Automatic Human Body Measurement for Virtual Fitting Using Deep Learning: The Scan Avatar-Captured 2D Image Dataset

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Keywords: human body measurements, 2D image, deep learning

Introduction

As online platforms continue to grow, virtual service is garnering attention, even in the fashion industry. Non-contact human body measurement is essential to provide users with services such as online shopping, virtual fitting, size advising, and designing made-to-measure clothing (Apeagyei, 2010). Many studies on non-contact body measurement have been conducted to address this issue. In particular, the method of measuring the body from 2D images has the advantage of being highly accessible and straightforward, shortening the time for the measurement and making the process easier by enabling users to acquire human body information using the ubiquitous mobile phone. Contact-free body measurement using 2D images allows technologies such as obtaining human measurement information (Sehgal et al., 2018), 3D human modeling (Lin et al., 2012), and the measurement of body fat (Affuso, 2018) to be virtual. The interest in such technologies is growing since they can be applied to functions for creating avatars and checking how well clothes fit the consumers and be actively used in virtual fitting platforms.

However, while many researchers have developed and attempted to commercialize services that automatically acquire body measurements using 2D images and information, they have found it challenging to search for the accurate measurement landmark and to obtain body measurements because people vary in shapes and sizes. This study aims to use the deep learning method for virtual fitting by using the circumference of the human body as the feature value for the automatic measurement of the human body. This study further attempts to present a new method for human body measurement by using 3D body scan data to create learning data for deep learning.

Methods

Although based on human factors and ergonomics, and anthropometry, this study focused on presenting essential items from the perspective of clothing science, the aim of which is to design clothes and determine the fit in a method related to clothing. Thus, this study extracted information on the bust circumference (chest), waist circumference, and hip circumference, which are essential items for clothing size. Existing studies on body measuring using 2D images have presented the following four steps for measurement: image acquisition, image pre-processing, identification of landmarks for measurement, and anthropometric measure.

This study used the 3D body scan database compiled by Size Korea for the image acquisition. 2D images of virtual avatars wearing measuring clothes were captured using the CLO 3D software. By using this method, this study overcame the limitations of being unable to collect measurement data when

ITAA Proceedings, #79 – https://itaaonline.org

collecting body images, as well as the fact that too much time and money is spent on acquiring body images and measurement data in a controlled lab environment.

In the image pre-processing stage, it was necessary to remove the background of 2D images and to extract the silhouette of the human body. In consideration of the complexity of the algorithm, this study did not develop a new algorithm that removes the background but chose to select an existing open-source model that measures the human body and allows one to select necessary parts for measurement. This study used Google's semantic segmentation, DeepLab V3, as the model to select an effective model that is compatible when combined with the algorithm of this study, the aim of which was to extract the body features and to identify the circumference.

This study also posited that identifying landmarks for measurement in 2D images would not be significantly accurate. The location of landmarks for measurement differs greatly by body type. Thus, it is difficult to produce one formula without classifying the body types. Moreover, the 2D images only confirmed the surface silhouette or the contour of the human body, and it was impossible to specify accurate coordinates as the front, and the side 2D images were acquired independently. Therefore, this study used the armpit and crotch, which are identifiable in the contour, to reduce the search area, and produced sliced features that divided the area into 127 parts. In this way, a total of 256 values, including height, shoulder width, front width 127, and side width 127, were derived as the feature values of one body.

Finally, this study attempts to calculate the human body measurement through deep learning by setting the resulting feature value as the independent variable and the actual human body circumference as the dependent variable. A simple, fully connected network was used, and 367 images were used for the learning process.

Results & Discussions

The developed algorithm was verified by eleven female subjects (age M 30.9, S.D. 3.17) in their 20s and 30s (IRB No. 2108/002-006). The research subjects participated in the experiment by wearing two types of measuring clothes, and a total of 22 images were collected. The research participants took direct measurements, 3D human body scans, and photos using their mobile phones. The results of applying the image (Data A) acquired from the 3D human body scan results and the 2D images (Data B) taken in the same way as the algorithm learning data were generated as follows.

The Mann-Whitney U test was used with the results of Data A and Data B. No statistically significant difference was found in any items, including the chest, waist, and hip circumference. This suggests that generating learning data with 3D data was effective since the 2D image generated from the 3D shape and the actual photographs showed the same results. The mean error of the direct measurement of the human body and the results of Data B was 0.74±1.83 (mean±SD) in, 0.69±1.12 in, and 1.91±2.08 in. This study compared the results with previous studies (Hung, 2004; Souza, 2020) that derived the 3D circumference measurements based on geometric formulas using 2D image input, extraction of feature values within the 2D images, and the feature values. The comparison showed an improvement from that of the previous studies, suggesting that the results have been improved and that the measurement of the human body using deep learning is significant.

Conclusion

This study finds the feature value by dividing the human body equally, not by selecting the landmarks and utilizes deep learning instead of calculating perimeter values of human body and building new training data by using the existing 3D human body DB (Size Korea) rather than the traditional method such as web crawling or subject recruitment, which was commonly used in fashion artificial intelligence. To resolve errors and improve accuracy in the future, additional research on extracting the outline of detailed body parts, such as the armpit or crotch, is necessary for more accurate human body measurement. More diverse learning data generation and additional learning are also needed.

Nevertheless, this study has academic, technical, and industrial implications in that it minimizes the limitations to the construction of existing datasets and proposes a method for extracting human body dimensions based on artificial intelligence, which is innovative in terms of convenience, ease, and cost reduction.

This work was supported by the SNU-Hojeon Garment Smart Factory Research Center funded by Hojeon Ltd.(0423-20210085)

References

Apeagyei, P. R. (2010). Application of 3D body scanning technology to human measurement for clothing fit. International Journal of Digital Content Technology and its Applications, 4(7), 58-68.

Sehgal, R., Gupta, R., & Anand, N. (2018). Automatic Extraction of 3d body measurements from 2d images of a female form. IOSR Journal of Polymer and Textile Engineering, 5(3), 07-17.

Lin, Y. L., & Wang, M. J. J. (2012). Constructing 3D human model from front and side images. Expert Systems with Applications, 39(5), 5012-5018.

Affuso, O., Pradhan, L., Zhang, C., Gao, S., Wiener, H. W., Gower, B., ... & Allison, D. B. (2018). A method for measuring human body composition using digital images. Plos one, 13(11), e0206430.

Korean Agency for Technology and Standards. (2010). 6 차 인체치수조사 [The 6th Size Korea 3D scan & measurement technology report]. Size Korea. Retrieved from https://sizekorea.kats.go.kr/03_report/6th.asp

Hung, P. C. Y., Witana, C. P., & Goonetilleke, R. S. (2004). Anthropometric measurements from photographic images. Computing Systems, 29(764-769), 3.

de Souza, J. W., Holanda, G. B., Ivo, R. F., Alves, S. S., da Silva, S. P., Nunes, V. X., ... & Rebouças Filho, P. P. (2020, July). Predicting body measures from 2D images using Convolutional Neural Networks. In 2020 International Joint Conference on Neural Networks (IJCNN) (pp. 1-6). IEEE.