The use of Augmented Reality to Deliver Enhanced User Experiences in Fashion Industry

Chamodi Jayamini, Asangika Sandamini, Thisara Pannala, Prabhash
Kumarasinghe, Dushani Perera, and Kasun Karunanayaka

University of Colombo School of Computing, Sri Lanka
2017is038@stu.ucsc.cmb.ac.lk,2017is013@stu.ucsc.cmb.ac.lk,
2017is062@stu.ucsc.cmb.ac.lk, jpk@ucsc.cmb.ac.lk, udi@ucsc.cmb.ac.lk,
ktk@ucsc.cmb.ac.lk

Abstract. With the advancement of new technologies, industries are developing rapidly. Among them, the fashion industry is a vast area that involves the production of raw materials, the production of fashion goods by designers, and retail sales. One of the most contributed technologies used in industry is Augmented reality. The use of new technologies can address the limitations of traditional fashion experience and enhance user experience. Undertaking a comparative thematic analysis of AR research in the fashion industry, this paper considers how AR applications evolve to enhance designer skills and knowledge throughout the past decades and the customization of clothes by users themselves to make a satisfactory and comfortable product. Secondly, the paper considers the enhancement of customer experience by analyzing how clothing retail has progressed with the adoption of AR applications.Finally, we have concluded the review paper by addressing the future research ideas. The results of the review show that possible improvements can be done for fashion designing and enhancing customer experience using AR and hybrid technologies.

Keywords: Augmented Reality, Machine Learning, fashion design, customer shopping experience, self customization.

1 Introduction

Dress is a powerful tool of influence since most of us accept the fact that in most cases, the way we dress reflects our first impression, a reflection of our character, and an insight into our likes and dislikes [1]. The fashion industry is a vast area that involves the production of raw materials, the production of fashion goods by designers, and retail sales [2]. Therefore, the fashion industry contributes a lot to the global economy [1]. However, several considerations in the traditional fashion industry such as customers may have to spend a lot of time for fit-on, skin diseases, and privacy concerns inside trial rooms have led the industry toward digitalization [3]. On the other hand, online shopping becomes massively accelerating with the closure of online retail shops during the Covid-19

pandemic [4], due to the restricted social life during the pandemic, and people tend to satisfy their needs and wants through online platforms [5]. However, with online shopping customers are unable to verify whether the item does fit or suit them, which raises the need for AR and ML [6].

The fashion industry acquires novel technologies such as AR and ML in order to enhance the customer experience in both online and offline shopping. AR can enhance the consumers' sensory perceptions [7], by blending the virtual world with the real world [8] and enabling interaction with the virtual garment items to encourage buying intentions [9]. The advancement of smartphones, tablets, cameras, and wearables (headsets) has made significant growth in the area of AR applications [10] and encouraged retailers to create immersive customer experiences. In recent years deep learning and machine learning have also come forward to make the best contribution to the fashion industry [11]. Object detection [12], data set training for predicting customer's tastes, and fashion designs [13] are some of the main applications that are used with the help of deep learning in this industry.

The rapid development of AR and ML in the fashion industry attracted growing academic research interest for past years [14]. The most notable research areas in the fashion industry with these technologies are virtual mirrors [15,16], virtual 3D images [17,18], virtual fashion shows [19], and custom designing systems [20 - 23].

This paper, therefore, seeks to contribute to our understanding of how AR and ML applications influence the customer experience and designer behavior of the fashion industry.

2 Literature Review

The literature review covers the contribution of Augmented Reality in fashion design, apparel self-customization, and enhancing the customer shopping experience. These three areas are discussed separately under the review. The fashion designing section consists of AR applications that would enhance designers' skills and knowledge. The apparel self-customization section covers the AR applications that allow users to themselves customize products in colors, styles or patterns, etc. cater to their preferences. The last section - enhancing customer experience includes the applications such as virtual mirror and virtual fashion shows, etc. where it removes the barriers in the traditional shopping experience.

2.1 Fashion Design

The fashion industry lies mainly in the design of clothes. Enhancing designers' creativity is what values the product design [24]. Throughout the past decades, many researchers have been carried out to enhance the design skills of fashion designers in various ways using Augmented Reality.

Ta et al. [25] proposed a solution for eFashion designers to create virtual interactive garment prototypes using augmented reality. From this application,

designers can quickly build, refine and test on-the-body interactions without the need to connect or program electronics. Simple paper tags with reflective markers and RFID tags that attach to the user's body with tapes or safety pins were used as in fig 1. When the user is in front of the mirror, each wearable tag is rendered on top of the designer's body. Unity, Kinect v2, and phidget RFIDs were used for initial implementation. The initial component tag set includes a button, accelerometer, simulated tweet events, LEDs, sound effects, and virtual cloth. Designers must combine three types of tags to form an input, connector, and output statement. As eFashion designers rarely work in isolation, Bod-IDE design can act as boundary objects facilitating communication between eFashion designers, engineers, and clients. The researchers have mentioned that the current implementation of this framework still cannot explore how real-world materials and fabrics would interact with virtual components such as light.
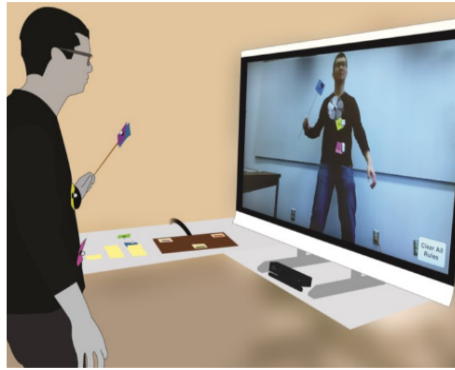

Fig. 1. Bod-IDE with a designer standing in front of the 'mirror' with tags fastened to their body. Source: Adopted from [25].
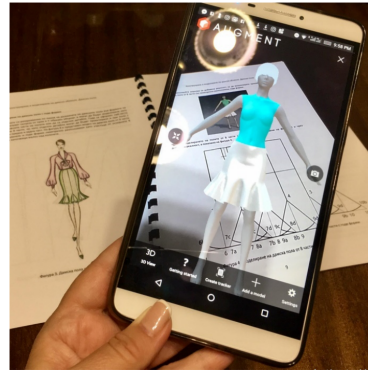

Fig. 2. Application of AR in pattern-making education. Source: Adopted from [17]

Fashion design education using innovative technologies like augmented reality is another concept, where the designers get the chance to enhance their designing knowledge and skills [26]. The main applications in this field are 3D model visualization [17], pattern-making education [17], and tutorials education [12].

In 2018, Kazlacheva et al. [17] have presented the innovations, which they use in fashion design education using Augmented Reality. In one application they have found that visualization of 3D models which the students can see on the displays of their mobile devices. The addition of a 3D dynamic model for the ladies figure with a dress, made it visualized in every direction and it is an easy and successful way for the costume to form recognition and differentiation. Fig 2 shows pattern-making education, with the use of AR markers. The students can see the result of the pattern-making process of the ladies' skirts.

In 2021, Borisova et al. [27] reviewed on developing textbook topics using the application of AR. They declare the opportunity that AR provides for the

visualization of 3D models using the QR codes which are in printed textbooks as 2D images. Additionally, created a 3D model composite of the symmetrical with asymmetrical elements.

In another research, in 2021, Elfekey and Elbyaly [12] measured how augmented reality affects the fashion designing student's skills in the functional, aesthetic, and creative fields. For the research, they used the methodology to examine the effectiveness of AR technology in developing students' fashion design skills within the application on smartphones with tutorial videos. For that, they develop an application that can be downloaded from the Google play store and they put the app in the design image in the book and by clicking the app they can find different videos and tutorials that help to design the product. This app proves that the design skills of fashion students are developed more than the hard skills of students. Mainly this research is limited to the female category as they have tested the application with female students only.

2.2 Apparel self-Customization

The concept of mass customization, defined as producing goods and services to meet individual customer needs [28]. Most of the industries have tended to practice mass customization as it is a very populated one [29]. In the field of the fashion industry, most of the time customers struggle in finding suitable clothes that cater to their needs [30]. Sometimes it may be colors, styles, patterns, or any other factors that result in them feeling uncomfortable wearing dresses. Therefore many researchers suggested a customization system for the users themselves in which the customer himself can customize the dress.

In 2009, Bradley et al. [20] had researched cloth with realistic illumination using augmented reality. For that, they wear a T-shirt or some clothes and from the AR application that they developed, they have selected the images and finally aimed the output to the shirt they were trying to see the final product output. From the research, they were trying to build a real-time flexible augmentation on cloth. For that, they used spare cloth tracking in video images using a new version-based marker system with the temporal conference. From the research, they prove that real-time 2D augmented reality on a non-grid object such as clothes can track a new circular system and apply the correct illuminations and shadows on the product used as in fig 3 adopted from [20]. From that, they can customize a product to the customer by identifying the correct illuminations and shadows. They have researched only light clothes with limited motions allowed.

In Mass customization, they produced a completely new product mode with a combination of customization and mass production. As the customers have various choices of brands, drapes, fabrics, and colors [21]. Here the research is only implemented for certain garment types. Rather than customization of the t-shirt, the researchers are trying to customize footwear with motion detectors.

In 2013, Luh et al. [22] presented a systematic framework for design customization of footwear for children. This system consists of novel functionalities which support customization and pattern development of shoes. Customization

design module behaviors controlled by JavaScript. Functions of the design module are color, texture, embroidery, carving style, and shape. Unity3D is used for the rendering of colors and texture, and the UVW mapping technique is used for mapping. It is important for users to quickly evaluate their design and give feedback in any customization design system. This paper proposed a further solution to a virtual try-on module as well as in fig 4 adopted from [22]. The ideation was implemented by ARToolKits and resides as an add-on in Unity3D. Kinect used for the object (foot) detection. And then this research applies the ICP algorithm to superimpose the trimmed model on the depth data captured by Kinect from the scene. The proposed solution encourages mass customization product development. Having the ability for consumers to personally design a product and interact instantly with it creates a highly desirable advantage for product customization. The research for footwear was limited to children and on the other hand.

Previously mentioned works have used Augmented Reality, specifically for T-shirts and footwear customization. In recent research carried out in 2021, Feng et al. [23] proposed a full-featured clothing customization system using Augmented Reality where it involves the implementation of the material library for the selection of styles, patterns, colors, and fabrics for the users to choose. The system is proposed not only in the custom designing phase, but users can also further fit on the virtual clothes. The system uses Azure Kinect somatosensory technology, OpenGL 3D rendering, and a somatosensory virtual fitting room. The user is allowed to apply various designs to the cloth, once satisfied he can try virtual fitting. The system consists of functional modules. The design sub-module includes the selection of patterns, colors, fabrics, and styles. In the virtual fitting sub-module, it captures the depth data stream of human bones through Azure Kinect Somatosensory camera and realizes bone-tracking processing process and 3D clothing virtual try-on the proper position on the human body. Then as the effect of rendering, it chooses appropriate rendering tools to render clothing textures, lighting, etc., so that people can see virtual clothing with more realistic effects through the display. The hand-made module is implemented and requires hand-made by skilled professionals.

2.3   Enhancing Customer shopping experience

Use of AR in the retail industry has various touchpoints of the consumer journey [31], one of them is the consumer shopping experience. However, shopping is a time-consuming activity for some people, while for others a much enjoyed one. Many approaches have been tried to simultaneously answer two fundamental shopper concerns: "does is suit" and "does it fit", therefore reducing guesswork involved in shopping to enhance consumer experience [32] using AR and ML for the past decades.

Research during 2018 [33] on marker-based AR used in a physical clothing retail environment through AR mobile applications, which interact with the consumer by triggering information on the product such as size, colors available, stock, etc, and visualizing a 2D pattern of the item. The highlighted functionality
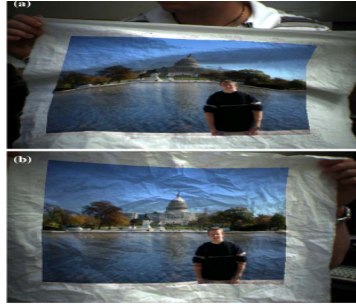
Fig. 3. Augmentation with correct illumination on cloth.a) Rippling cloth; b) wrinkled cloth.Source: Adopted from [20].
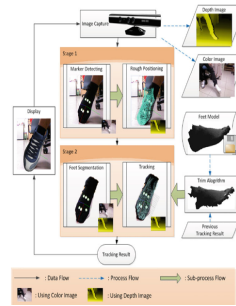

Fig. 4. Functional structure of real-time self- customization foot tracking.Source : Adopted from [22].

in this application [33] was verifying the fitting of the item using a physical mannequin. As an extended version of the above solution [33], in 2019 Ahmad et al. proposed a solution [18] to utilize the 3D model of a t-shirt by scanning a catalog. Unity3D and Vuforia augmented reality kits have been used for the development of both AR applications [33, 18].

AR in fashion retailing includes virtual try-on using personalized or non-personalized virtual models to simulate the appearance of the apparel product combinations on a body form [34]. The survey conducted by Moroz in 2019 [35] about the tendency of using Virtual Fitting Room (VFR) in the generation of 1981 to 1999 has results suggests that using 2D is complicated than using 3D for sticky mapping the clothes and 3D models has a lack of consideration of facial features and hairstyles to match the fit [35].

Furthermore, the 'Magic Mirror" concept is one of the most popular virtual try-on solutions hence the solution can be used inside physical clothing stores. Kim and Cheeyong's study [15] in 2015 indicated a "Magic Mirror" using a large screen. The screen displays various outfits for the user with prioritizing make-up and hair simulations also. For the interaction, this solution [15] uses a touch system. A more recent study (2019) [16] proposed a more advanced virtual trial room using IOT mirrors to offer consumers a more realistic try-before-you-buy shopping experience for apparel. AR has been used for skin color recognition and apparel recommendation according to skin color for this study [16].

Studies show the impact of AR on consumers' fashion experience, satisfaction, enhancement of the perception of reality, and overall a fun, pleasant, and personalized experience to be relevant for users [36]. This was further supported by Liu et al. (2020) [19] findings, where it emerged that AR used for virtual fitting of online stores through using AR-HMD and Microsoft HoloLens (allowing users to virtually see how the dress would fit on their life-sized personalized 3D human avatars as in fig 5, while doing the daily activities and interacting the avatar with the real physical world [19]) was regarded as contributing to the 'fun factor of shopping experience [32].

An explosive growth occurred, using ML for the fashion industry during the past few years. Regarding ML, more recent research [37] states that the availability of large-scale datasets such as DeepFashion has fueled recent progress in applying deep learning to fashion tasks [38]. Amongst the latest applications, Yu et al. [38] proposed a fashion design framework using generative adversarial training which helps in achieving great success in synthesizing realistic images. The specialty of the proposed system [38] is instead of suggesting existing items from the dataset, the system [13] synthesizes images of new items that are compatible with a given query item. The framework [13] automatically models the user's fashion taste then designs an item to a given query item.

Overall, Scholz and Smith [39] (2016) stress the importance for both online and offline retailers of adopting immersive AR, crafting experiences that generate value for consumers, and thus the importance of focusing on consumer experience [39].
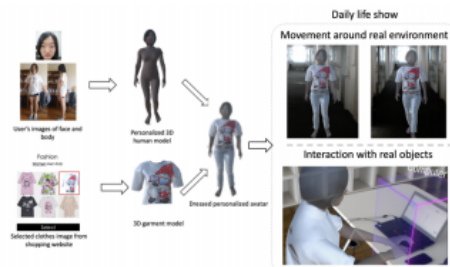

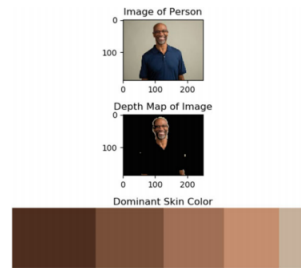**Fig. 5.** Life-size avatar for virtual try-on. Source: Adopted from [19].

Fig. 6. Skin segmentation and dominant tone/color extraction for clothing color recommendation. Source: Adopted from [16].

3 Conclusion and Future works

The review creates insights into the clothing industry including fashion, and how those industries have acquired novel technologies such as AR, VR, Mixed Reality, and Machine learning for their development.

AR has huge potential in transforming the fashion industry towards digitalization by introducing the applications such as virtual fashion shows, virtual showrooms, virtual fitting rooms, virtual fit-or-sizing tools, digital jewelry, virtual stylists, and magazine catalogs. With the latest advancement of AR in the industry, many luxury fashion brands use their AR applications for virtual showrooms and market their products using AR advertisements during the Covid-19 pandemic. The AR provides a number of benefits to the designers, customers, and retail sellers. Designers can test out ideas virtually and float them with consumers before actually creating the physical pieces. Without these innovations,

customers may face many issues considering having to spend a lot of time for fit-on, skin diseases, and privacy concerns inside trial rooms. However, with AR applications people are able to customize the clothes if necessary.

Most of the above-discussed research achievements are still in the development phase and not yet applied into today's activities fully functionally. However, with the Covid-19 restrictions, people are eager to embrace such innovations. Therefore, probably the future of the fashion industry will happen online, and all the brands will have to develop their own strategies to manufacture and market their products in the digital world. Most of the successful fashion retailers will not only make their products available online but also will create an immersive digital shopping experience with things like AR filters on Facebook/Instagram, virtual sizing tools, virtual showrooms, and virtual stylists. Furthermore, researchers expect that the industry will become data-driven, sustainable, digital, and simplified in the future. The industry is becoming data-driven as the benefits of using data in fashion bring numerous advantages such as fashion predictions. Apart from that, the fashion industry is known as one of the biggest contributors to waste therefore in the future it needs to be sustainable by following eco-friendly production methods by following virtual personalization and digitization. The clothes will become simplified with many people working from home and the clothing will likely be simple and comfortable. Overall, AR will impact the fashion industry, everything from runway shows to shopping, and set to connect physical retail with digital retail. Having AR applications will be more important to retailers than having a website in the near future.

However, to provide an advanced AR experience to the end-user, it is essential to consider the infrastructure requirements needed by the AR applications. The hardware required for AR applications mainly consists of a smartphone or laptop, camera, and graphic card, and special devices such as smart glasses, virtual retina displays, and head-mounted displays [27]. AR applications that are connected to the cloud, require a network connection with 100mbps bandwidth and low latency. Higher throughput of 5G will be necessary for the AR environment that is streamed from the cloud, since in the future when the consumers accessing rate becomes high, the devices will need to be able to access and manage huge data storage. AR is currently being implemented using smartphones since they are more affordable and feasible to the general public. However, using an augmented reality application from the mobile phone requires significant battery power and processing power as it involves the needity to use energy-consuming hardware such as cameras, orientation sensors, GPS, and image recognition. Network slicing, distributed cloud, and edge computing technology may also be required to guarantee the stable performance of the applications.

Finally, it can be concluded that the future of the fashion industry is going to be successful with the advancement of augmented reality and machine learning.

References

1. Hutchison, H.(2021). Fashion Industry: Importance to Society - Matrix. [online] Matrix. Available at: https://www.matrixdubai.com/public-relations/fashion-

industry-importance-to-society/

2. Major, J. and Steel, V.(2021). Fashion Industry — Design, Fashion Shows, Marketing, and Facts. [online] Encyclopedia Britannica. Available at: https://www.britannica.com/art/fashion-industry.

3. Shihu, X., Yuhan, L., Yuzhao, L., Kelvin, C., Soh, M. and Jiro, T.(2021). Rethinking the Fashion Show:APersonal Daily Life Show Using Augmented Reality. [ebook] The Thirteenth International Conference on Advances in Computer-Human Interactions. Available at: http://iplab.jpn.org/paper/achi2020xu.pdf.

4. Meyer, S. (2021). Understanding the COVID-19 Effect on Ecommerce. [online] The BigCommerce Blog. Available at: https://www.bigcommerce.com/blog/covid-19-ecommerce.

5. Koch , J., Frommeyer, B. , and Schewe G., "Online Shopping Motives during the COVID-19 Pandemic—Lessons from the Crisis," Sustainability, vol. 12, no. 24, p. 10247, Dec. 2020, doi: 10.3390/su122410247.

6. Liu, Y., Liu, Y., Xu, S., Cheng, K., Masuko, S. and Tanaka, J.(2020). CoComparing VR- and AR-Based Try-On Systems Using Personalized Avatars. Electronics, [online] 9(11). Available at: https://www.mdpi.com/2079-9292/9/11/1814.

7. Yaoyuneyong, G., Foster, J., Johnson, E. and Johnson, D.(2016). Augmented Reality Marketing: Consumer Preferences and Attitudes Toward Hypermedia Print Ads. Journal of Interactive Advertising,, [online] pp.16-30. Available at: https://www.tandfonline.com/doi/abs/10.1080/15252019.2015.1125316.

8. Huang, T. and Liao, S.(2015). A model of acceptance of augmented-reality interactive technology: the moderating role of cognitive innovativeness. [online] 15, pp.269-295. Available at: https://link.springer.com/article/10.1007/s10660-014-9163-2.

9. Kim, J. and Frosythe, S.(2008). Adoption of Virtual Try-on technology for online apparel shopping. Journal of Interactive Marketing, [online] 22(2), pp.45-59. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1094996808700100.

10. McCormick, H., Cartwright, J., Perry, P., Barners, L., Lynch, S. and Ball, G.(2014). Fashion retailing – past, present and future. Textile Progress, [online] pp.227-321. Available at: https://www.tandfonline.com/doi/abs/10.1080/00405167.2014.973247.

11. Vaccaro, K., Agarwalla, T., Shivakumar, S. and Kumar, R.(2018). Designing the Future of Personal Fashion. [online] pp.1-11. Available at: https://dl.acm.org/doi/abs/10.1145/3173574.3174201.

12. Elfeky, A., and Elbyaly, M., "Developing skills of fashion design by augmented reality technology in higher education," Interactive Learning Environments, pp. 1–16, Dec. 2018, doi: 10.1080/10494820.2018.1558259.

13. Yu C., Hu Y. , Chen Y. and Zeng B. , "Personalized Fashion Design", Ieeexplore.ieee.org, 2019. [Online]. Available: https://ieeexplore.ieee.org/document/9010857.

14. Bonetti, F., Warnaby, G. and Quinn, L.(2018) Augmented Reality and Virtual Reality in Physical and Online Retailing: A Review, Synthesis and Research Agenda. In: Jung T., tom Dieck M. (eds) Augmented Reality and Virtual Reality. Progress in IS. Springer, Cham.

15. Kim, M., and Chee-yong, K., "Augmented Reality Fashion Apparel Simulation using a Magic Mirror", Semanticscholar.org, 2015. [Online]. Available: https://www.semanticscholar.org/paper/Augmented-Reality-Fashion-Apparel-Simulation-using-Kim-Chee-yong/a59f1a5c7033bd2e94f78f7d558077874295e8ff.

16. Sourav, S., Swarnapali, K., Shreya, J. and Dhanashree, H.(2021). Advances in Intelligent Systems and Computing. [ebook] pp.479-487. Available at: https://www.springer.com/series/11156 .

17. Kazlacheva1, Z., Stoykova1, V., Georgieva, K., and Ilieva, J., "Application of innovative technologies in fashion design education," IOP Conference Series: Materials Science and Engineering, 01-Dec-2018. [Online]. Available: https://iopscience.iop.org/article/10.1088/1757-899X/459/1/012080.

18. Ahmad, S., Zainol, Z., Yunos, R. , Kadir, A., Ghazali, M. and Murad, M., Application of Augmented Reality (AR) in T-Shirt Catalog, Semanticscholar.org, 2021. [Online]. Available: https://www.semanticscholar.org/paper/Application-of-Augmented-Reality-(AR)-in-T-Shirt-Ahmad-Zainol/299886329486f4932d66b9197637d0799334bc1d.

19. Shihu, X., Yuhan, L., Yuzhao, L., Kelvin, C., Soh, M. and Jiro, T.(2021). Rethinking the Fashion Show:APersonal Daily Life Show Using Augmented Reality. [ebook] The Thirteenth International Conference on Advances in Computer-Human Interactions. Available at: http://iplab.jpn.org/paper/achi2020xu.pdf.

20. Bradley, D., Roth, G., and Bose, P. , "Augmented reality on cloth with realistic illumination," Machine Vision and Applications, vol. 20, no. 2, pp. 85–92, Nov. 2007, doi: 10.1007/s00138-007-0108-9.

21. Dong, B., Jia H., Li, Z. and Dong, K., "Implementing Mass Customization in Garment Industry," Systems Engineering Procedia, vol. 3, pp. 372–380, 2012, doi: 10.1016/j.sepro.2011.10.059.

22. Luh, Y.,Wang, JB.,Chang, J. et al. Augmented reality-based design customization of footwear for children. J Intell Manuf 24, 905–917(2013). https://doi.org/10.1007/s10845-012-0642-9.

23. Feng, L.,Ma, L. and Ng, L., "Personalized customization system solution using augmented reality technology",2021.

24. Kim, H. and Cho, S.(2000). Application of interactive genetic algorithm to fashion design. Engineering Applications of Artificial Intelligence, [online] 13(9), pp.635-644. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0952197600000452.

25. Ta, K., Sharlin, E. and Oehlberg, L.(2021). Bod-IDE — Proceedings of the 2018 ACM Conference Companion Publication on Designing Interactive Systems. [online] Dl.acm.org. Available at: https://dl.acm.org/doi/abs/10.1145/3197391.3205408.

26. Videnov ,K., Stoykova, V., Kazlacheva ,Z.(2018) Application of Augmented Reality in Higher Education ARTTE Applied Researches in Technics, Technologies and Education (Yambol: Faculty ofTechnics and Technologies) vol 6no 1 pp 1-9.

27. Borisova, T., Stoykova, V., Kazlacheva, Z. and Videnov, K., 2021. Developing an augmented reality textbook for Bachelor and Master programmes "Design, technology and management of the fashion industry". IOP Conference Series: Materials Science and Engineering, 1031(1), p.012123.

28. Pine ,B., "Mass customizing products and services," Planning Review, vol. 21, no. 4, pp. 6–55, Apr. 1993, doi: 10.1108/eb054420.

29. Liu ,N. , Chow ,P. , and Zhao ,H., "Challenges and critical successful factors for apparel mass customization operations: recent development and case study," Annals of Operations Research, Mar. 2019, doi: 10.1007/s10479-019-03149-7.

30. Gilmore ,J., and Pine ,B. , "The four faces of mass customization." Harvard Business Review, vol. 75, no. 1, 1997, p. 91+. Gale Academic OneFile,Accessed 11 May 2021.

31. Javornik ,A. Journal of Retailing and Consumer Services, 2016. Augmented reality: Research agenda for studying the impact of its media characteristics on consumer behaviour. [online] 30, pp.252-261. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0969698915301351.

32. Pachoulakis ,I. and Kapetanakis ,K.(2012). Augmented Reality Platforms for Virtual Fitting Rooms. The International Journal of Multimedia and Its Applications,4.

33. Jonson ,M., 2021. Exploring Designs for Enhancing the In-store Customer Experience through Digital Product Information in Fashion Retail. [online] DIVA. Available at: https://www.diva-portal.org/smash/record.jsf?pid=diva2

34. Lee ,L., Meyer ,T. and Smith ,J.(2021). Reinventing the Customer Experience: Technology and the Service Marketing. Service Management: The New Paradigm in Retailing, [online] pp.143-160. Available at: https://link.springer.com/chapter/10.1007/978-1-4614-1554-1-9.

35. Moroz ,M., "Tendency to Use the Virtual Fitting Room in Generation Y - Results of Qualitative Study," Foundations of Management, vol. 11, no. 1, pp. 239–254, Jan. 2019, doi: 10.2478/fman-2019-0020.

36. Poushneh ,A. and Vasquez ,A.(2017). Discernible impact of augmented reality on retail customer's experience, satisfaction and willingness to buy. Journal of Retailing and Consumer Services, [online] 34, pp.229-234. Available at: https://doi.org/10.1016/j.jretconser.2016.10.005.

37. Rostamzadeh ,N., Hosseini ,S., Boquet ,T., Stokowiec ,W., Zhang ,Y., Jauvin ,C. and Pal ,C.(2018). Fashion-Gen: The Generative Fashion Dataset and Challenge. [online] (2). Available at: https://arxiv.org/pdf/1806.08317.pdf.

38. Liu ,Z., Luo ,P., Wang ,X. and Tang ,X.(2015). Deep Learning Face Attributes in the Wild. In: IEEE International Conference on Computer Vision. [online] pp.3730-3738. Available at: https://openaccess.thecvf.com/content-iccv-2015/html/Liu-Deep-Learning-Face-ICCV-2015-paper.html.

39. Scholz,J. and Smith ,A.(2016). Augmented reality: Designing immersive experiences that maximize consumer engagement. Business Horizons, [online] 59(2), pp.149-161. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0007681315001421.