Antropometric parameters problem solving of shoe lasts by deforming membranes with medium weight

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Abstract. The paper presents research results into getting a virtual model of shoe last and anthropometric parameters change. The most important change occurs in the fingers region. Alternatives CAD-CAM technology for next generation is based on DELCAM software for the CAM procedure and simulation of MATLAB software. This research has led to the virtual changes of the last, anthropometric parameter - the width of the fingers (L₉) and shoe last length - (L₀) and images have been achieved with the representation in section of the shoe last changed from the original shoe lasts by FEM method (Finite element method) in MATLAB environment. The results are applied in the textile industry and in the elaboration of linings consumption or in the development of leather substitutes on fabric, knitted or woven material type.

1. Introduction
To deform shoe lasts in anthropometric parameters areas, are required specialized programs on footwear. The most important changes are in the finger area, in the fingers perimeter and in the top of the leg (shoe lasts), where you can see the direct influence of the fashion line.
Virtual modified shoe lasts are archived in a database, which can be removed and then modified at any time according to the needs in the field of footwear manufacturing and market trends in the field.

2. The experimental part
In this research we used DELCAM software, but only for CAM procedure [1]. DELCAM also has DELCAM Crispin Shoes design module [2], but it was not available due to high costs of acquisition, respectively confidentiality regime imposed by the concerned company.
That approach would certainly be the most appropriate for achieving virtual model deformation, but not for Small and Medium Factories specialized in textile and footwear, a reason for seeking alternative art technology, cheaper and easier to implement.
The proposed alternative is based on MATLAB simulation program [3], [4] which certainly will lead to positive results [1]. However, the used program will not have the comfort and convenience that is at DELCAM Crispin Shoes Design [5].
In addition, extensive work is needed (in future research) to create a reliable procedure, well-defined and in place, namely the creation of virtual databases of so generated shoe lasts. Along the research were analyzed and implemented several iterative trials highlighting the possibility to modify anthropometric parameters of virtual shoe lasts by transforming them into linear sizes [6-14].

3. Results and discussions
As a result of the research, in Figure 1 (a, b, c, d) are images of virtual changes of the shoe last anthropometric parameter - the width of the fingers ($l_d$) and representing the section of the shoe lasts changed from the original shoe lasts, with values - ranging from 5 to 20 mm, by FEM method (Finite Element Method) in MATLAB environment [15].

![Figure 1. a – Image analysis with FEM method of the scanned and warped shoe lasts by changing the finger width of 5 mm](image1a)

![Figure 1. b – Image analysis with FEM method of the scanned and warped shoe lasts by changing the finger width of 10 mm](image1b)
Figure 1. c – Image analysis with FEM method of the scanned and warped shoe lasts by changing the finger width of 15 mm

Figure 1. d – Image analysis with FEM method of the scanned and warped shoe lasts by changing the finger width of 20 mm

In Figure 2 (a, b, c) are images of virtual changes of the shoe last anthropometric parameter - shoe lasts length (Lp), as compared to the original shoe lasts, with values ranging from 5 to 15 mm, FEM method [3], [4] in MATLAB environment [15].

Figure 2 a. Images analysis with FEM method of shoe lasts image scanning and deformed by changing the length of 5 mm
Figure 2 b. Images analysis with FEM method of shoe lasts image scanning and deformed by changing the length of 10 mm

Figure 2 c. Images analysis with FEM method of shoe lasts image scanning and deformed by changing the length of 15 mm

In Figure 3 (a, b, c, d) are images of virtual changes of the shoe last, as follows: a - geometric pattern, b - network triangulation with small number of finite elements, c - triangulation network with a number of finite thick element; d - triangulation network with a number of more often finite elements.
Figure 3 (a, b, c, d). The geometric triangulation networks and of virtual shoe lasts

In Table 1 it is show the Item type: Lagrange – Quadratic tetrahedral.

| Name of parameter            | Value     |
|------------------------------|-----------|
| Number of freedom degrees    | 39711     |
| Number of grid points        | 2014      |
| Number of domain elements    | 7991      |
| Number of boundary elements  | 2438      |
| Number of edge elements      | 238       |
| Item report / volume         | 0.0013    |

Geometric model is generated by the cloud of points and the points which are scattered were removed [1], [2]. Triangulation method increased the number of triangles (FE – finite elements) with data in Table 1 and gradual interpolations were made to reach a continuous surface needed to process of virtual shoe lasts for CAM to be physically processed on machine tool equipped with the CAM procedure by roughing with big step, then fine, and finally very fine finishing [3], [4].

4. Conclusions

Other researchers in the country are interested in mathematical modeling, to find specific equations needed to achieve shoe lasts pattern.

There is a partnership with DELCAM Crispin Shoes Design Company that can provide shoe lasts scanning and creation, and then stored in a database of different shoe lasts models [4].

The collected and stored information will have access to it and be able to develop collaboration. DELCAM Company provides post processing programs, but initially it takes 3D virtual model of the shoe lasts, which will be achieved through mathematical modeling [1].

In this paper work, the authors had attempted the development of a practical method that does not complicate the problem and allowing the development of shoe lasts without mathematics advanced knowledge of the user.

References

[1] ***www.delcam.com
[2] ***www.delcamshoes.com
[3] Moaveni S 1999 Finite element analysis, theory and application with ANSYS, Prentice Hall, New Jersey, USA
[4] Vickers G W 1999 *Numerically controlled machine tools*, University of Victoria, Canada

[5] Drişcu M and Mihai A 2008 *Proiectarea încălţăminte cu sistemul Crispin Dynamics CAD Suite - Engineer*, Editura Performantica, Iaşi, Romania

[6] Albu A, Ganea M, Bondrea I, Indrie L, Prichici M and Romocea S 2010 Processes of scanning and virtual modeling of the lasts in footwear Industry, *Annals of the Oradea University, Fascicle of Management and Technological Engineering* IX(XIX)

[7] Albu A 2009 *Virtual performing of the shoe last model able for CNC machining* Conferinţa Naţională Tehnico-Ştiinţifică (cu participare internaţională), Ediţia a VII-a "Tehnologii moderne pentru mileniul III", 5-7 noiembrie, Oradea, Romania

[8] Albu A, Ganea M, Morar M and Indrie L 2009 Possibilities of virtual solid correction in the case of shoe last by using of the antropometrical parameters, *Annals of the Oradea University, Fascicle of Management and Technological Engineering* VIII(XVIII)

[9] Albu A, Ganea M and Ungur P 2007 *Considerations about mathematical model of the spatial surface of the lasts in the shoe industry*, Simpozionul international Inter-ing-2007, Tg. Mureş, Romania, 15-16 November

[10] Cocea M 2005 A study for the mathematic modeling of 2D irregular shapes for footwear CAD system, *Buletinul Institutului Politehnic din Iaşi - Știința și Ingineria Materiaelor* LI(LV) 219-225

[11] Cocea M and Croitoru D F 2003 *Proceduri CAD destinate proiectării încălţăminte*, Editura Gh. Asachi, Iaşi, Romania

[12] Croitoru D F 1987 *Utilaje și automatizări pentru industria confecţiilor din piele*, Iaşi, Romania

[13] Drişcu M 2008 *Modelarea formelor plane şi spaţiale ale încălţăminte*, Editura Pim, Iaşi, Romania

[14] Ganea M 2010 *Mașini și echipamente tehnologice pentru prelucrarea suprafețelor în 4 și 5 axe CNC*, Editura Universității din Oradea, Romania

[15] Ganea M and Ganea C 2000 * Tehnologia prelucrării suprafețelor curbe spațiale*, Editura Universității din Oradea, Romania