Automated Garment Measurement Prototype: A Contactless Means

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ABSTRACT

In garment industry, preparing garment patterns accurately is one of the most important factors in the production of fit garments. Body measurement is the first process that must be encountered before any custom-made garment can be designed. The current practice of obtaining the measurement is by traditional methods using tools like measuring tapes. However, this method is considered to be time-consuming and at times could be inaccurate. Moreover, during this pandemic situation, the conventional way of measuring shall be avoided. Hence, an Automated Garment Measurement Application (AGMA) is proposed. The main objective of this paper is to present the viability of obtaining body measurements via AGMA as the contactless means. The application, which is still prototype, applies the TensorFlow's PoseNet technique, allows customers' body measurement be made from a user's uploaded image, thus leaving the needs to be physically present. The evaluation results show that the respondents perceive that it is viable as it could help them to obtain more accurate body measurements in almost no time.

Keywords: Tailoring application, Automated measurement, Garment measurement.

I INTRODUCTION

Measuring garments requires correct tools and the know how to accurately measure the garments. Not only that, manual garment measurement is also time consuming and prone to human errors. With regards to the ready made garments, the sizing specifications vary from manufacturer to manufacturer. Traditional measurements are performed by experienced tailors using some instruments, mostly by means of a measuring tape, which is intended for measuring circumferences and curvatures. Most measurements made on the subjects are taken in position of standing. However, a few measures need to be taken in different positions. The conventional measurement method requires the consumer to be physically present to allow measurement be made. During this pandemic situation, activities that require such close physical contact between the involved parties should be avoided. To certain extent, this could be harmful especially when the Covid-19 viruses are in the community. To the utmost possible, contacts among individuals should be minimized, if it is not totally unavoidable.

Improper fittings often results in higher rate of return in online shopping. Consumers, especially online shoppers, are educated better and more demanding nowadays. They are no longer satisfied with standardized products that force them to compromise. Bearing those issues in mind, it is very important for customers to get customization services, and enable them to attain near to personalized garments from the market. In line with that and as proposed by Xia *et al.* (2018), the prototype of an Automatic Garment Measurement Application (AGMA) is proposed.

The proposed prototype will take an uploaded body image of a customer, and produces measurements in no time, and thus allows the measurements be used to get the best-fit garments. Considering the pandemic situation, the customers could get the measurement services from the comfort of their homes, without the needs to leave their homes. Most importantly, they can do so without any contact with others.

To allow nearly accurate estimates, it is important to get the data that are necessary to produce a satisfying garment with quality near to a tailor-made one. Fundamental variables of such data include length, circumference, density and textile matter behavior. Having had these data, it will significantly reduce the amount of data to be analyzed and to be sent out for creating a smart pattern. Moreover, by using anthropometric measurements, like shape and density, it will enable us to identify key referential points, which are essential to ensure proper fit. These points, when combined with data related to textile textures and behaviors, will allow personalized pattern grading, and this would the focus of the current work.

Hence, the main objective of this paper is to present the viability of obtaining body measurements via contactless means as enabled by proposed prototype by looking into the subjects responses on the AGMA experiments.

II RELATED STUDIES

In this section, the details of the concepts related to garment measurements and other relevant concepts as highlighted in previous studies are discussed.

Clothing is one of the most intimate objects associated with the daily life of individuals, as it covers most parts of our body most of the time. A significant proportion of modern consumers understand the importance of clothing and they demand apparel products with higher added values in terms of functional performance to satisfy various aspects of their biological and psychological needs during wear.

The goal of any sizing system for clothing is to provide a set of sizes that fit most individuals and suggest the set as standard sizes. It is important to note that he sizing systems from country to country varies as the body dimensions chosen to divide the population differ. However, the basic structure of most sizing systems is very similar (Kausher & Srivastava, 2019; Xia & Istook, 2017; Faust *et al.,* 2006; Fan *et al.*, 2004).

With regards to body measurements, Beazley et al. (1998) suggested a procedure for undertaking a size using International Organization for Standardization (ISO) 8559:1989 (E) which included a natural sequence of body measurement comprising three types of data which is horizontal, vertical and others.

According to Devarajan and Istook (2004), in the eighteenth century, tailors made custom-made clothing by tailors used various measuring methods that were developed by professional dressmakers and craftsmen. Their techniques for measuring and fitting their clients were unique. In the 1920s, the demand for the mass production of garments created the need for a standard sizing system. In the 1930s, mail-order houses became popular. This led to frequent returns of ill-fitting garments. Hence, a large anthropometric survey of 10,042 women was conducted to develop a sizing system for women's apparel.

In 1999 until 2002, Zhang (as cited in Reitenbach *et al.* 2009) surveyed 2800 women from East, North and South China, using traditional Martin measuring techniques. Sixty-two body positions were considered and 12 body parameters were drawn of the female torso.

Further to this, research by Wang *et al.* (2011) has found that the posture of the participant being scanned has an impacts significantly on the anthropometric measurements of the participant However, these researchers focused on the statistical difference between ‘scan’ and ‘dynamic’ posture, or specifically ‘between foot measurements’ and therefore the degree of influence which ‘natural’ and ‘scan’ posture has on the readings is still unknown. However, these studies did not address the precision of the scan measurements themselves.

Wang *et al.* (2011) and Bigaard *et al.* (2005) discuss waist circumference definition and its variation. Wang *et al.* (2011) compared manual measurement between four waist locations, though not the same four as investigated in Bigaard *et al.* (2005). However, both authors agree with that the waist should occur between the top of the iliac crest and lowest palpable rib (see Figure 1). This is in accordance with medical definitions, and suggests landmarks that are easier and more consistent to locate within the population.

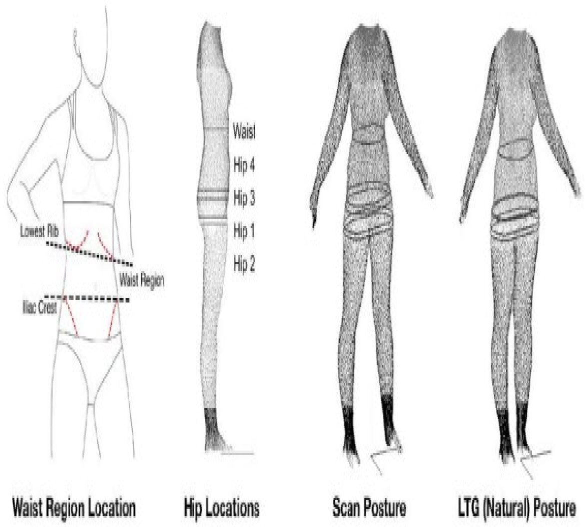

Figure 1. Scan Images showing the vertical positions of the hip girth and waist measurements on a human body and the postures used during body scanning capture

Wearing a fit garment usually eases wearer’s movements and thus brings comfort. Jay (1969, as cited in Sohn, 2012) defines eases in fit garment as “the difference between the pattern and body dimensions and as a crucial component of achieving good fit and comfort.” Ease is an additional amount added to the body measurements at certain critical points on the pattern. During pattern construction, a small amount of ease must be added the measurements for comfort and freedom of movement as highlighted. However, ease is not just a simple addition to the dimensions. It depends on many factors including body movement, fabric characteristics, comfort preferences, and garment style. Ease directly affects garment fit, appearance and comfort. There are two types of ease: wearing ease and design ease. However, for comfort, most important of these is the wearing ease that refers to the ease of movement while the clothing is worn.

Wearing ease is critical in garment fit as incorrect wearing ease can limit movement and at times causes wrinkles. There are keypoints where the amount of ease directly affects fit: bust, waist, hip, arm circumferences and armcye. Therefore, the definition of good fit may differ among individuals and situations. In fit research, however, good fit refers to clothing that provides a neat and smooth appearance and maximum comfort in an intended style of garment.

III AUTOMATED GARMENT MEASUREMENT PROTOTYPE

In developing the prototype for the Automated Garment Measurement, the engine that enables measurements for a good fit with wearing ease garment, as discussed in the subsequent section, is the utmost important. As such, Quasar Framework Quasar, 2020) was used as the development platform and TensorFlow PoseNet (Abadi *et al.*, 2015; Verma, 2020) used to detect and estimate the key points of human pose estimation.

Human pose estimation is a computer vision technique used to predict the position/pose of body parts or joint positions of a person in images or videos. PoseNet algorithm detects 17 key points based on the input (human image) detected. The 17 key points are the left and right coordinates of eyes, ears, shoulders, elbows, wrists, hips, knees, and ankles, and the nose. In addition, it also provides the value of key point confidence score that tells if an estimated key point position is accurate and ranges between 0.0 and 1.0, or the respective key points be hidden (Verma, 2020). Allowing the confidence score be determined, the key point positions produced is therefore nearly accurate. However, as for garment measurements, only the related key points estimate will be considered, thus leaving out five irrelevant estimates namely the nose, and both the left and right of the eyes and ears. The relevant key points that made up the parameters for garment measurements are shoulders, elbows, wrists, hips, knees, and ankles. However, depending on the types of garments, only appropriate parameters values will be used at any time. From any two key points, the distance between them can be calculated, and appropriate scale could be applied. From the calculation, the value of relevant parameters for garment measurement that is the lengths (or distances) can be determined.

The Quasar Framework and the TensorFlow's PoseNet are available as open source and thus being adapted for the prototype development. The Android Studio was used as the main integrated development environment (IDE) tool. Further, the Firebase development platform was used to facilitate crucial functions like database for data storage. Screenshots in Figures 2, 3, 4, 5 and 6 show the selected interfaces of AGMA.

Figure 2 shows an interface that requires the user to upload an image taken using digital camera that follows certain specification. Figure 3 is the condition after an accepted image has been uploaded.

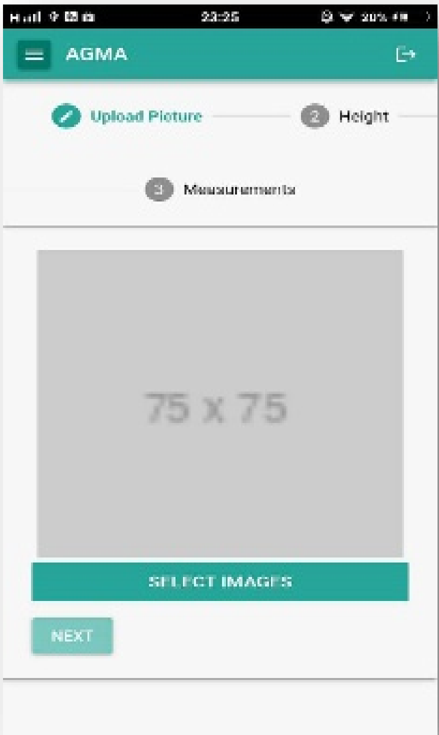

Figure 2. Main Interface for Upload Image

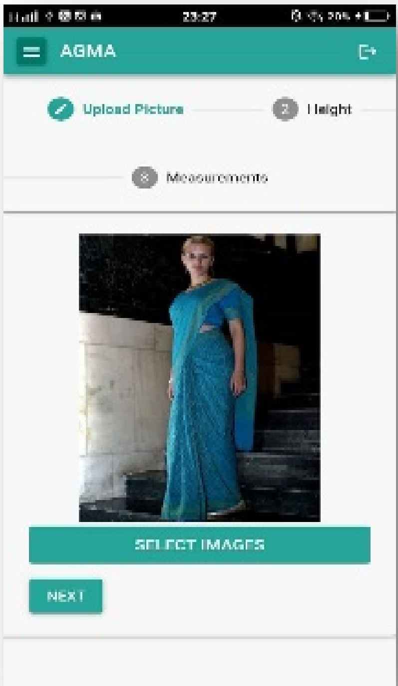

Figure 3. Interface of image Uploaded

Then, AGMA will calculate the values of the required parameters for a garment based on the key points that were detected by implementing the TensorFlow's PoseNet algorithm. The results are shown in Figure

4. On the list of garments' template, the user could choose the desired design as shown in Figure 5. However, in the list in Figure 5, mock designs are used.

Figure 4. Interface to View Body Measurement

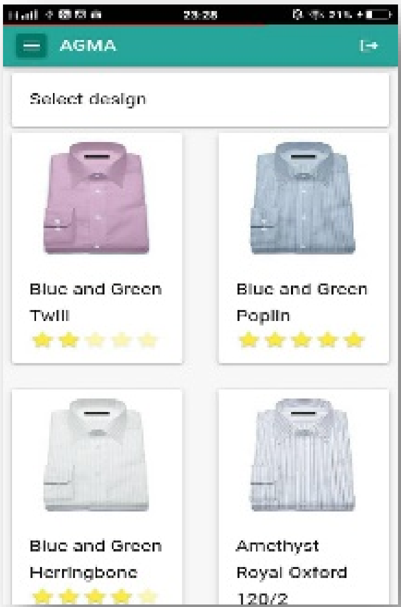

Figure 5. Interface to View Garment Template

Once the user selects the design, the design screen together with its measurements will be shown as illustrated in Figure 6. If the measurements of the selected design meet the measurements produced, then the user could confidently says that the design is a good fit and thus help the user to make an appropriate decision.

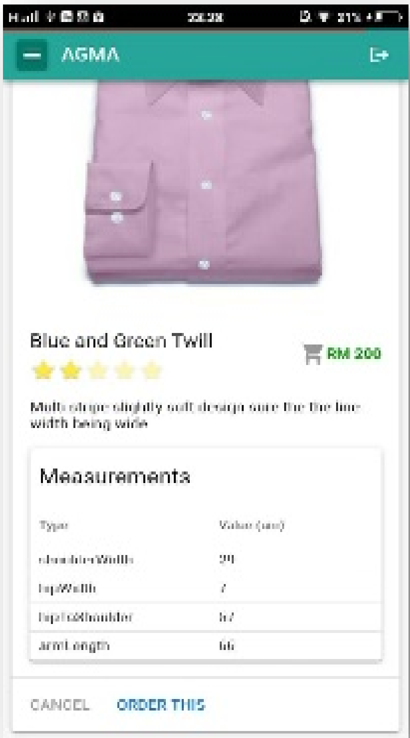

Figure 6. Interface to View Garment Required Measurements

IV EVALUATION OF AUTOMATED GARMENT MEASUREMENT

A. The Evaluation Setting

A usability evaluation was conducted on 25 respondents, consisting of tailors and consumers. The respondents were approached randomly and participated in the study on a voluntary basis. The instruments used for the evaluation were the Automated Garment Measurement prototype and a post-task questionnaire. The post-task questionnaire was adapted from Otieno *et al.* (2008) which comprised of Section A on the respondents' demographic information; Section B on the respondents opinion about Automated Garment Measurement prototype in a five-point Likert scale where 1 represents strongly disagree, and 5 represents strongly agree. Section B intends to measure the respondents' perception on the usefulness, ease of use, and their satisfaction of the prototype.

The respondents followed the following protocols to perform the evaluation: (1) read and signed a consent form; (2) use the prototype as stated in the experiment procedure; (3) answer the post-task questionnaire.

The results of the evaluation on AGMA are presented in the Section B.

B. The Respondents' Demographic Information

Analysis of the respondents' demographic information revealed that 22 respondents aged between 21 and 25, thus made up the majority of the respondents, and the rest is of other age categories Regarding types of user 14 of them respondents are customers and, 11 is tailors. As the evaluation setting is at an education center, it is logical that the age group is within that range, and the consumer is more than the tailor. The consumers are mainly students within the setting. As for the gender, male is 14, and female is 11. An analysis was conducted on the respondents' responses in Section B of the post-task questionnaire. The respondents' perception towards the usefulness and the ease of use of AGMA were gauged. It also measured the respondents' satisfaction towards AGMA. Table 1 shows the average responses for all items of the stated constructs.

V CONCLUSION AND FUTURE WORKS

The AGMA prototype that was developed provides a viable contactless means of obtaining body measurements for various usages including for garment-related business as illustrated in this paper. Shall the prototype be upgraded to become a fully workable robust applications, it may be helpful in curbing the spread of the Covid-19 diseases, to some extent.

There are many aspects of body measurements and manage garment-related issues can be studied. The core reason for the development of AGMA is to enable the customers and tailors to get the measurement done in few seconds and accurately, thus facilitate those in the industry to transform their ways of doing business. Therefore the technologies used by whoever uses the application should support the core objective of the system if it were to remain relevant.

A lot still needs to be done in order to make available technology effective. This may involve training of the staff on how to enter the right and relevant data into the system and the management to keep updating the application. IT and computer systems need to be kept being upgraded as more and more IT facilities software are introduced in today's IT market. The researcher acknowledges the fact that this application does not handle all staff the tailor shops have like the asset section and staff members in the tailor shop.

Table 1. User Responses on AGMA

Item	Average
Usefulness of AGMA	
I can register an account using the AGMA without any error.	4.40
I can login AGMA with the registered email and password.	4.40
The search button can function well.	4.53
AGMA meets my needs	4.10
AGMA does everything that I would expect it to do.	4.10
AGMA is useful in overall.	4.37
Ease of Use of AGMA	
AGMA is easy to use.	4.20
AGMA is easy to user friendly.	4.23
AGMA is flexible.	4.27
AGMA is easy to learn how to use it	4.40
I can use AGMA without written instruction.	4.33
I can easily remember how to use AGMA	4.23
I do not notice any inconsistencies as I use AGMA.	4.27
My interaction with AGMA is clear and understandable.	4.23
I can use AGMA successfully every time.	4.33
Satisfaction of AGMA	
I will recommend AGMA to my friends.	4.17
AGMA works the way I want it to work.	4.37
I feel I need to have AGMA in my smartphone.	4.60
AGMA is wonderful and pleasant to use.	4.50

The researcher therefore suggests that for further research into building an application that captures all fields as pertains the tailor shop. Body measurement and the relationship between them change with changing lifestyles, leisure patterns, dietary habits and also growing population diversity. Consequently, the association between garment sizes and body measurements also changes all the time. As a result, regular sizing surveys and measurement series have to be performed to provide a scientific foundation to these and to further provide information on the necessary size segments and their geographical market shares.

REFERENCES

Abadi, M., Agarwal, A., Barham, P., Brevdo, E., Chen, Z., Citro, C., Corrado, G. S., Davis, A., Dean, J., Devin, M., Ghemawat, S., Goodfellow, I., Harp, A., Irving, G., Isard, M., Jia, Y., Jozefowicz, R., Kaiser, L., Kudlur, M., Levenberg, J., Mane, D., Monga, R., Moore, S., Murray, D., Olah, C., Schuster, M., Shlens, J., Steiner, B., Sutskever, I., Talwar, K., Tucker, P., Vanhoucke, V., Vasudevan, V., Viegas, F., Vinyals, O., Warden, P., Wattenberg, M., Wicke, M., Yu, Y. & Zheng, X. (2015). TensorFlow: Large-scale machine learning on heterogeneous systems. Software available from tensorflow.org.

Beazley, A. (1998). Size and Fit: Formulation of Body Measurements Tables and Sizing Systems, Journal of Fashion Marketing and Management, 2(3), 260-284.

Beazley, A. (1999). Size and Fit: The Development of Size Charts for Clothing, Journal of Fashion Marketing and Management, 3(1), 66-84.

Bigaard, J., Spanggaard, I., Thomsen, B.L., Overvad, K., & Tjønneland, A. (2005). Self-reported and technician-measured waist circumferences differ in middle-aged men and women. The Journal of nutrition, 135(9), 2263-2270.

Devarajan, P. & Istook, C.L. (2004, Summer). Validation of Female Figure Identification Technique (FFIT) for Apparel Software, Journal of Textile and Apparel, Technology and Management, 4(1), 23.

Fan, W.J. & Hunter, L. (2004). Clothing Appearance and Fit: Science and Technology, Woodland Publishing Ltd., Cambridge.

Faust, M.E., Baptiste, P. & Carrier, S. (2006). Variations in Canadian Women's Ready-to-Wear Standard Sizes, Journal of Fashion Marketing and Management, 10(1), 71-83.

Google Research. Tensorflow serving (2016). tensorflow.github.io/serving/.

Gordon, C.C. (1986). Anthropometric Sizing and Fit Testing of a Single Battle-dress Uniform for US Army Men and Women. In Performance of Protective Clothing (edited by R.L. Barker and G.C. Coletta) (ASTM STP 900), American Society for Testing and Materials, Philadelphia, PA, USA, 591-592.

Kausher, H., & Srivastava, S. (2019). Developing Structured Sizing Systems for Manufacturing Ready-Made Garments of Indian Females Using Decision Tree-Based Data Mining. International Journal of Materials and Textile Engineering, 13(12), 571-575.

Kavukcuoglu, K. (2016). Deepmind moves to tensorflow, Google Research Blog, Apr. 2016 (accessed May 24, 2016), http://googleresearch.blogspot.de/2016/04/deepmind-moves-totensorflow.html

Keras: Deep learning library for theano and tensorflow. https://keras. io/. Accessed: 2017-03-15

Murray, D. (2016). Announcing tensorflow 0.8 âA ¸S now with distributed ˘ computing support! Google Research Blog, April 2016 (accessed May 22, 2016), http://googleresearch.blogspot.de/2016/04/announcingtensorflow-08-now-with.html

Otieno, R. (2008). Approaches in Researching Human Measurement: MMU model of Utilising Anthropometric Data to Create Size Charts, EuroMed Journal of Business, 3(1), 63-82, 2008.

Quarsar Framework V1.15..1. Build high-performance VueJS user interface in record time. [Online] Available: https://quasar.dev (Accessed: November 6, 2020).

Rampasek, L. & Goldenberg, A. (2016). Tensorflow: Biology's gateway to deep learning? Cell Systems, 2(1), 12–14. [Online]. Available: http://dx.doi.org/10.1016/j.cels.2016.01.009

Reich, N., & Otten, P. (1991). Clothing and dressing needs of people with arthritis, Clothing and Textile Research Journal, 9(4), 34-40.

Reitenbach, M.E.F.R., Jochems, A.J., Molenbroek, J.F., Ball, R., & van Eijk, D.J. (2009). User experience of office chairs and anthropometrics of female Chinese and Hong Kong Chinese office and factory workers. The Ergonomics Open Journal, 2(1), 1-12.

Sohn, M. (2012). Analysis of upper body measurement change using motion capture. Ph.D Dissertation, Faculty of Graduate School, University of Minnesota. Retrieved from the University of Minnesota Digital Conservancy, http://hdl.handle.net/11299/156234.

The TensorBoard repository on GitHub. http://github.com/ tensorflow/tensorboard. Accessed: June 15, 2017.

Verma, P. (2020). Human pose estimation using TensorFlow's PoseNet model: Tracking human movement with pose estimation using PoseNet. Online: https://heartbeat.fritz.ai/human-pose-estimation-using-tensorflows-posenet-model-e5770f0a0a31 (Accessed: 14 January, 2021).

Wang, Y.J., Mok, P.Y., Li, Y., & Kwok, Y.L. (2011). Body measurements of Chinese males in dynamic postures and application. Applied Ergonomics, 42(6), 900-912.

Xia, S., & Istook, C. (2017). A method to create body sizing systems. Clothing and Textiles Research Journal, 35(4), 235-248.

Xia, S., West, A., Istook, C., & Li, J. (2018, October). Acquiring accurate body measurements on a smartphone from supplied colored garments for online apparel purchasing platforms and e-retailers. In Proc. 3DBODY. TECH 2018-9th Int. Conf. Exhib. 3D Body Scanning Process. Technol. Lugano, Switzerland(pp. 126-130).