Automated technique for designing the basic foundations of a clothing drawings

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Abstract. The article considers the process of formalisation of the automation of the design of garments by introducing the author's method of constructing the basic basis of the drawing of shoulder garments. In order to develop the curves of the structure, an analytical method of design using spline interpolation by third-order polynomials is proposed.

1 Introduction

Modern foreign computer-aided design (CAD) systems used in the garment industry differ in many respects, such as the degree of automation of design processes, the functionality of specific design solutionsdesign tasks, methods for describing design and storing data, interface features, ease of use and many other characteristics [1-2].At present, the domestic garment industry is actively using two-dimensional CAD garments for design work and model preparation. Some of the most common foreign CAD clothing in Uzbekistan are Gemini (Romania), Julivi (Ukraine), LECTRA Systems (France), Грация (Ukraine), Ассоль (Russia), Gerber (USA), etc. various functions of the design stages of patterns. Different countries use their own sets of dimensions and quantities of external clothing. Each of the technologies used has its advantages and disadvantages, which ultimately translate into the quality of the final product planting [3].

Experience in operating these systems in the domestic context has revealed some difficulties in adapting them, especially in drawing up the basic framework (BW). In CAD, BW drawings can be obtained in two ways: graphics or an analytical description of graphics. It was found that the use in existing systems of methods for developing the foundations of structures based on analytical methods does not provide a high-quality fit of clothing. The use of graphical methods for constructing drawing elements - curved contours requires a lot of design experience and the need to make changes to the drawings of clothing patterns to ensure the quality of fit. This circumstance determines that these systems have limited capabilities when creating an optimal clothing design system.This circumstance causes the fact that these systems have limited capabilities in creating an optimal clothing design system.This article is devoted to the improvement of the method of constructing the basic bases in automatic mode, development of the formalized description

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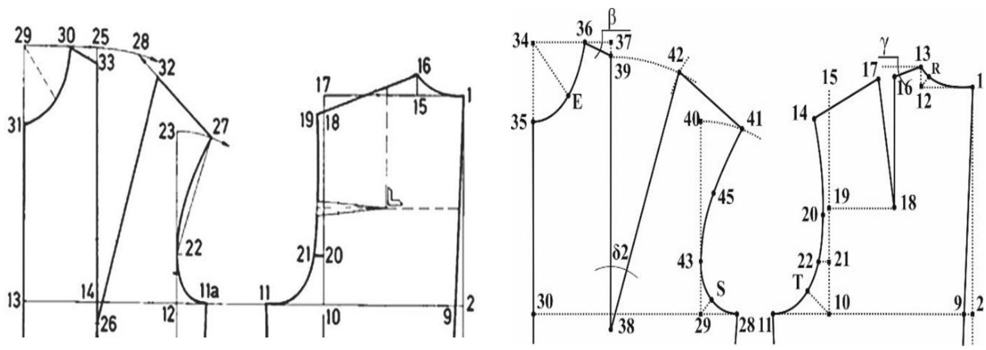
of the design processes of the drawing guaranteeing the high quality planting of garments, which is the purpose of this work [4-9].

2 Research methods

In order to solve the problem, the work uses structural-functional analysis, methods of obtaining details of the clothes, methods of expert assessment, method of interpolation spline interpolation with third-order polynomials, software products of standard Windows XP and application graphics packages.In order to develop an optimized method for designing shoulder garments based on the results of experimental studies of the design parameters and fit of models of various design methods, the modern German design method "Müller and Son" [10] (hereinafter referred to as the "Muller method"), used in the most common European clothing CAD systems, was chosen as the initial one [10].

In order to ensure a high-quality planting of women’s and men’s humerus products, a method is proposed for determining the support section of the basic structure according to the nature of the change in the inclination angles of the humerus of the typical shapes depending on the size [12]. The Müller design method introduced changes to the definition of coordinates of structural points and the sequence of their calculation (Fig. 1).



a) b)

Fig. 1. Upper Outline of the Basic Framework of Women’s Shoulder Clothing : a) M.Muller Sohn b) proposed

According to the proposed methodology, the position of the first point of the back and the shelf (points 16, 39) is determined by the formula:

$$16x = \mathrm{Cos}\gamma * d,\ d \in [3.0, 5.0\,] \qquad (1)$$

$$16y = \sqrt{d^2 - 16x^2} \qquad (2)$$

here$\angle\gamma -$ is the recommended slope of the shoulder line of the back corresponding to the data in the table.

$$39x = \mathrm{Og}/10 + 0.5 \qquad (3)$$

$$39y = ((\mathrm{Og}/10 + 0.5) - \mathrm{Shsh.z})/ctg\beta \qquad (4)$$

$$M_{36-39} = \sqrt{((\mathrm{Og}/10 + 0.5) - \mathrm{Shsh.z})^2 + 39y^2} \qquad (5)$$

Where Og-girth chest,Shsh. z–back neck width,$\angle\beta$- recommended values for the inclination of the shoulder line of the back according to the table, M_{36-39}– the distance between points 36 and 39 of the drawing. In the shelf, the slope of the shoulder line at point 41 is determined as follows:

$$r_1 = R_{29} = \text{M}_{29-40} \quad (6)$$

$$r_2 = R_{40} = \text{Og} \cdot 0.06 \quad (7)$$

$$41x = r_2 \cdot \sqrt{4 \cdot r_1^2 - r_2^2}\ /2r_1$$

or

$$41x = (\text{Og} \cdot 0.06) \cdot \frac{\sqrt{4 \cdot M_{29-40}^2 - (\text{Og} \cdot 0.06)^2}}{2 \cdot \text{M}_{29-40}} \quad (8)$$

$$41y = \sqrt{r_1^2 - 41x^2} \quad (9)$$

Where M_{29-40}– the distance between points 29 and 40 of the base.

Based on the proposed approach, the change in the position of the shoulder point of the shelf and back, depending on the size and volumetric silhouette shape of the product, has been eliminated.

In order to provide high precision in the calculation and determination of the coordinates of design points in the design of the curves of the basic base, instead of the existing cumbersome graph analysis method, Method of design of curves using spline interpolation of third order polynomials is proposed [10]. The third-order spline interpolation function is as follows:

$$f(x) = \begin{cases} a_1x^3 + b_1x^2 + c_1x + d_1,\ if\ x \in\ [x_1, x_2] \\ a_2x^3 + b_2x^2 + c_2x + d_2,\ if\ x \in\ [x_2, x_3] \\ \dots \\ a_nx^3 + b_nx^2 + c_nx + d_n,\ if\ x \in\ [x_n, x_{n+1}], \end{cases} \quad (10)$$

here, $a_{1...n}$, $b_{1..n}$, $c_{1...n}$, $d_{1...n}$ - random coefficients, $x_{1...n}$– coordinates of points on the axis$x$.

Determining the curves of the armhole of the front and the back of the base warp by the spline interpolation method is as follows. The design points of the armhole 28, S, 43, 45, 41, 14, 20.22, T, 11 are determined. Armhole curves are approximated by conjugated segments S1, S2, S3, S4, S5, S6, S7, S8 passing through these points (Fig. 2).

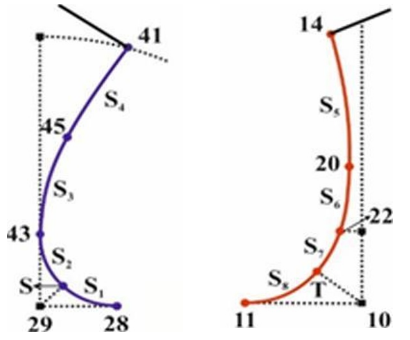


Fig. 2. Shape of the curve of the sleeve of the base a) front armhole, b) back armhole

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The coordinates of the points of the edge of the shelf are defined by formula:

$$28x = 1/3 * (\text{Shpr} + \text{Pshpr})$$

$$S_x = \sqrt{M_{29-S}^2 - S_y^2} \quad (11)$$

$$43x = 1/3 * (\text{Shpr} + \text{Pshpr}) \quad (12)$$

$$45x = \frac{43x - 41x}{2} - h_{45} * \frac{41y - 43y}{\sqrt{(43x-41x)^2 + (41y-43y)^2}} \quad (13)$$

$$45y = \frac{41y - 43y}{2} + h_{45} * \frac{43x - 41x}{\sqrt{(43x-41x)^2 + (41y-43y)^2}} \quad (14)$$

Where Shpr – armscye width, Pshpr – allowance to the armscye width.
The coordinates of the points of the seat back are defined by the formulae:

$$20y = a + y \quad (15)$$

$$20x = \sqrt{\left(\sqrt{M_{18-19}^2 + a^2} + z\right)^2 - (a + y)^2} \quad (16)$$

$$y = \frac{a * \left(\left(\sqrt{M_{18-19}^2 + a^2} + z\right) - \sqrt{M_{18-19}^2 + a^2}\right)}{\sqrt{M_{18-19}^2 + a^2}} \quad (17)$$

$$22x = 11x - f, \; f \in [1.0 \ldots 1.5] \quad (18)$$

$$22y = \text{M}_{10-15}/4 \quad (19)$$

Figure 3 shows a block diagram of the algorithm for automatically constructing a drawing of the base frame.

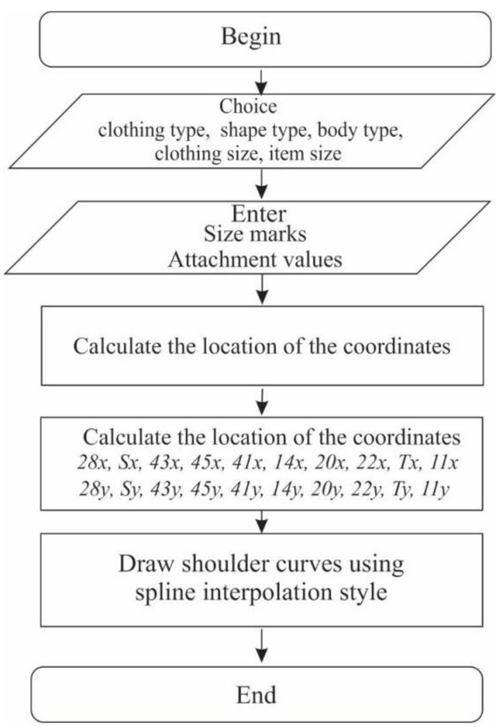


Fig. 3. Block diagram of the algorithm for automatically constructing a drawing of the base frame.

The solution of the problem of constructing a curve and calculating optimum values of the boundary parameters of the sleeve structure at a given length of the gap, taking into account the properties of the fabric, ensuring the permanence of the given values of the addition to the shoulder girdle and the norm of planting for different sizes of clothing is set in work [9].

3 Results and discussion

According to the Muller method, in order to determine the factors affecting the quality of the fit of the product, experimental studies were carried out on changes in the elements of the basic foundations depending on the size and silhouette shape of clothing. On the basic framework drawings obtained by various CAD (Gemini, Gerber, Assyst) it is found that the angle of the shoulder of the back ∠γ (figure 4) varies depending on the size and width of the item, this range of angle change decreases with the size of the clothing [5-10].

The change in the angle of inclination with an increase in the half-girth of the chest of 4 cm in the range from small size (Og=84 cm) to large size (Og=116 cm) is 4.14^0, and between sizes - $0.46\text{-}0.61^0$. The nature of the change in the inclination of the shoulder of the shelf (∠β) differs from that for the backrest (Fig. 5). In the range of sizes from Og =84 to Og =104, the angle of the shelf decreases, and for sizes Og =108 and more, the angle of inclination increases, which is due to the method of forming a table of dimensional parameters (design technique). It has been found that such changes in practice affect the balance of the product, resulting in even greater shoulder stitch dislocation. To address these shortcomings, the dimensional table has been modified to stabilize the humerus position.

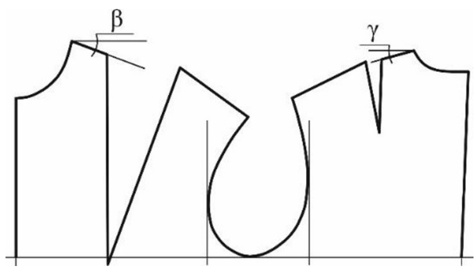
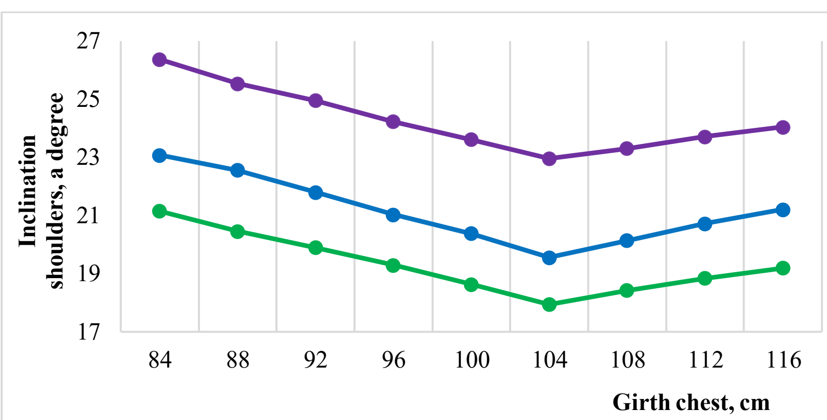


Fig. 4. Drawing and measuring diagram of supporting portions of female shoulder clothing



a)

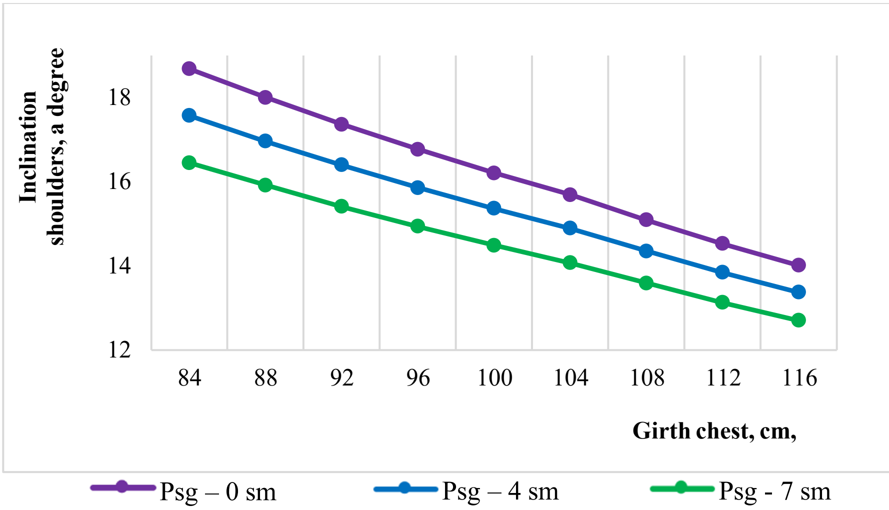


Fig. 5. The size of the clothing depends on the humerus angle of the shelf a) front b) back

According to the results of expert assessment of the planting of models of women's and men's clothing, the position of the humerus point for the average size Og=100sm is determined. Based on the change in the pitch of the angle of inclination of the arm of the type shapes in the range of size Og=84 -116 sm, A method for determining the base section of the basic structure is proposed, and a table for calculating the weight angles of the shoulder tilt of the shelf and back for the design of women's and men's clothing is developed.The developed recommended inclination values of the shoulder pad of the shelf and back, the dimension table has made a formalized database for the technique of automated design of garments.

Based on the proposed approach to the design of drawings of the front, back and set-in sleeves - input parameters, a formalized description of the construction of structural elements and algorithms, a methodology and software for automating the design of the foundations of women and men's shoulder clothing have been developed.

Fig. 6 shows individual modules and screen fragments of the results of the implementation of the developed system for computer-aided design of the basic foundations of clothing.The software includes the following interfaces and modules: interface for selecting the type of clothing, the type of figure and silhouette of clothing; module of dimensional features and constructive additions; module for calculating the coordinates of structural points of the base base; module for automatic construction of the basic framework; module for calculating armhole parameters; interface for selecting the fit rate and the values of the increase in the girth of the shoulder, taking into account the type of material; module for calculating the coordinate points of the arm sleeve; module for constructing an eye curve using the spline interpolation method; a module for measuring the length of the circle and checking the compliance of the Dock values with a given value; module for saving data in *DXF format for integrating the system with existing CAD systems [1-6].

The software for automatically constructing the basic framework is created on a platform comprising the following components: Microsoft Windows; Microsoft SQL Server 2008 database; Visual Studio Tool Programming Environment; C#, SQL programming languages.

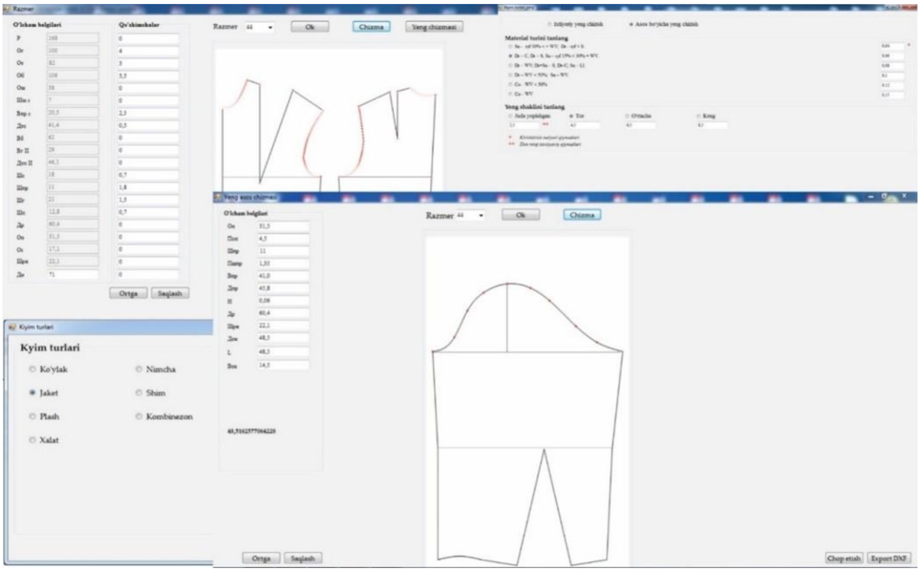


Fig. 6. Screen implementation fragments of individual system modules

Experimental testing of designs of various sizes derived from the system demonstrated the high accuracy of the theoretical models proposed.

4 Conclusions

Based on the results of studies on the development of an automated methodology for the design of basic drawings:

- A method has been developed for a formalized description of the input parameters and the process of designing clothing structural elements. The implementation of the algorithm, design methodology and software for designing women's shoulder garments based on the proposed design approach provides automatic design of the basic basis of clothing.;

-A method for analytic calculation of coordinates of structural points and a mathematical model for the design of curves of the structure of the basic base using interpolation splines of third-order polynomials are proposed;

-Developed a methodology and system for the automated design of drawings for the basic bases of women’s shoulder clothing, which makes it possible to increase the speed and quality of drawings of garments.

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