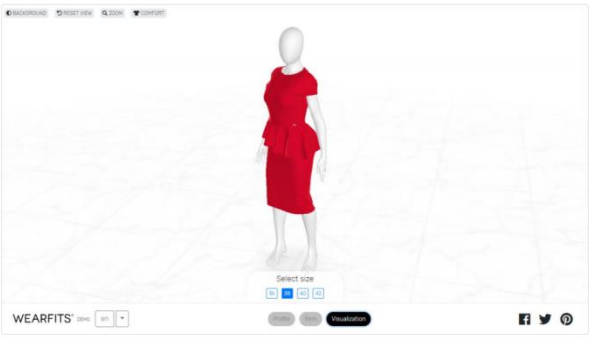

Figure 3. An example of a three-dimensional virtual fitting room (3D mannequin), from visualization

3. A Virtual Dressing Room

The online equivalent of the almost universal in-store changing room, a virtual dressing room allows customers to try on clothing to check one or more of size, fit, or style virtually rather than physically [12]. It is also sometimes referred to as a virtual fitting room or a virtual changing room, though they perform different functions. Fit technologies first started to become widely reported in 2010, but they have since become more generally available from a wider range of vendors and are being used by more well-known businesses in their online stores. Depending on the issue it solves (size, fit, or styling), or the technological method, a fit technology can be categorized. There are numerous distinct technological approaches, but which is the most reputable and well-established [according to who? [size recommendation services, body scanners, 3D solutions, 3D customer models, dress-up mannequins/mix-and-match, photo-accurate virtual fitting rooms, augmented reality, real models, etc.] Augmented reality (AR) is a live direct or indirect view of a physical, real-world environment whose elements are augmented (or supplemented) by computer-generated sensory input such as sound, video, graphics, or GPS data. It is connected to a broader idea known as "mediated reality," in which a computer alters (perhaps even lessens rather than augments) one's perception of reality. As a result, technology works through improving how one now perceives reality. Contrarily, virtual reality simulates the real environment in place of it. Traditionally, augmentation is done in real-time, inside a semantic framework, and with ambient components like sports scores on TV while a game is in progress. Advanced augmented reality (AR) technology makes it possible to incorporate computer vision and object

recognition, for example, and makes the information about the user's immediate surroundings dynamic and digitally manipulable [18]. On top of the real world, artificial information can be superimposed about the surroundings and its inhabitants.

It takes a lot of time and effort to try on clothes at stores. Additionally, it is possible for customers to receive clothing from internet retailers that does not suit them. Therefore, the idea of a real-time virtual dressing room allows people to purchase clothing without wearing it. Due to its potential for profit, virtual try-ons of clothing from the provided database have recently attracted an excessive amount of attention. One of the key steps in developing a real-time virtual changing room system is the detection of the user and the user's body parts. Imagine a person entering a store to purchase clothing. He then chooses his outfit from the database of outfits before taking a picture of himself. The consumer can view his image wearing the chosen dress model by using this virtual dressing room. He then chooses whether to purchase clothing. The presence of a person is detected using a face detection algorithm. By creating an overlaid image with the chosen dress model, the lower body detection algorithm is utilized to extract the customer's lower body, which is then presented on the screen.

4. KINECT SENSOR:

Developing the Kinect Sensor is Microsoft. The Kinect Sensor has four microphones, a depth sensor, and an RGB camera. For improved night vision, the depth sensor includes an infrared (IR) sensor. If you're utilizing an IR sensor, you'll need an IR camera. An infrared camera's functionality is dependent on structured light. The infrared laser and the broadcast grating are the only parts of the IR projector [19]. IR projection technology's well-documented facts include the geometry of the IR projector and camera as well as the projected pattern of IR dots. If a dot on the image matches a dot on the projector pattern, a 3D image can be projected.

An IR depth map should be created using the Kinect sensor. The darker pixel is nearer to the camera's focal point because depth measurements should be represented by grey values. Without depth information (represented by black pixels), the points may be too far apart or too close together to be approximated, hence no representation will be produced. if no depth data are gathered.

Figure 4: Kinect Sensor.

5. Design:

Online dressing rooms, sometimes referred to as virtual fitting rooms or virtual changing rooms, perform a similar function as in-store changing rooms. Customers can check the following information online rather than in person: size, fit, and style. Fit technologies have been the subject of numerous reports since 2010 [22], but they are now available from a wider variety of sources [20]. More and more well-known retailers are starting to use these technologies in their online storefronts. Fit technology can be categorized according to the problem it solves (such as size, fit, or style) or according to the technical method. There are numerous technology options available.

i. Size recommendation services

Customer-recommendation systems decide the suggested size. These methods can only offer rudimentary information on fit because size and fit are two distinct ideas. There are several different size recommendation methods available. Algorithms developed for purposes other than clothing, like ring sizers, may offer suggestions. One of these approaches is Find My Ring Size. [22] While some methods involve asking candidates about their personal style preferences as part of the hiring process, others involve combining measurements with existing products (a process called as biometric sizing). Dimensions may be generated from a company's own brand products or from suppliers' databases of garment design measurements.

ii. Body scanners

Webcams, smartphone cameras, or Microsoft's Kinect are used in one type of body scanner, while a more recent model requires users to go to the scanner personally. If you plan to use web or mobile camera technology, maintain a set distance from it and carry something that can serve as a gauge of the camera's size (like a CD). The most advanced scanners, such as those using laser or millimeter wave detector technology or massive arrays of Kinect sensors, aren't seen in most businesses because of their complexity and cost; instead, they're found at shopping malls and large department stores. Customers must go to a location to have their information scanned and used on websites. Body scanner fit technology was introduced in 2005 with the release of Levi’s [23]. Intellifit was purchased by Unique Solutions in 2009[23], and in October of that same year, the business was rebranded as Me-ality [24]. Weekday's body scan jeans, for instance, use them to make individualized clothing [24].

iii. 3D solutions

A virtual world-like experience is created using computer-generated 3D visuals in 3D fitting rooms. Based on consumer body measurements and form data, these technologies create a virtual mannequin (avatar). To build the avatar, customers must input measurements of themselves. It is possible to customize the avatar in terms of race, skin tone, hairstyles, and even a picture of the customer's own face. Customers may see how they'll appear while wearing the apparel, accessories, and other products you're selling if you utilize the avatar in this manner. Some of the more advanced versions let you compare a variety of clothing styles side by side and try on a variety of items all at the same time.

iv. 3D customer’s model

Customers can use these technologies to build a 3D model of themselves using information from scans or other sources, such images, or videos.

v. Fitting room with real 3D simulation

The benefits of 3D solutions and those of photo-accurate fitting rooms are combined in this space. The method creates a 3D mannequin that precisely represents the consumer dressed in numerous apparel items using images and basic body measurements. The consumer is frequently given a size recommendation, but they may also opt for alternative sizes to get a better idea of how well they'll fit.

vi. Dress-up mannequins/mix-and-match

In this variation, apparel and accessories are photographed on actual mannequins. The mannequins are then digitally covered up, revealing a virtual depiction of the brand in their place. The virtual mannequin may then be moved around and combined by the purchaser. By standardizing photographic techniques, several of these technologies might be used to lower the cost of using human models in clothing photography.

vii. Photo-accurate virtual fitting room

This appearance is produced by combining real models with dress-up mannequins. Instead of shooting things on real people, images are created utilizing robotic mannequins that can change size and shape to fit the bodies of customers. With the aid of computer-controlled mannequins, clothing in each size is videotaped and stored in a database as the mannequins instantly transform from one body form and size to another. A mannequin with computer control expedites the procedure.

The mannequin is typically taken out of the finished photographs and replaced with an avatar that accurately represents the company's logo.

The database gets the appropriate set of images—those in which the mannequin has the same proportions as the customer—and shows them to the consumer when they enter their measurements into the system.

viii. Augmented reality

A picture of a garment or accessory is often superimposed over a live video feed from the customer's camera in VR augmented reality systems to create a virtual reality experience. Due to an overlay 3D model or picture that moves with the customer, the virtual item of clothing or accessory will appear to be worn by the customer in the video. For the AR virtual dressing rooms to function, a webcam, smartphone camera, or 3D camera like the Kinect is typically necessary. Zugara's Webcam Social Shopper makes it simple to comprehend how this operates. Another example of augmented reality in virtual dressing rooms is the use of a 3D camera to change specific details of a garment or accessory inside of a display.

ix. Real models

Currently, several internet retailers offer easy access to the first edition. The item's measurements and the qualities of the wearer are both mentioned in the description. Some businesses even go so far as to offer

pictures of clothing on various models wearing various sizes. Customers may view videos of each model, which they can walk or move around on the screen to get a better idea of how the outfit might look on them.

6. Conclusion:

Customers occasionally complain about having to spend hours physically donning numerous outfits as they search for things. This could be difficult if you're under pressure and have a short window of time. Using a Virtual Mirror that doubles as a virtual trial room could help you overcome this challenge. Nodal points on the body are drawn using a Kinect sensor, and this information is then utilized to create an image of clothing covering the user's body, obviating the need to physically put on clothing and saving time for the wearer. A person also observed that the Kinect sensor transmits this information to a host device (such as an Xbox or computer), which processes the information in a variety of ways, including identifying the identity and even the position and movement of persons in front of the Kinect. Person also learned that the Kinect for Windows Software Development Kit is compatible with two different Kinect sensor bars (SDK). The Kinect for Windows device has been built for closer-range tracking so that a single computer user can use it to interact with a system that is nearby, while the Kinect for Xbox device has good long-range performance for monitoring gaming players.

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