AUTEX Research Journal, Vol. 9, No4, December 2009 © AUTEX

KNITTED FABRICS PICTURES COMPUTER ANALYSIS IN THE 3D SYSTEM

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Abstract:

The paper shows the new method of measurement of yarn length in loop which was developed regarding computer analysis of knitted fabrics pictures on the base of real axis loom path described by co-ordinates in coordinate system XYZ. The measurements of the three-dimensional yarn length in loop were realized in specially developed computer program "The three-dimensional analysis of the loop's picture" that also gives the possibilities of graphic presentation of real shape indicated axis loom path in rectangular coordinate system XY, XZ, YZ. There is shown the characteristic of developed research place that enables the realization of measurements in compute program in 3D system on the base of registered knitted fabrics pictures in particular measurement surfaces. It was also indicated that developed method of measurement of three-dimensional yarn length in loop regarding computer analysis of knitted fabrics pictures is characterized by high precision and gives results closer to experimental values than results gets by using theoretical methods.

Key words:

Yarn length in loop, computer analysis of picture, analysis of the loop's picture, knitted fabrics

Introduction

The topic of many research works [1, 2, 3, 4, 5, 6, 7] realised by Duttona, Dalidowicza, Smirfitta, Doylego and many others was description of knitted fabrics size caducity causes, and in some also description of their stable condition. Lack of knitted fabrics size stability determines the necessity of establishing their structure by parameter of yarn length in loop. It is only one of knitted fabric structural parameters which is independent on conditions in which is analysis of its structure under the condition that outside forces activating on the knitted fabric don't cause its constant deformations [8, 9, 10]. Moreover, while knitted fabrics manufacturing there is a possibility of regulation and controlling the length of yarn knitted in loops. By using the parameter with describing of knitted fabric structure, there is a possibility of controlled change of knitted fabrics structural properties while their manufacturing.

Commonly known and used laboratory methods of yarn length measurement in loop of made knitted fabrics consist on measuring of yarn length ripped out of described number of loops or also on establishing of yarn length in loop parameter on basis of knitted fabric sample surface mass with particular density. These methods are sometimes difficult for realisation in view of complicated knitted fabric structure, and furthermore, they cause destruction of tested knitted fabric sample. Regarding knitted fabrics structures, in which loops are made of some yarns, yarn length in loop described on a basis of knitted fabric surface mass is an mean length of yarn lengths in component loops. Moreover, not always there is a possibility of destroying tests realisation for describing of yarn length in yarn, eg. for ready products. In this case the knitted fabric morphology is described by parameters of course, wale and surface density and knitted fabric thickness. Data recreation or designed knitted fabrics structures on a basis of only these parameters is significantly difficult by reason of high size instability of knitted fabrics. As result knitted fabrics characterised by similar structure with designed or recreated knitted fabric show different structural properties, and further also usage properties.

For knitted fabrics with particular stitch, being in particular conditions, there are some dependences linking knitted fabrics structural parameters like: course density, wale density and yarn length in a loop. Knowledge of these dependences enables theoretical prediction of knitted fabric structure on a basis of regulated during knitted fabric production the parameter of yarn length in a loop. For establishment of these dependences is necessary knowledge of loops geometry of which knitted fabric is created. Theoretical ways of establishing dependences between structural parameters are based on knitted fabrics loops models which were developed on a basis of some establishments simplifying through only geometric (Peirce [11], Chamberlain [8], Shinn [12], Dalidowicz, Alison [8]), mechanical (Leaf [13, 14], Glaskin [15], Munden [16], Postle [17, 18], Shanahan [19, 20], Grosberg [21, 22], Hepworth [23, 24], MacRory [25], Doyle [26, 27], Wolfaardt and Knapton [28]) and energetic deliberations (Jong i Postle [29, 30], Choi and Lo [31]). The analysis of theoretical values of yarn length in loop obtained on a basis of dependences between structural parameters and experimental values from measurements, enables the verification loop model developed for given stitch. Identity of verified parameter values testifies that taken loop model is characterised by structure similar to real loop structure. But it is necessary to point out that developed theoretical models through way of various research considerations show knitted fabric loop with established, similar to real shape, which is able to be experimental verified

only on a basis of knowledge of real path of a yarn in loop. It is very problematic issue because of spatial character of knitted fabric loop structure.

The solution of this problem was taken up in seventies Kopias [10] by describing shape of spatial curve which is created by axle of yarn formed into a knitted fabric loop in rectangular coordinate system as a function z=f(x,y). For finding the form of this function, author used the geometric method based on graphic establishment of yarn axle views to surfaces of rectangular coordinate system XY (surface parallel to knitted fabric surface) and X'Y' (surface slanting to knitted fabric surface with an angle α). The establishment of coordinates values of points on yarn axle (x, y) and (x', y') was realised on a basis of yarn axle view properly to the surfaces XY and X'Y', where yarn axle was established on a basis of a picture of loop made in knitted fabric surface XY and surface X'Y' slanting to knitted fabric surface with an angle α. The coordinates z of point were established on a basis of geometric dependences between point coordinates in two rectangular coordinate systems XYZ and X'Y'Z'. Geometric dependences between point coordinates in rectangular coordinate systems XYZ and X'Y'Z' and diagrams of lines views to two surface slanting regard themselves, allow to establish the coordinates (x, y, z) of any number of points on considered curve. The graphic-geometric method developed on a basis of real knitted fabrics loops pictures allowed the author to analyse the knitted fabrics loops shapes and to properly describe the dependences for the yarn length in loop with usage of sizes loop which was justified by using the pattern verification with usage of theoretic loop models of Dalidowicz and Alison and empiric data.

The developed by author method of analysis morphology of knitted fabrics loop and resulting from its usage the precision of established dependence linking structural parameters of knitted fabric loop, became the inspiration for development of method integrated with using the system of computer analysis of knitted fabrics loops picture for measurement of real yarn length in a loop being the spatial curve [32].

The analysis of knitted fabrics spatial geometry with usage of computer technique of picture transformation

New method of measurement of yarn length in loop was developed on a basis of real path of loop axle described by coordinates in spatial system XYZ based on a computer analysis of knitted fabrics pictures.

For realisation of measurements spatial yarn length in a loop in developed for this purpose computer programme ,,ANALIZA PRZESTRZENNA OBRAZU OCZKA" (,,SPATIAL ANALYSIS OF LOOP PICTURE"), it was necessary to design and build the proper research place enabling the observation and registration of knitted fabrics pictures in two surfaces - with an angle 90 and 45° to knitted fabric surface (Figure 1).

Developed computer programme ,,ANALIZA PRZESTRZENNA OBRAZU OCZKA" (,,SPATIAL ANALYSIS OF LOOP PICTURE") is for establishing and measuring the real yarn length in loop in surfaces XYZ on a basis of computer analysis of pictures in 3D system. For defying in programme one spatial loop are necessary the pictures of two plain loops (presenting the knitted fabric loop in its surface and in surface slanting to it with an angle 45° with established yarn axles being loops axles (Figure 2a and 2b).

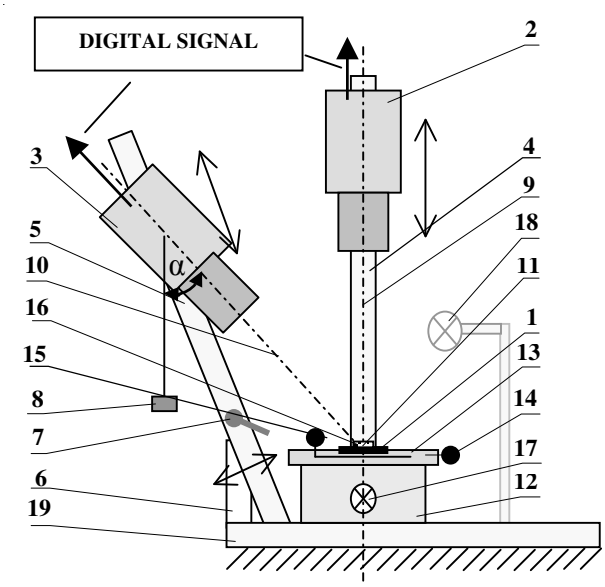

Figure 1. The draft of research place, 1 - knitted fabric sample, 2 - camera giving the picture in knitted fabric surface; way of fixing enabling moving the camera in vertical direction, 3 - camera giving the picture in surface slanting to knitted fabric surface with an angle ; way of fixing enabling setting the camera with described angle and enabling moving the camera on a fence 5, 4 - camera tripod 2, 5- c a m e r a tripod 3; possibility of setting with various angles regarding camera tripod 2, 6 - stable tripod fixing 4, 7 - screw linking of tripod 4 with element 6, enabling the change of tripod 4 position with various angles, 8 - extender plumbing; enable the establishment of inclination camera 3 angle to knitted fabric surface, 9 - camera axle 2, 10 - camera axle 3, 11 - registered picture of knitted fabric part being in camera axles, 12 - table base, 13 - moving table, 14 - manual knob enabling table 13 rotation around the camera 2 axle, 15 - manual knob enabling moving table in horizontal direction, 16 - microscope patter glass, 17 - source of light passing through knitted fabric sample 1, 18 - source of light contrasting from knitted fabric 1, 19 - base of measurement place construction.

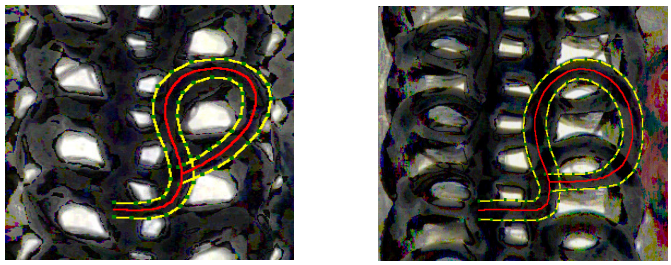

figure 2a figure 2b

Figure 2. Photos of knitted fabric watched with an angle 90° (figure a) and with an angle 45° (figure b).

For establishment of coordinates z of yarn axle were used geometric dependences between points coordinates in rectangular coordinates systems XYZ and X'Y'Z', which are turned regard themselves with an angle α=45° around the axle X (Figure 3) [32].

Coordinates of any point P are linked by dependences:

$$x_m = x'_m \tag{1}$$

$$\frac{z_m}{BD} = ctg\alpha \tag{2}$$

$$BD = OB - y_m \tag{3}$$

$$OB = \frac{y'_m}{\cos\alpha} \tag{4}$$

$$OB = \frac{y'_m}{\cos\alpha} \tag{5}$$

Concerning above, coordinates zm are estimated of the dependence:

$$z_m = \frac{y'_m}{\sin\alpha} - y_m \; ctg\alpha \tag{6}$$

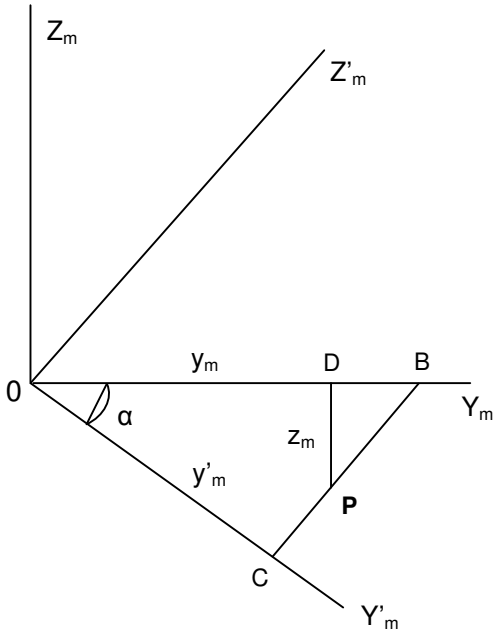

Figure 3. Coordinates of point P in rectangular coordinates system XYZ and in moved regarding it around the axle X with an angle α.

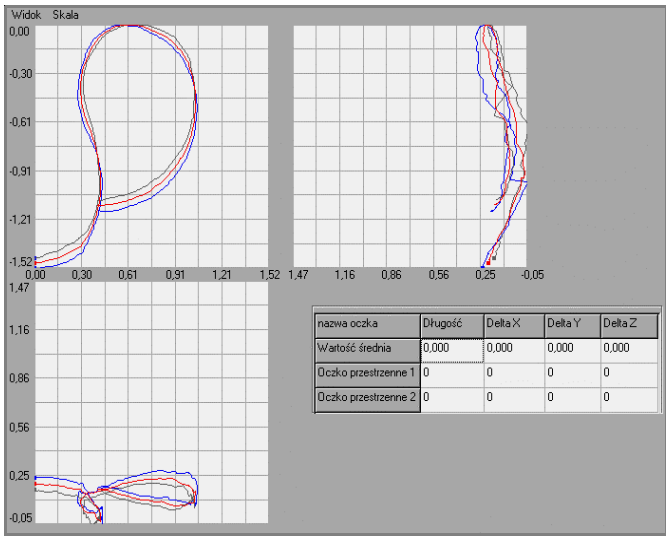

Figure 4. The graphic picture of yarn axle creating a loop in a coordinates system XYZ.

The result of measurement of yarn spatial length in loop is the mean value estimated in computer programme on a basis of next results of measurements of yarn spatial length in a loop. The advantage of developed programme is a possibility of measurement realisation in a plain 2-dimensional system. Furthermore, the programme enable graphical presentation of spatial loop (loops) axle in a form of views to the surfaces YX, XZ and YZ (Figure 4).

The assessment of results of yarn lentgh in loop measurement according to the computer standard

The computer method of yarn length in loop measurement was assessed in a range of a measurement precision. Measurements of yarn length in loop according to developed computer method was realised for 10 variants of two-guide-bar warp knitted fabrics differing by stitch and density. There were realised n=5 measurements of yarn length in a loop for all of warps. The results of research were shown in a table 1. With mean values of yarn length in a loop lOG and lOD, properly for upper warp OG and bottom OD, the table includes the values of relative random error of arithmetic mean of n measurements U'OG and U'OD for 95% level of confidence and k=n-1 number of degree of freedom.

Table 1. The results of yarn average length in a loop according to the computer method of measurement in a programme ,,ANALIZA PRZESTRZENNA OBRAZU OCZKA" (,,SPATIAL ANALYSIS OF LOOP PICTURE").

Identification of knitted fabrics variants	Upper warp		Bottom warp	
	l_{OG}	U'_{OG}	l_{OD}	U'_{OD}
	[mm]	[%]	[mm]	[%]
1	3,31	3,2	3,52	2,6
2	4,43	2,5	4,70	2,4
3	4,03	3,7	4,36	1,7
4	4,76	1,8	5,05	1,7
5	3,04	2,5	3,20	3,9
6	4,06	2,6	4,26	3,1
7	3,91	3,1	3,96	4,4
8	4,70	2,5	4,71	1,9
9	3,23	1,4	3,86	3,0
10	4,09	3,6	5,05	3,6

The verification of developed method of measurement was realised on a basis of assessment of convergence of yarn length in a loop measurement results obtained of the measurement during realisation of technological samples on the machine.

There was also carried out the comparison analysis of value of yarn length in a loop of measurement computer method l and obtained as a result of usage of loops theoretic models of Alison l_A, Dalidovic l_D [8] and Grosberg l_G [21, 22], concerning the real yarn length in loop l_{rz}, received as a result of its measurement during realisation of technological samples on a machine. This activity was aimed to show if new measurement method of yarn length in a loop l with usage of picture computer analysis gives the results closer to that which was received during realisation of technological samples on a machine, or closer to that values are yarn lengths in a loop described in a theoretical way with usage of loops models Alison l_A, Dalidovic l_D [8] and Grosberg l_G [21, 22].

On the diagrams (Figure 5 and 6) were shown the results of comparison analysis of used methods of describing yarn length in a loop as a values of relative random errors of yarn

length in loop values l, l_A, l_D, and l_G regarding the real yarn length in a loop l_{rz}, estimated according to the formula:

$$\varepsilon' = \frac{\varepsilon}{X} \qquad (7)$$

where:
ε - relative error = A-X,
A - value received of the measurement computer method and of loops models,
X - value of real yarn length in a loop of measurement during technological realisation of samples on the machine.

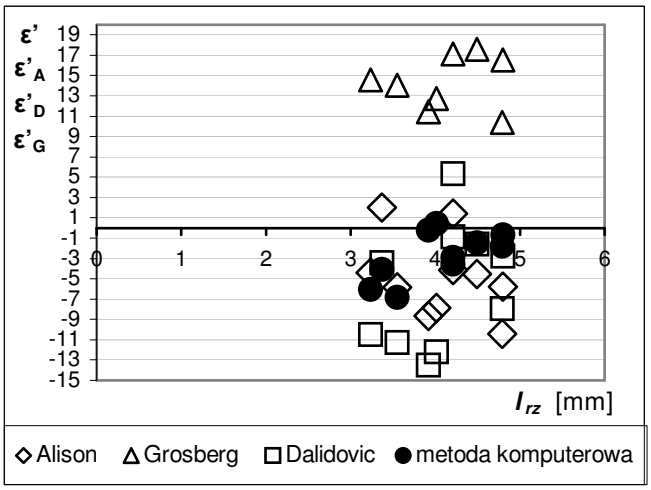

Fig. 5. Relative error of theoretic yarn length in a loop of loops models ε'_A, ε'_D, ε'_G and length described by computer method ε' in a function of real yarn length in a loop l_{rz} for upper warp.

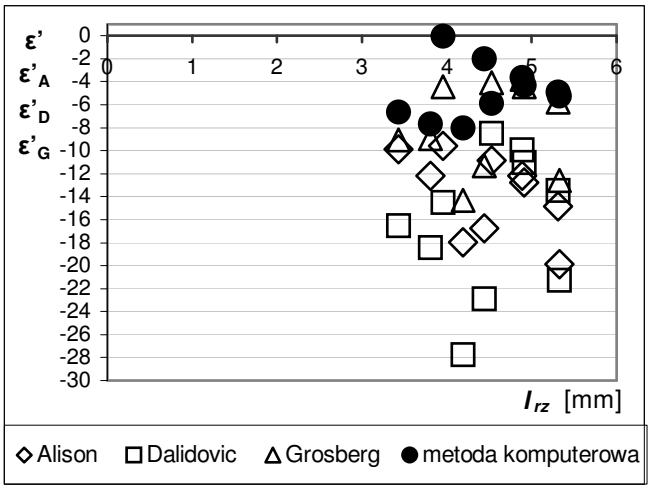

Figure 6. Relative error of theoretic yarn length in a loop of loops models ε'_A, ε'_D, ε'_G and length described by computer method ε' in a function of real yarn length in a loop l_{rz} for bottom warp.

Summary

Developed measurement method based on knitted fabrics pictures computer analysis allowed to establish yarn length in a loop on a basis on a real path of loop axle, described by coordinates in a rectangular system XYZ. The results of yarn length in a loop measurements according to this method are characterised by an error not 5%, and for which variants 2% (table 1). Precision of method mostly depends on the operator precision while leading yarn edge and on loops pictures which should present in a clear way section of yarn trestles in a loop.

The results of relative errors of yarn length in a loop (figure 5 and 6) show, that the smallest errors, so the closest values regarding real yarn length in a loop lrz were received by using measurement method based on computer analysis of 3D pictures.

Developed computer programme ,,ANALIZA PRZESTRZENNA OBRAZU OCZKA" (,,SPATIAL ANALYSIS OF LOOP PICTURE") is easy to use and enables also fast measurement realisation of loops size parameters in 2D system. Valued advantage of the programme is that data is recorded in a programme in a format .*opo, not engaging a lot of computer memory. However, knitted fabrics pictures .*bmp, needed for realisation of measurement and full data reading, are declared from the CD. The results of yarn length in a loop measurement are registered in a programme as a form of measurement points with coordinates xyz and they can be also used in different calculation programmes.

The programme gives the possibility of visual presentation of real shape of established loop axle in a rectangular coordinates system XYZ (figure 4), which can also be used for comparison analysis of loops shape in various knitted fabrics variants.

Acknowledgement

The topic was realised in a range of doctoral dissertation about ,,Structure and properties of a new group of warp-knitted fabrics manufactured with the use of warp-knitting machines equipped with a tuck presser"in the Department of Knitting Technology and Structure of Knitted Products of Technical University in Lodz (Poland).

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