Chapter 89
Modeling the Risk Factors in Ergonomic Processes Using Fuzzy Logic

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Abstract This paper presents an approach to minimize the risk for transforming measured body data between various postures. In this research the measured human body is substituted by a proper set of critical points using fuzzy logic. They are used as a basis of transforming the data, and they are required to describe specific body postures. Artificial neural networks have been applied to the actual conversion of data. The input is a set of demographic data and the coordinates of the critical points characterizing a given posture.

Keywords Ergonomics · Fuzzy logics (FL) · Body postures

89.1 Introduction

Engineers and ergonomists are keen to exploit the potential of the three dimensional (3D) anthropometric technologies. The 3D measurements are more deployable and provide a more elaborated micro level description of the human

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bodies in comparison with the traditional manual 1 or 2D data processing. In many industrial design cases, there is a need to take into consideration various postures of the human body when the product is designed. This paper presents an approach to minimize the risk for transforming measured body data between various postures. In this research the measured human body is substituted by a proper set of critical points using fuzzy logic. They are used as a basis of transforming the data, and they are required to describe specific body postures. Artificial neural networks have been applied to the actual conversion of data. The input is a set of demographic data and the coordinates of the critical points characterizing a given posture.

The rest of the paper has been organized as follows:

Section 89.2 presents overview of the similar work.

Section 89.3 describes mathematical formation of ergonomics process, followed by sect. 89.4 which processes an algorithm to evaluate the demographic data feed into the model.

Section 89.5 finally presents scope of work and conclusion.

89.2 Literature Survey

Recently there are substantial numbers of research breakthroughs in ergonomic modeling. The problem of sharing and reusing information in the lifecycle (LC): from design, manufacturing to operation, maintenance and recycling have been directed through perfect ergonomics modelling [3]. The results reported in those publications have been obtained in the European research project ManuVAR (211548)—Manual Work Support throughout System Lifecycle by Exploiting Virtual and augmented Reality (VR/AR) [1].

In many fields of science, including biology, psychology, and so on, human observers have provided linguistic descriptions and explanations of various systems. However, to study these phenomena in a systematic manner, there is a need to construct a suitable mathematical model, a process that usually requires subtle mathematical understanding. Fuzzy modeling is a simple, direct, and natural approach for transforming the linguistic description to a mathematical model [4]. Considering this line of research, ergonomics interventions often focus on reducing exposure in those parts of the job having the highest exposure levels, while leaving other parts unattended. A successful Intervention will thus change the form of the job exposure distribution. This disqualifies standard methods for assessing the ability of various exposure measurement strategies to correctly detect an intervention's effect on the overall job exposure of an individual worker, in particular for the safety or ergonomics practitioner who with limited resources can only collect a few measurements [5].

89.3 Mathematical Proposition

Fuzzy Logics (FL) provides an appropriate logical mathematical framework to handle problems with such characteristics, since [6]:

deals with uncertainty and imprecision of reasoning processes;
allows the modelling of the heuristic knowledge (that cannot be described by traditional mathematical equations); and

Allows the computation of linguistic information.

The basic fuzzy linguistic to formulate fuzzy model can be shown in following scheme: Fig. 89.1

Hence, the particular ergonomic modelling for assessing the risk and uncertainty has been accomplished through fuzzy logic [7]. In this chapter, we consider

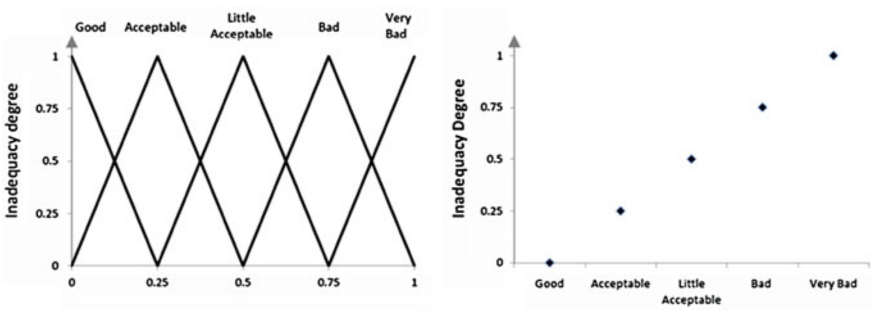
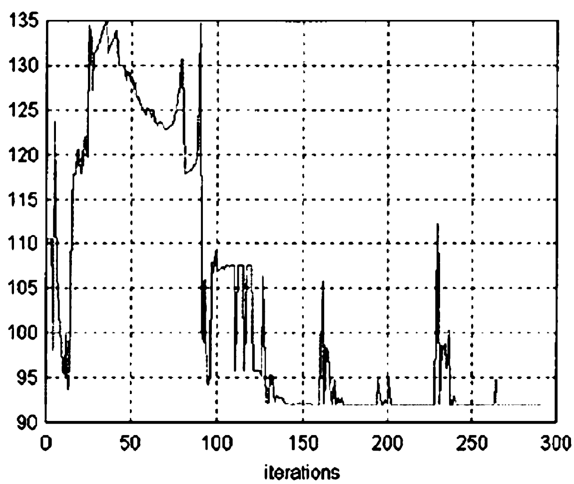


Fig. 89.1 Fuzzy linguistic componenets

Fig. 89.2 Different Iterations during working movements

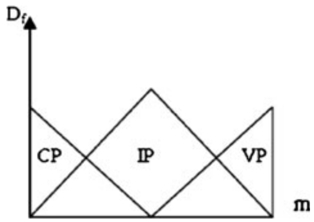


the basic formulation of fuzzy to keep track the different risk evaluation ergonomic movement.

$$G = \textit{the sum of } (\mu_i * \beta_i) / \textit{the sum of } (\mu_i)$$

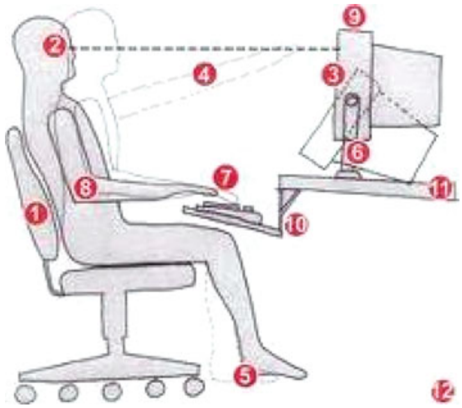
where : 1<= i <= m, m : number of rule, B: centroid of the backend membership function correspond for each rule. μ: factor of membership correspond for each rule. This intelligent task uses the fuzzy linguistic terms and calculates for each degree of membership functions under expertise of an expert system (ES). An ES is a computer program that functions, is in a narrow domain, dealing with specialized knowledge, generally possessed by human experts. Fig. 89.2

89.4 Proposed Algorithm




```
Begin
    Start set up environment for postures/* Point 1
Fig. 89.3*/
    Initialization
Move
   IF {the movement is Recorded} DO End task
                ELSE
Begin
L1:If {the 1st Posture is detected?} DO
     Begin
        Change the direction.
            Move
               Free ()
            is attended.
     End task.
     Else Goto L1.
   End.
End
```

Fig. 89.3 Courtesy: http://www.armannd.com/



89.4.1 Data Set and Analysis

The developed model focused on in simple office environment, and identified a total of certain primary risk associated with task. Using the proposed algorithm, the different crtical ergonomic points in a posture has been evaluated (shown in red marks)

Risk factor category	Relative weight	Work iterations	Instances o fuzzy	Membership value
Task	w1 = 0.2657	x1:	Total typing hours (per day)	(0.231,0)
		x2:	Typing speed	(0.144,0)
		x3:	Continuous typing time	(−0.078,0)
		x4:	Hand temperature	(0.039,0.298)
		x5:	Comfortability of	(−0.133,0.044)
		x6:	workstation	(−0.152,0.115)
		x7:	Work surface hardness	(0.059,0)
		x8:	Hand rest time	(−0.007,0)
		x9:	Rating of perceived exertion	(−0.001,0)
			Working under pressure	(0.051,0)

89.5 Conclusion

The paper elaborates the risk in ergonomics movement during office environment using fuzzy logic as a primary tool. The data set adopts different linguistic attribute to evaluate the de-fuzzified results.

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