Calculation of the body measurements after analyzing the historical pattern block

To cite this article: S C Zhang and V E Kuzmichev 2018 IOP Conf. Ser.: Mater. Sci. Eng. 459 012087

View the article online for updates and enhancements.
Calculation of the body measurements after analyzing the historical pattern block

S C Zhang¹ and V E Kuzmichev¹,²

¹Ivanovo State Polytechnic University, Department of Garment Design, 21 Sheremetev Av., Ivanovo, 153000, Russia
²Wuhan Textile University, Fashion Faculty, No.1 Sunshine Avenue, Jiangxia District, Wuhan, 430200, Hubei Province, China

wk37@list.ru

Abstract. The trends of contemporary fashion design are considerably referring to the historical costumes. Regarding the relevant records of pattern block drafting methods of historical costumes, although the patterns and their concrete indexes are accessible, the anthropometric features of the corresponding historical wearer are uncharted. The purpose of this research is to employ the 2D CAD and 3D virtual try-on technologies to reconstruct the historical costumes to calculate and assess the anthropometric measurements of the historical wearers, validating by the results of virtual system “historical costume – body”.

1. Introduction
In the contemporary fashion market and industry, the historical European costume has been one of the most essential inspiration of designing. Especially on the runways of yearly fashion weeks in Paris, Milan, New York, London, the relevant elements and features of historical costumes have been appeared in many notable brands’ designs[1].

To optimize the research of historical costume, many authors have applied the new virtual try-on technology to their field, which was proved feasible. However, most researchers investigated only the clothing itself without considering the vital impact of body in the virtual environment[2][3]. Thus, to precisely reconstruct the historical clothing and improve the efficiency of construction, the primary factor is the establishment of identical avatar which is consistent with the historical male body. Namely, in the virtual system “historical costume-body”, the appearance, morphology, and anthropometric indicators of the reconstructed virtual avatar should be the same as the ones of the cotemparaneous European body[4]. In this exploration, the virtual male body of 1740s was reconstructed through adaption of body height matchable with the historical pattern. The obtained avatar was manifested as the duplicated historical body in accordance with the measurements from Russian typical figure of men dimensional signs for fashion design system[5].

2. Experiment

2.1. Men’s costume
Men’s full-skirted coat in 1740s was chosen for reconstruction. Figure 1 (a) shows this coat which is made in the small-patterned figured, extra width at the sides had to be arranged in pleats. These fanned out over the hips below the waist where the side seams ended[6]. Waistcoats were worn for undress from the middle of the century[7]. This costume made of silks, brocades and damasks, such beautiful
fabric that decoration became unnecessary. Enhancing by the observations of corresponding inside underwear, fabrics and ingredients, craftsmanship, the reconstruction of these costumes in 3D CAD were proposed with the adapted historical pattern blocks[8].

![Pattern blocks](image)

**Figure 1.** Men’s full-skirted coat in 1740s (a), pattern block of coat (b), pattern block of waistcoat (c)

### 2.2. Adapting the height of avatar in Clo3D

After sketching the historical pattern blocks as equal scale, the two kinds of historical clothes were reconstructed in 3D CAD software Clo 3D, with the adjusted avatar height in accordance with the patterns.

Taking the 1740s’ clothing as an example (Figure 2.), the concrete method was:

1. Mark the landmarks of BNP (back neck point), waist line(WL) and waistband line(WBL) on the back pattern.
2. Measure the distances from BNP to WL, from BNP to WBL and from WL to WBL on the pattern, respectively recorded as L1, L2 and L3.
3. After virtual historical clothing was dressed on the avatar in Clo 3D, measure the distance from BNP to WL, from BNP to WBL and from WL to WBL along the clothing surface, respectively recorded as L1’, L2’ and L3’.
4. Adjust the avatar height to ensure L1=L1’, L2=L2’ and L3=L3’ respectively, and record the heights as H1=180.5cm, H2=183.5cm and H3=180.5cm.
5. Calculate the average value $H_{\text{mean}}=181.5$cm of these heights, which would be the originally applied male height of the historical pattern. Moreover, with the pupillary distance of the man in the photo measured, the scaling method could be also utilized to calculate the height with peculiar ratio.

![Avatar height adjustment](image)

**Figure 2.** Virtual system "body-coat", adapting the height of avatar during virtual try-on

### 2.3. Calculating the bust and waist girth of avatar

Reconstructed full-skirted coat in 1740s in Clo3D software with the height of European male avatar was 181.5cm. Figure 3a showed upper part of its 3D image. Additionally, the cross-sections on bust level, waist level and the overlapping images of body and costumes were obtained in Figure 3b. The bust girth and waist girth of historical wearer were calculated by the formula (1) and (2) respectively,
where \( L_1 \) represents the circumference of the coat at bust level, as the length of green line (Figure 3b); \( a \) represents the distance between the front edge of coat at bust level, as the length of red line (Figure 3); \( t \) represents the thickness of coat and underwear. Measured \( L_1 \) is 97.61 cm, \( a \) is 3.78 cm, \( t \) is 0.5 cm in Clo 3D software separately, then we can get the bust girth is 98.25 cm, and calculate the waist girth is 74.35 cm by same way.

\[
L_1 = (\text{Bust Girth-}a) + 2 \pi t (\text{waistcoat + coat}) \quad (1)
\]

\[
L_2 = (\text{Waist Girth-}b) + 2 \pi t (\text{waistcoat + coat}) \quad (2)
\]

3. Results and discussion
Avatar with the height of 181.5 cm that reconstructed in Clo 3D software was imported into Rhinoceros software, 49 anthropometrical data were measured and recorded according to the methods of body measuring which demonstrated in Russian typical figure of men dimensional signs for fashion design system. Figure 4 shows the schemes of bodies measuring in this system.

By using the formula (1) and (2), bust girth and waist girth of virtual model were both obtained. It can be confirmed that this avatar’s morphological characteristics conforms to the table of No.4 in Russian typical figure of men dimensional signs for fashion design system, that is, the bust girth between 88-104 cm. After combing with the height of avatar, we can get the other 46 measurements.
Figure 4. Diagram in Russian typical figure of men dimensional signs for fashion design system

Table 1 contains the anthropometrical measurements which were used in dimensional sign and the difference between 49 sets of dimensions in pairs (the numbers 1, 27, 98...26 are following Figure 4). It can be found that 5 pairs are identical and little difference among 39 groups but they still belong to same male body shape standard. There are also 5 sets of data with large variance, mainly concentrated on the length of avatar’s arm, such as 32\textsuperscript{nd}, 33\textsuperscript{rd} and 90\textsuperscript{th}.

| No. | Measurement                          | Difference | No. | Measurement                          | Difference |
|-----|-------------------------------------|------------|-----|-------------------------------------|------------|
| 1   | Height                              | 0.50       | 27  | Crotch height                      | 0.20       |
| 98  | Neck height front                   | 0.93       | 104 | Waist to lower hip                 | -0.39      |
| 4   | Neck height side                    | 0.20       | 77  | Crotch length                      | -0.70      |
| 5   | Shoulder point height               | -0.06      | 49  | Distance crotch to waist           | -0.10      |
| 6   | BP point height                     | -3.54      | 28  | Upper arm girth                    | 1.12       |
| 7   | Waist height                        | 0.00       | 29  | Wrist girth                        | 0.33       |
| 9   | Knee height                         | 0.00       | 30  | Hand girth                         | 0.10       |
| 10  | Neck height back                    | 0.20       | 31  | Shoulder width                     | 0.35       |
| 11  | Armpit height back                  | -0.58      | 32  | Upper arm length to neck           | 5.40       |
| 87  | Breast height                       | 0.00       | 33  | Arm length to neck                 | 4.56       |
| 12  | Thigh height                        | 0.10       | 90  | Hand length to neck                | 5.77       |
| 13  | Neck girth                          | 0.58       | 34a | Upper bust level to neck           | -0.30      |
| 14  | Upper bust girth                    | 2.18       | 35a | Bust point to neck                 | -0.39      |
| 15  | Bust girth (horizontal)             | 2.55       | 36a | Waist to neck front                | 0.50       |
| 16  | Under bust circumference             | 0.40       | 38  | Armhole girth                      | 0.38       |
| 18  | Waist girth                         | -0.35      | 39  | Neck to back width                 | 0.04       |
| 19  | Hip girth (with abdomen)            | 0.60       | 40  | Neck to waist center back          | 0.19       |
| 20  | Hip girth                           | 0.56       | 43  | Neck to waist back                 | 0.08       |
| 21  | Thigh girth                         | 0.80       | 44  | 36a+43                              | 0.58       |
| 22  | Knee girth                          | 0.74       | 45  | Width armpits                      | 0.80       |
| 23  | Calf girth                          | 0.80       | 46  | Bust points width                  | 0.60       |
| 24  | Ankle girth                         | 0.06       | 47  | Back width (armpit level)          | 0.06       |
| 51  | Foot girth                          | 0.20       | 57  | Arm diameter (armpit level)        | 0.37       |
| 25  | Side seam 3D waistband              | 0.00       | 48  | Head circumference                 | 0.23       |
| 26  | Waistband front height              | 0.00       |     |                                     |            |
4. Conclusion

Through the observation of historical costume, the reconstructions in virtual environment were proposed. The way and the algorithm how to get the original male body measurements from the historical pattern in accordance with the pattern block parameters, fabric thickness, air gap, etc. were developed. Thus, the detailed anthropometrical database and morphological features were attained accordingly. While 5 existing measurements of reconstructed avatar in CLO 3D were different with the Russian National Standard. In the future, the avatar will be formed in other software like Optitex, MakeHuman, etc. and make comparisons. The changeable morphology of virtual avatar will be considered when the corset is worn. This research proposed and validated the method of obtaining body measurements from pattern blocks and picture of historical costumes and virtual try-on technologies. This approach will be helpful to accurately exhibit the features of historical costumes for researchers of historical costumes and digital museum.

References

[1] Kuzmichev V E, Moskvin A, Surzhenko E and Moskvina M 2016 Computer reconstruction of 19th century trousers International Journal of Clothing Science and Technology 29(4) pp 594-606

[2] Martin K and Ko H 2009 Virtual Historical Costume Across Cultures and Disciplines In: Proc. of the 15th Int. Conf. on Virtual Systems and Multimedia 9-12 September 2009 Vienna Austria pp104-108

[3] Kang Y, Wu S, Ko Y, Kang Z Y, Kim N and Ko H 2013 Digital production of traditional costume In: Proc. of the 1st Int. Conf. on Digital Fashion London Digital Fashion 2013 Secretariat 16-17 May 2013 pp 329-335

[4] Kuzmichev V E, Moskvin A and Moskvina M 2018 Virtual reconstruction of historical men’s suit Autex Research Journal vol.18 No.3

[5] Central Scientific Research Institute of Scheinon Industry 2005 Typical Figure of Men Dimensional Signs for Fashion Design (Moscow)

[6] Norah W 1964 The Cut of Men’s Clothes (New York: Theatre Art Books)

[7] Vincent W D F 1898 The Cutter’s Practical Guide to Cutting and Making all Kinds of Waistcoats (London: The J. Williamson company limited)

[8] Vincent W D F 1898 The Cutter’s Practical Guide to Cutting and Making Shirts, Undergarments, Collars, and Specialite Clothing for Various Occupations (London: The J. Williamson company limited)