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Definition of Foot Size Model using Kohonen Network

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***Abstract*—**In order to define a new model of Tunisian foot sizes and for building the most comfortable shoes, Tunisian industrialists must be able to offer for their customers products able to put on and adjust the majority of the target population concerned. Moreover, the use of models of shoes, mainly from others country, causes a mismatch between the foot and comfort of the Tunisian shoes.

But every foot is unique; these models become uncomfortable for the Tunisian foot. We have a set of measures produced from a 3D scan of the feet of a diverse population (women, men ...) and we try to analyze this data to define a model of foot specific to the Tunisian footwear design.

In this paper we propose tow new approaches to modeling a new foot sizes model. We used, indeed, the neural networks, and specially the Kohonen network.

Next, we combine neural networks with the concept of half-foot size to improve the models already found. Finally, it was necessary to compare the results obtained by applying each approach and we decide what's the best approach that give us the most model of foot improving more comfortable shoes.

***Keywords*—**Morphology of the foot, foot size, half foot size, neural network, Kohonen network, model of foot size.

I. Introduction

THE foot is the element on which the human being is based on the earth. That why it was necessary to ensure the comfort of the foot by studying the morphological and dimensional characteristics of the foot. This paper describes, on the first time, the morphology of the foot. Then it presents the implementation of our approaches. Finally, in order to evaluate the results of the proposed approaches, we select some measures to evaluate their performance and we extract some histograms based on many dimensional characteristics foot as: the length of the foot, the width of the joint, the height of Instep...

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II. Morphology of the Foot

A. Anatomy of the foot

The foot has twenty six bones, fifty-six ligaments, thirty two joints, five hundred blood vessels and five hundred nerves under the arch [1], [2].

B. Figures Morphological and dimensional characteristics of foot

The study of the foot's anatomy leads us to know the morphological parameters of the foot that will allow calculating the dimensions of interest in this work.

These dimensions are:

- *Lengths:* There are 14 foot lengths. These lengths are necessary to design a shoe.
- *Heights:* It has 10 heights. The most important heights are heights of the first metatarsal and the height at the entrance. It's one of the essential measures for the shoe design [1].
- *Widths:* There are three widths main level of the joint prior to foot, the heel and the width of the ankle.
- Angles: The angles are in number of five. They determine the overall shape of the foot.
- *Perimeters:* The number of perimeters is seven.

The Fig. 1 [4] describes some dimensions of the foot.

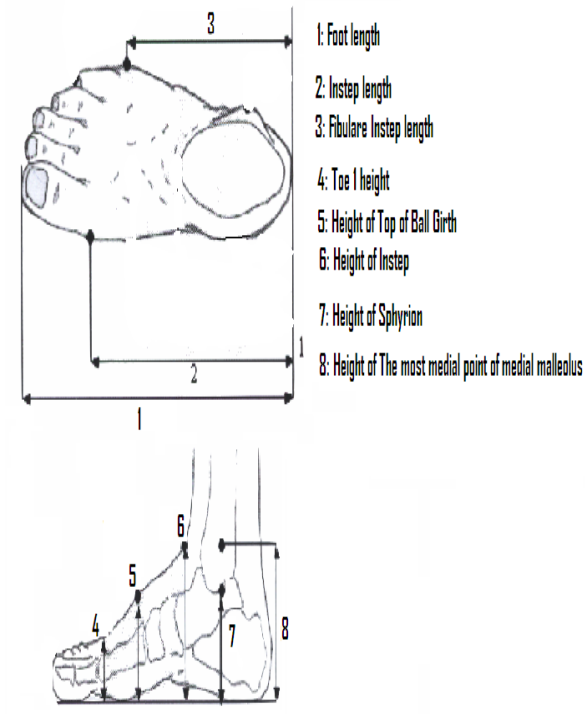


Fig. 1 Dimensions of the foot

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In order to modeling these dimensional parameters, we proposed tow neuronal approaches to define a model of Tunisian foot.

III. Proposed Approaches

Neural networks represent a modern approach used for data analysis, due to their ability to generalize and learn from the data [4], [5]. Their ability to model very different issues, complex structures, hence the idea of using neural networks in modeling the foot sizes.

From the different architectures of neural networks, we choose the self-organizing maps of Kohonen to implement our proposed approaches because the Kohonen network use an unsupervised learning, such learning is a method that does not need desired output. The network itself will categorize the input variables and produces the most satisfactory output. Our first approach to define a Tunisian foot model is Modeling the foot Sizes by Kohonen networks (MSK) and the second approach is Modeling the Half Sizes using Kohonen networks (MHSK).

IV. Modeling the Foot Size by Kohonen Network (MSK)

We choose to use the linear architecture (one dimension) of the Kohonen network: In each the number of node of the grid is 15 neurons that represent the sizes of foot (from 29 to 44 for the women and from 31 to 46 for man).

The output represents the model of the foot for each size. The main step of our approach is the learning phase. In the next section, we describe this phase (learning):

After a random initialization values of each neuron in the grid, we begin a learning cycle which described in the following:

- Present an input vector associated with a stimulus to the grid (network).
- Find the winner node K. It is the node which the associated vector is the nearest to the input vector.
- Change the weight Wik of winner node k and its neighbors. The modification of synaptic weights of the winning neuron and its neighbors is using the Kohonen learning rule as follows [4], [5]:

$$W_i(t+1) = W_i(t) + \alpha(t) * V(i,k,t) * [X_i(t) - W_i(t)] \quad (1)$$

Where: [xi (t) - wi (t)] represents the Euclidean distance between the input vector X and the output vector W at time t, α (t) is the learning coefficient and V (i, k, t) represents the neighborhood function.

At the end of algorithm, the self organizing map covers the entire topology data.

The Fig .2 shows schematically the process of Kohonen learning for our approach MSK.

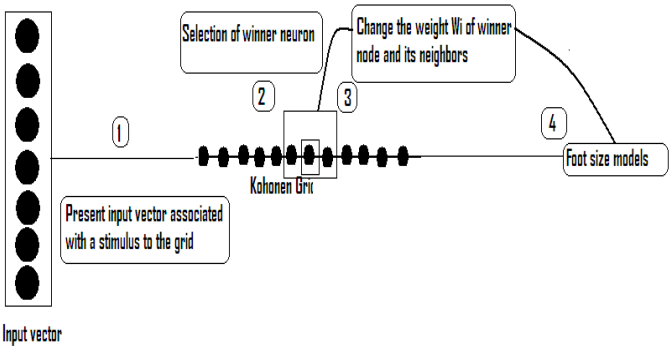


Fig. 2 Process of learning of MSK

V. Modeling the Half Size of Foot by Kohonen Network (MHSK)

To improve more comfort of foot, and design of footwear models more accurate and near to the actual dimensions of the Tunisian population, we will develop the concept of half-size, which describes the difference in length between two successive sizes.We define a new approach to model the half sizes by the Kohonen network (MHSK).The principles of operation and implementation of MHSK are the same principles of the MSK approach. The difference is in the network architecture: we don't use the linear architecture, but we use a triangular grid architecture which allows changing the neighborhood of neurons as described in Fig. 3.

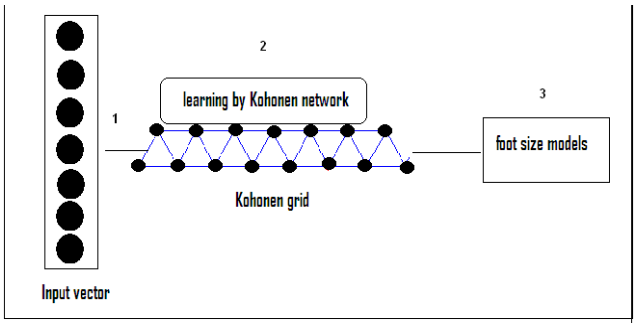


Fig. 3 Process of MHSK learning

VI. Performance Evaluation

In order to evaluate our approaches, it was necessary to measure some quality critters and compare the results obtained by applying our approaches and those obtained by the statistical method (SM) [6]: this method based on calculating the mean of all foot measures (means of lengths, heights, Widths, angles and perimeters) and give us the final foot size model. It's necessary to pointing out that any statistical analysis method presents several challenges: It is therefore, a method that is based on the calculation of averages and differences between variables.

This is an inflexible method that is not able of adapting to the new variables. This critter of quality is: the mean square error (MSE). MSE is the metric that measures the distortion in a model.

The Fig. 4 below describes the Variation of the MSE in function of foot length of women's foot size and men's foot size.

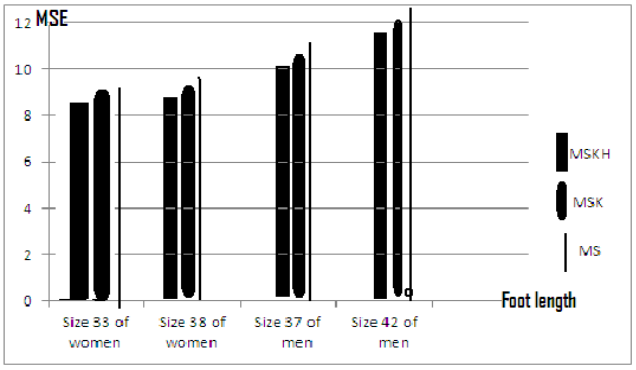


Fig. 4 Variation of the MSE in function of length of women's foot size and men's foot size

We can observe that: the MSE of the length of the foot between the methods MHSK, MSK is less than that of the statistical method. So we can see that unconventional methods based on neural networks, give results closer to the actual values recorded in the database and improve the footwear models found.

Thus, we can see that the MSE of MHSK is generally lower than those of MSK and the MS. So we can conclude that the self-organizing maps, combined with the notion of half size, can improve the modeling of foot sizes compared to methods based on neural networks only or other conventional methods such as statistical modeling.

VII. Conclusion

We detail, in this paper, the implementation of our tow proposed approaches to define a new Tunisian foot sizes model. We conclude that approaches based on hybrid systems (combining half size and neural networks) are performing very interesting especially in comparison with simple neural approaches or statistical methods. We plan, as a continuation of this work, the use of our models in the industry to improve the quality of shoes built: Tunisian industrialists can offer their customers through these models, products more comfortable and able to fit the most of the Tunisian population.

References

[1] BOUTEILLER J.M., MARCHESSOUX C, FERNANDEZ, « Comparison study between 3d modelling of human foot", 3D Human Modelling, Paris, avril 2003.
[2] MARCHESSOUX Cédric, "Système d'acquisition 3D pour le pied humain", 12 décembre 2003.
[3] THEVENET J.M. "Rêves de pompes, pompes de rêves", Janvier 1988.
[4] Teuvo Kohonen, "Self-organized formation of topologically correct feature maps. Biol". Cybernetics, volume 43.
[5] Teuvo Kohonen, "Self-Organizing Maps", Springer, Berlin, Germany
[6] Naima SANAA, Sarra TRABELSI, Nourreddine HAMDOUN, Mahmoud MANSOURI, Mohamed Elakremi BRAHMI, Amara ZADDEM, "Caractérisation de la morphologie du pied Tunisien et développement d'une technique adaptée pour la chaussure tunisienne", Juin 2008
[7] Olfa KANOUN, Mohamed Hedi KALLEL & Mohamed Salim BOUHLEL « Adaptativité du Quantificateur Vectoriel à la Compression d'Images Médicales par Réseau de Neurones » U. R. Sciences Et Technologie de l'Image et des Télécommunications (SETIT) , 2007.
[8] Kristof Van Laerhoven "Introducrtion to an artificial neural network", 2007.
[9] P.DEGOULET, M.FIESCHI, "Informatique médicale ",3éme édition, Masson », 1998.

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