# Anthropometrical Virtual Try-on: A Survey on Virtual Try-ons and Human Body Dimension Estimation

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**Abstract.** By 2026, the global apparel business is anticipated to be worth almost USD 2 trillion. Customers may use virtual try-on technology to see how a piece of clothing might appear on them. Many studies have been conducted on the many aspects of Virtual Try-on, including 2D and 3D representations of the human body, as well as Human Body Dimension Estimation. This study attempts to identify methods and approaches that might be useful in developing a far more complete virtual try-on system. Virtual try-on was utilized by 44% of respondents while purchasing on a retail site. As a result, 69 percent of those polled claim they bought the goods online or at a shop. We first introduce what virtual try-on and human body dimension entails. Then we discuss the different techniques that have been employed till date for the same while discussing some prevalent issues and future opportunities on the topic.

**Keywords:** Virtual Try-on, Body Measurement, Dimensions, Apparel.

## 1 Introduction

In the past few years with the rise of e-commerce websites, online shopping for fashion apparels has seen a significant increase. The apparel market worldwide was at USD 1.3 trillion in 2020 which rose to USD 1.5 trillion in 2021 and is expected to reach USD 1.7 trillion in 2022. If the current trajectory continues and no unanticipated events such as COVID occur, the global clothing industry is expected to reach roughly USD 2 trillion by 2026 [1]. To gain competitive advantage over their competitors many e-commerce websites have introduced virtual try-on technology. Virtual try-on technology allows a customer to visualize how a certain apparel would look on them before actually purchasing it. Virtual try-on technology is not only limited to fashion apparels but also extends to shoes, eye-glasses, jewelry, make up and any other accessories. Fashion firms and enterprises may use virtual try-on technology to combine the physical and virtual to create a customer experience that is secure, convenient, and efficient for customers, whether they are shopping in-store or online. It saves time for users lost while donning different apparels and also helps to curb the hesitation faced while purchasing apparels online.

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The challenge of describing a human body form is difficult and application-dependent. Somatotyping (general anthropometric categorization) is based on a series of measures taken using specialist tools (the ordinary tape being just one of them). Anthropometric data can help the virtual try-on technology in being a bigger success. Fashion apparels don't only need to look good, but they must be of a suitable size for the person to actually look better. Anthropometric data of the person can help the virtual-try on technology in telling how the fashion apparel will actually look on the person i.e. if the apparel fits the person or not. There have been previous researches with regards to anthropology using various technologies but most of them were directed in either multiple directions or not on the fashion apparel industry. [2, 3, 4, 5]

Many works have been done on the individual areas of Virtual Try-on both in the 2D and 3D depictions of the human body and also in the area of Human Body Dimension Estimation that range from simple Computer Vision techniques to more complex ones involving 3d scanning, and 3D structural depictions of human body. But research to combine both these areas for effective application of a virtual try-on that can also help a consumer visualize what the fit of a specific garment of a particular size would look like, is scarce. In this direction, the survey aims to perform a thorough literature review of both these areas and to look for ways and techniques that may be helpful to achieve the goal of both these functional areas to cater to the task of a much more comprehensive virtual try-on system.

The different sections in this paper are structured as follows: in Section 2 and Section 3 human body dimension estimation and Virtual Try-on have been discussed respectively. In Section 4 we present the literature survey pertaining to both the topics introduced in Section 2 and Section 3. Section 5 outlines future working directions and open issues and conclude this paper in Section 6.

## 2 Human Body Dimension Estimation

Designers, architects, engineers, and others who create goods or processes have become increasingly aware of the need for anthropometric data on the people who use their products over time. Of course, the requirement for anthropometric data and the types of data required differ significantly between applications. The fit is "hard" in certain areas, such as a respirator for protection against breathing dangerous gases, and "soft" in others, such as a loose clothing like a bathrobe. The bathrobe's fit can be approximate and yet serve its function, while the respirator mask must match closely to the geometry of the face to ensure proper contact and avoid leakage. In the case of the bathrobe, information on height and a few body girth measurements for the target user group may be all that is required to give adequate body coverage for a satisfying interface. For the respirator mask, however, complete three-dimensional measurements of individual facial geometry may be necessary to obtain a correct fit.

Traditional anthropometric measures are conducted by skilled anthropometrists utilizing some devices, usually a measuring tape which is meant for measuring circumferences and

curvatures. Most measurements collected on the participants are done in posture of standing. However, a few steps need to be done in different positions.

Some body measurements defined in [6] is depicted in *Figure 1*.

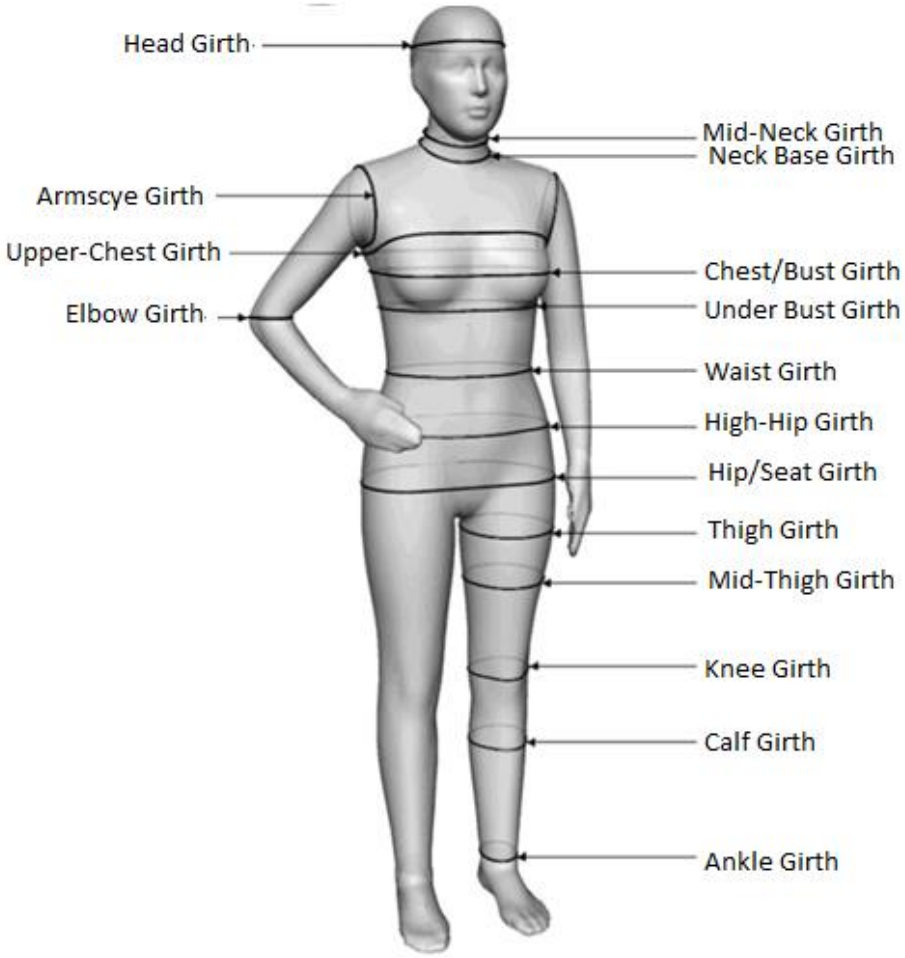


**Fig. 1.** Body Measurements defined in [6]

## 3 Virtual Try-on of Apparels

The image generating task of changing the clothing item on a person into a new item, supplied in a separate product image, is referred to as image based virtual try-on. Virtually wearing the garments may enhance a customer's experience, as it provides them a sense of how these goods might appear on them, especially with the rising trend toward online purchasing.

While virtual try-on is comparable to image synthesis, it has its own set of challenges. The synthetic picture should match the following requirements when given photographs of a person and a clothing item: (1) The body shape, identity and pose of the individual should be retained. (2) By reflecting the person's pose and body shape, the garment should automatically deform to the required clothing region. (3) The apparel product's details should be preserved. (4) In the original image, the body parts initially obscured by the person's attire should be accurately depicted.

Because the offered apparel picture is not originally fitted to the human image, meeting these requirements is difficult, leaving the development of virtual try-on well behind online consumers' expectations. Virtual try-on photographs, in example, have a lower resolution than regular pictures on online purchasing platforms.

More than four out of ten internet shoppers have utilized a virtual try-on option.

According to a survey of US consumers conducted by Vertebrae [17], a provider of 3D and augmented reality (AR) commerce solutions, 44 percent of a retail site respondents have used virtual try-on during shopping on the site, and 69 percent of those respondents have said they ended up buying the product in the store or online as a result.

Virtual try-on uses augmented reality (AR) with a front-facing camera to allow customers to view how clothing items might look on their own face or body. Three out of four respondents had utilized virtual try-on when purchasing on a retail site in the recent year.

Furthermore, nearly eight out of ten (77%) respondents who have never tried virtual try-on would do so if it were freely accessible on a retail site. If a brand offers virtual try-on, over half (49%) of respondents are likely or very likely to buy from them.

## 4 Literature Survey

Many attempts to obtain measurements using non-contact methods have been undertaken in the past, and some of these are given here.

Hung, Witana, and Goonetilleke [7] suggested a method for extracting male anthropometric measures from 2D photographs. They employed front, side, and back photos and used a Visual Basic application to develop the method for extracting the measures.

Lin and Wang [8], as well as Jiang, Yao, Li, Fang, Zhang, and Meng [9], developed algorithms for recognizing body characteristics from 2D photographs of people. They also created 3D models using 2D photos of a person's front and sides. [10]

Using the local frequency maps of the pictures, Khan, Bhuiyan, and Adhami [11] devised methods for extracting body characteristics from 2D photos.

Saito, Kouchi, Mochimaru, and Aoki [12] created a 3D model of the torso area by extracting the silhouette from 2D photos and optimizing it using a target model.

Pradhan, Gao, Zhang, Gower, Heymsfield, Allison, and Affuso [13] proposed an automated approach for producing a 3D model of a body by creating and collecting ellipse-like slices from 2D back and side photos of the body using length and breadth data.

Gu, Liu, and Xu [14] used orthogonal silhouettes to create girth prediction models for adolescent female bodies.

'Measure' [15] by Google Tango is a computer program that measures items based on their photographs. It does not, however, provide girths and is not particularly accurate when measuring a human body. Various Kinect-based technologies are already in use, which scan the entire 3D human body and offer information at a far cheaper cost. However, there is a disadvantage: the reconstructed models are of poor quality because to low quality depth data from Kinects. [16]

In [7] the mathematical model proposed for body dimension estimation utilises two images, a front-view image and a side-view image. For calculating the body dimension different body parts are approximated as circle or ellipse, like neck shape approximated as ellipse. Now utilising the two images major and minor axis length for neck are calculated and neck girth is calculated based on this data.

Virtual try-on techniques are mainly classified into two groups: 3D model-based approaches [18, 19, 20, 21] and 2D image-based approaches [22, 23, 24, 25, 26, 27]. Although 3D model-based techniques may precisely imitate clothing, their use is limited due to their reliance on 3D measurement data.

2D image-based techniques are computationally efficient and acceptable for practical application since they do not rely on any 3D information. CAGAN [28], suggested by Jetchev and Bergmann, was the first to present the job of swapping fashion items on human photographs. VITON [22] proposed a coarse-to-fine synthesis approach including TPS modification of garments to solve the similar issue. Most extant virtual try-on solutions attempt to generate perceptually compelling photo-realistic pictures by addressing distinct components of VITON. CP-VTON [23] used a geometric matching module to learn the TPS transformation parameters, which improved deformation accuracy. The human-parsing maps of a person wearing the target garments were predicted in advance using VTNFP [25] and ACGPN [26] to guide the try-on picture synthesis. Despite the fact that picture quality at high resolution is an important aspect in determining the usefulness of generated images, none of the methods outlined above could produce photo-realistic images at high resolution.

## 5 Future Directions and Open Issues

The advancement and practicality are two facets that have to run in tandem to create a viable real world application, many 3D model based virtual try-on and body measurement options exist to properly replicate clothing characteristics and accurate body measurements but they are less practical due the high cost and cumbersome scanning procedures involved. This limits its use against the regular consumer. Conversely, 2D processes are greatly practical as images can be captured easily with a smartphone but the techniques available to us presently are not much sophisticated to make a robust use of the idea. Though many big brands offer such capabilities, they are somewhat limited and can be improved upon. There also remains a vast uncharted territory to be explored with the possibility of combining both of these techniques to further enhance the virtual try-on technology while giving the option to consumers to get tailor fitted estimated regarding their clothes. Also an intelligent system can be constructed which

smartly recommends the size, style, color that would fit and look good on the consumer based on their body shape and structure.

## 6 Conclusion

In the past few years machine learning and artificial intelligence has been used in varous fields to solve problems reducing human effort and saving time and at the same time in making things convenient for the user. One such space is the use of machine learning techniques to virtually get body measurements and try different fashion apparels. Although the work done in this direction has increased significantly in recent years but despite all these works an accurate, reliable, simple and effective solution has not been found because of various limitations arising due to technology (software and hardware both). To overcome these limitations various solutions have been provided which are reviewed in this survey, some of them have proven to be quite effective and have been able to find place in commercial spaces, though they still require quite an amount of work before truly becoming ideal solutions, whereas some of the ideas are still in developmental phase. Though it might seem that quite an amount of work is already done in this domain but since fashion apparels are one of the booming and profiting industries and because of its future prospects it will automatically get greater attention and thus more research will be done in future to enhance the already researched technologies.

## References


[1] P. Smith. Global revenue of the apparel market, 2013-2026, Statista (2022).

[2] Sheldon, W. H., Stevens, S. S., & Tucker, W. B. The varieties of human physique. Harper (1940).

[3] Kohlschütter, T. Human Body Modelling by Development of the Automatic Landmarking Algorithm. (2012)

[4] H. Gandhi, M. Jain, A. Butalia. Tailoring Measurement and Virtual Try-on. International Journal of Advance Research in Computer Science and Management Studies, Vol. 1, Issue 5. pp 111-117. (2013)

[5] Lee, Dong-seok & Kim, Jong-soo & Jeong, Seok & Kwon, Soon-kak. Human Height Estimation by Color Deep Learning and Depth 3D Conversion. Applied Sciences. 10.5531. 10.3390/app10165531. (2020)

[6] American Standards for Testing and Materials (ASTM). Standard terminology relating to body dimensions for apparel sizing. (Vol. 07-02, Designation: D5219-09). (2009)

[7] Patrick Chi-Yuen Hung, Channa P. Witana, and Ravindra S. Goonetilleke (2004). Anthropometric Measurements from Photographic Images. Human Performance Laboratory, Department of Industrial Engineering and Engineering Management, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong. Work with Computing Systems 2004. H.M. Khalid, M.G. Helander, A.W. Yeo (Editors) . Kuala Lumpur: Damai Sciences.

[8] Yueh-Ling Lin, Mao-Jiun J. Wang (2011). Automated body feature extraction from 2D images. Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Taiwan, ROC. Expert Systems with Applications 38 (2011) 2585–2591. Elsevier Ltd.

[9] Lingyan Jiang, Jian Yao, Baopu Li, Fei Fang, Qi Zhang, Max Q.-H. Meng (2012). Automatic Body Feature Extraction from Front and Side Images. A Journal of Software Engineering and Applications, 2012, 5, 94-100 doi:10.4236/jsea.2012.512b019

[10] Yueh-Ling Lin and Mao-Jiun J. Wang (2010). Constructing 3D Human Model from 2D Images. Department of Industrial Engineering and Engineering Management, National Tsing Hua University, Hsinchu, Taiwan. 978-1-4244-6484-5/10/$26.00 ©2010 IEEE.

[11] Jesmin Khan, Sharif Bhuiyan, and Reza Adhami (2011). Feature Point Extraction from the Local Frequency Map of an Image. Hindawi Publishing Corporation Journal of Electrical and Computer Engineering Volume 2012, Article ID 182309, doi:10.1155/2012/182309.

[12] Shunta Saito, Makiko Kouchi and Masaaki Mochimaru, Yoshimitsu Aoki (2012). Simple system for 3D body shape estimation. doi:10.1109/GCCE.2012.6379580

[13] Ligaj Pradhan, Song Gao, Chengcui Zhang, Barbara Gower, Steven B. Heymsfield, David B. Allison, and Olivia Affuso (2015). Feature Extraction from 2D Images for Body Composition Analysis. 2015 IEEE International Symposium on Multimedia.

[14] Bingfei Gu, Guolian Liu & Bugao Xu (2016). Girth prediction of young female body using orthogonal silhouettes, The Journal of The Textile Institute, DOI: 10.1080/00405000.2016.1160756

[15] Google Tango, Measure, play.google.com/store/apps/details?id=com.google.tango.measure (2017),.

[16] Jing Tong, Jin Zhou, Ligang Liu, Zhigeng Pan, and Hao Yan (2012), Scanning 3D Full Human Bodies Using Kinect, IEEE Transactions on Visualization and Computer Graphics, Vol. 18, No. 4

[17] D. Berthiaume. Survey: Virtual try-on becomes real phenomenon. https://chainstoreage.com/survey-virtual-try-becomes-real-phenomenon (2021)

[18] Peng Guan, Loretta Reiss, David A Hirshberg, Alexander Weiss, and Michael J Black. Drape: Dressing any person. ACM Transactions on Graphics (TOG), 31(4):1–10, 2012.

[19] Masahiro Sekine, Kaoru Sugita, Frank Perbet, Bjorn Stenger, and Masashi Nishiyama. Virtual fitting by single-shot body shape estimation. In International Conference on 3D Body Scanning Technologies, pages 406–413, 2014.
[20] Gerard Pons-Moll, Sergi Pujades, Sonny Hu, and Michael J Black. Clothcap: Seamless 4d clothing capture and retargeting. ACM Transactions on Graphics (TOG), 36(4):1–15, 2017.
[21] Chaitanya Patel, Zhouyingcheng Liao, and Gerard PonsMoll. Tailornet: Predicting clothing in 3d as a function of human pose, shape and garment style. In Proc. of the IEEE conference on computer vision and pattern recognition (CVPR), pages 7365–7375, 2020.
[22] Xintong Han, Zuxuan Wu, Zhe Wu, Ruichi Yu, and Larry S Davis. Viton: An image-based virtual try-on network. In Proc. of the IEEE conference on computer vision and pattern recognition (CVPR), pages 7543–7552, 2018.
[23] Bochao Wang, Huabin Zheng, Xiaodan Liang, Yimin Chen, Liang Lin, and Meng Yang. Toward characteristicpreserving image-based virtual try-on network. In Proc. of the European Conference on Computer Vision (ECCV), pages 589–604, 2018.
[24] Xintong Han, Xiaojun Hu, Weilin Huang, and Matthew R Scott. Clothflow: A flow-based model for clothed person generation. In Proc. of the IEEE international conference on computer vision (ICCV), pages 10471–10480, 2019.
[25] Ruiyun Yu, Xiaoqi Wang, and Xiaohui Xie. Vtnfp: An image-based virtual try-on network with body and clothing feature preservation. In Proc. of the IEEE international conference on computer vision (ICCV), pages 10511–10520, 2019.
[26] Han Yang, Ruimao Zhang, Xiaobao Guo, Wei Liu, Wangmeng Zuo, and Ping Luo. Towards photo-realistic virtual try-on by adaptively generating-preserving image content. In Proc. of the IEEE conference on computer vision and pattern recognition (CVPR), pages 7850–7859, 2020.
[27] Haoye Dong, Xiaodan Liang, Xiaohui Shen, Bochao Wang, Hanjiang Lai, Jia Zhu, Zhiting Hu, and Jian Yin. Towards multi-pose guided virtual try-on network. In Proc. of the IEEE international conference on computer vision (ICCV), pages 9026–9035, 2019.
[28] Nikolay Jetchev and Urs Bergmann. The conditional analogy gan: Swapping fashion articles on people images. In Proc. of the IEEE international conference on computer vision workshop (ICCVW), pages 2287–2292, 2017.