Classification of Anthropometric Data using Neural Networks

Ricardo Ferreira Vieira de Castro[1,2], Pedro Henrique Gouvêa Coelho[1],
Joaquim Augusto Pinto Rodrigues[1,2] and Luiz Biondi Neto[1]
[1]*State University of Rio de Janeiro, FEN/DETEL, R. S. Francisco Xavier, 524/Sala 5006E, Maracanã, RJ, 20550-900, Brazil*
[2]*Instituto Nacional de Tecnologia - INT, Rio de Janeiro, Brazil*

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Abstract: This paper proposes the use of neural networks to help with the solution to a problem demanded by the productive sector in the manufacture of work cabinets compatible with the characteristics of a group of individuals that characterize a good sampling of the studied population. The study is intended to serve as a basis for further work aimed for good ergonomics in meeting the basic conditions necessary for the comfort and welfare of the operators of these jobs. In this investigation we used Kohonen neural networks to sort the data related to the height of the seat-eye level and length of the seat forearm-hand. The results showed that the use of this tool is effective and allows its application in studies using more anthropometric variables making possible to explore further needs.

1 INTRODUCTION

Anthropometry is the field of anthropology that studies the physical dimensions of the human body. For this reason, studies are focused on the acquisition of data related to the size, length and movements of the limbs (Ferreira, 1988). In ergonomics two types of anthropometric dimensions are found: static and dynamic. The static corresponds to physical measurements of the body at rest, while the dynamics are related to measures of body in movement. To apply the data correctly, it is important to evaluate the key influencing factors such as race, ethnicity, diet, health, physical activity, posture, body position, clothing, time of day etc. (Minetti, 2002).The anthropometric Measurements of a user serve to adapt the production means, when using any tool or instrument. Anthropometry helps to: evaluate positions and distances to the range of control devices and information and to define spaces around the body, identify objects or features that prevent or interfere with the movement. According to (Minetti ,2002) when the machinery or equipment fit properly to the body, from the point of view of dimensional errors, accidents, discomfort and fatigue, decrease significantly. Anthropometric methods are among the basic tools to work for the evaluation and project development in which the variations in size, proportions, mobility, strength and other factors that define physically human beings are considered. This paper is organized in five sections. The first section is the present introduction. The second section discusses the anthropometry. Section three describes the model used. Section four describes the method of data acquisition and shows results and discussions and the paper ends with section five depicting results and future work.

2 ANTHROPOMETRIC SURVEY

The anthropometric survey data shows the variability of the dimensions of a population, therefore measures that refer to a population in another region with different socio-economic levels, age and sex can not be taken into account (Barros, 1996). The anthropometric measures of a research are essential data bases for designing a position that satisfies ergonomically the employees because only from the dimensions of individuals is that one can define, in a rational basis, the proper sizing, both for the working machine such as the activity involved aiming basically, safety, efficiency and worker comfort. The first step is then to obtain the anthropometric measures of the operator in order to adapt the work to the operator, in order to achieve a

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correct posture, a more favorable body position and higher speed and precision of muscle movements, thereby increasing the efficiency limb movements of the operator. The dimensions of body parts vary from individual to individual, but also in the same body, throughout its life. There is no individual whose dimensions are fully harmonic, i.e. they are all components defined on average basis. Figure 1 shows one anthropometric measure being carried out.

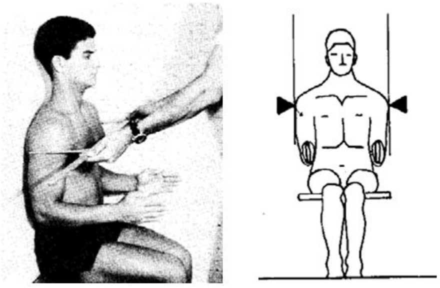


Figure 1: Horizontal distance between the top surfaces of the lateral deltoid muscles.

3 KOHONEN NEURAL NET

As for all the neural networks, the Kohonen neural networks are formed by a number of simple elements, called neurons arranged in more complex structures that work together as shown in Figure 2. Each neuron is a processing unit that receives inputs from outside world or from other neurons, and produces a response to other neurons or to the outside world. As the neurons of the brain, neural networks are interconnected by branches through which the stimuli are propagated. The learning process strengthens the links that lead the system to produce more efficient responses.

What distinguishes a Kohonen network from the others is a two layer structure in which one is its input and the other is for processing where a map is formed.

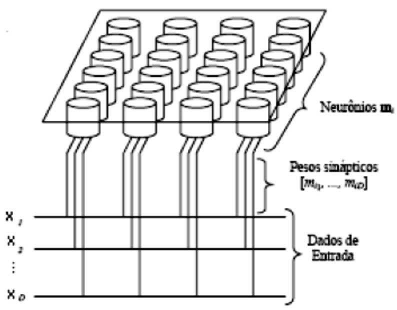


Figure 2: Kohonen Neural Network Structure.

The Kohonen feature map searches the organization of relationships between patterns. The arriving patterns are classified by the units they activate in the so called competitive layer.

Similarities between patterns are mapped in proximity relationships on the grid near the competitive layer. Once training is complete, the relationships between patterns and clusters are observed in the competitive layer.

The Kohonen network provides advantages over the classical techniques of pattern recognition because it uses the parallel architecture of a neural network and provides a graphical organization of the relationships.

4 RESULTS

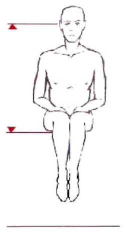
The universe of the original study consisted of a population comprised of 338 individuals 231of which was men and 107 was women where 51 anthropometric variables were taken into account for the work project and tools. All data were stored in an Excel spreadsheet that contained information for each operator. For each anthropometric measure, statistic data were extracted. Figure 3 shows an example of an anthropometric report concerning the measurement HEIGHT OF EYE LEVEL - SITTING.

The data statistical analysis was performed by using percentiles which is a separator which divides the distribution in 100 equal parts, from smallest to largest, for any specific type of body size. The percentiles used in the analysis yield the values for the studied variables of 1, 2.5, 5, 25, 50, 75, 95, 97.5 and 99.

In this research work, the MATLAB software was used including the set of routines Somtoolbox. Practical tests were performed in order to find a SOM (Self Organized Map) model to analyze the data repository. Twenty five neurons was used comprising a grid of 5x5 neurons. The input variables used were: Height of Eye Level – Sitting, and Seated Leg-Length Forearm as shown in Figure 4.

Through the application of a system based on a Kohonen Neural Network which uses a unsupervised method it was possible to make a correlation between two measurements and a representative of degree of relevance to the operation and control for work cabinet development. Figure 5 shows an example of Ergonomic Design of of Control Room where the two anthropometric measurements, object of this study, were taken into account.

In a previous study from the authors, statistical results were obtained only for each anthropometric measurement, without further identification of any



Total	Tamanho da amostra	337
Total	Tamanho da população	5523
Total	Estimativa do total	422263,69
Total	Estimativa da média	76,45
Total	Estimativa da variância	12,32
Total	Estimativa do desvio-padrão	3,51
Total	Estimativa do coeficiente de variação	4,59
Total	Mínimo observado	60,6
Total	Máximo observado	85,8
Total	Intervalo de variação observado	25,2
Total	Estimativa do percentil 1	66,91
Total	Estimativa do percentil 2,5	69,21
Total	Estimativa do percentil 5	70,73
Total	Estimativa do percentil 25	74,16
Total	Estimativa do percentil 50	76,44
Total	Estimativa do percentil 75	78,77
Total	Estimativa do percentil 95	82,35
Total	Estimativa do percentil 97,5	83,05
Total	Estimativa do percentil 99	83,65

Homem	Tamanho da amostra	231	Mulher	Tamanho da amostra	106
Homem	Tamanho da população	5100	Mulher	Tamanho da população	423
Homem	Estimativa do total	391473,02	Mulher	Estimativa do total	30790,67
Homem	Estimativa da média	76,76	Mulher	Estimativa da média	72,79
Homem	Estimativa da variância	11,4	Mulher	Estimativa da variância	9,07
Homem	Estimativa do desvio-padrão	3,38	Mulher	Estimativa do desvio-padrão	3,01
Homem	Estimativa do coeficiente de variação	4,4	Mulher	Estimativa do coeficiente de variação	4,14
Homem	Mínimo observado	66,2	Mulher	Mínimo observado	60,6
Homem	Máximo observado	85,8	Mulher	Máximo observado	79
Homem	Intervalo de variação observado	19,6	Mulher	Intervalo de variação observado	18,4
Homem	Estimativa do percentil 1	66,76	Mulher	Estimativa do percentil 1	60,9
Homem	Estimativa do percentil 2,5	69,56	Mulher	Estimativa do percentil 2,5	66,88
Homem	Estimativa do percentil 5	71,16	Mulher	Estimativa do percentil 5	67,45
Homem	Estimativa do percentil 25	74,49	Mulher	Estimativa do percentil 25	70,84
Homem	Estimativa do percentil 50	76,66	Mulher	Estimativa do percentil 50	72,62
Homem	Estimativa do percentil 75	78,93	Mulher	Estimativa do percentil 75	74,62
Homem	Estimativa do percentil 95	82,45	Mulher	Estimativa do percentil 95	77,46
Homem	Estimativa do percentil 97,5	83,13	Mulher	Estimativa do percentil 97,5	78,26
Homem	Estimativa do percentil 99	83,67	Mulher	Estimativa do percentil 99	78,67

Figure 3: Sample of a Report Concerning an Anthropometric Measurement.

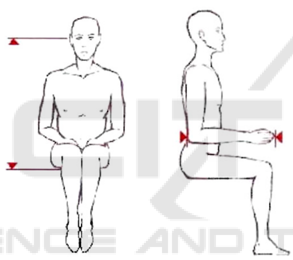


Figure 4: Height of Eye Level - Sitting / Seated Leg-Length Forearm.

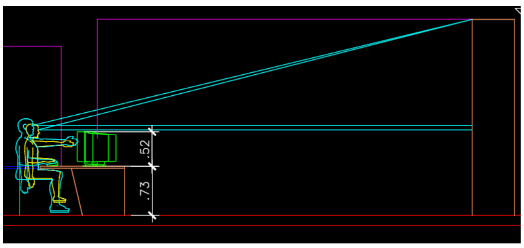


Figure 5: Ergonomic Design of a Control Room.

correlation between Height of Eye Level - Sitting and Seated Leg-Length Forearm. Using a 3 x 3 matrix Kohonen it is possible to identify groups that have similarities in the relationship between those two anthropometric measurements. Figure 8 shows the results of the SAMPLE SOM HITS algorithm applied (Kazapi, 2004).

Figure 6 shows the distribution of points in a two dimensional plane and their respective centroids in blue dots (Sewo, 2003). The plot depicts the distribution regarding the two weights along the plane after the kohonen neural network training process.

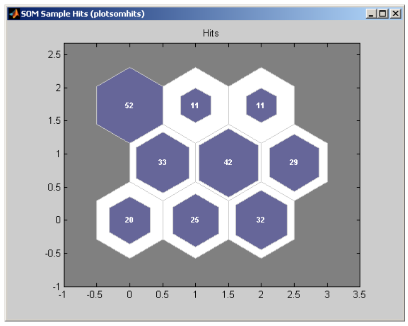


Figure 6: Results of the Sample Som Hits Algorithm.

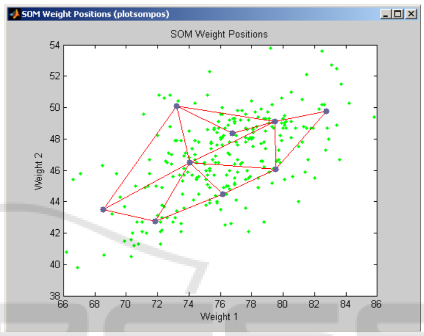


Figure 7: Som Weight Positions.

5 CONCLUSIONS

Nine groups of percentiles were used in the statistical model. To develop the mathematical model for the correlation of two anthropometric measures under study would require a certain expenditure of labor devoted to this task. The work presented here explores the use of categories for classifying patterns that in our study is very important to identify the groups that have similarities in content between anthropometric measures dedicated to this study. The results here shown are preliminary and for the completion of the research a large data base would be needed. The current results indicate the research seems to be in the right direction.

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