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WEAR PREDICTION OF THE EQUIPMENTS USING THE FUZZY APPROACH

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Abstract. The wear of an equipment is one of the main factors that influence its capacity to perform the specified functions. An equipment goes from the state of function to the failure through several intermediary states, characterized by certain levels of performance. Consequently, the the fuzzy set theory is proposed to predict the wear of equipments. For this purpose, the fuzzy techniques for the identication of wear of equipments are presented. A case study of the cold plastic deformation tools wear prediction demonstrates the efficiency of the approach.

1. INTRODUCTION

The reliability modeling of technical systems is based on the notion of failure, when at least one of the system performance transgresses its prescriebed limits. This definition of failure assumes the knowledge of relevant system performances as well as of their tolerance limits. If it is dificult to specify this information, the notion of failure can be represented in terms of fuzzy sets and used in system failure engineering [4].

In the case of equipments, wear is one of the main causes of their failure, so that is very important to be estimated [2]. However, the estimation of the equiment's wear is difficult, since its mechanisms are based on physical and chemical processes, which are not governed by deterministic laws. In such situations, theory of fuzzy sets is one of the most used in describing the behavior of equipments.

Several case studies are available in the literature on this subject and they clearly demonstrate the importance of fuzzy approach in addressing how to deal uncertainty in the area of equipments. In [3], Fonseca&Knapp present a fuzzy reasoning algorithm for failure mode screening. Other author used fuzzy to represent machine condition [5].

The aim of this paper is to present the use of the fuzzy techniques identify the wear of equipment.

2. FUZZY SYSTEMS

The system performances, taking into account the wear of this system , consider that this systems have two stages: stage of good function ans stage of failure. The transition between these stages is achieved by serval intermediate stages, which are characterized by certain levels of performances.

The fuzzy theory of system [3,4,6] studies systems with multiple stages and presents a flexible mathematical alghoritm which allows the choosing of decisions on the base of models developed by this theory.

We shall present the basic structure of a fuzzy systems. The fuzzy systems function on the following principle (figure 1):

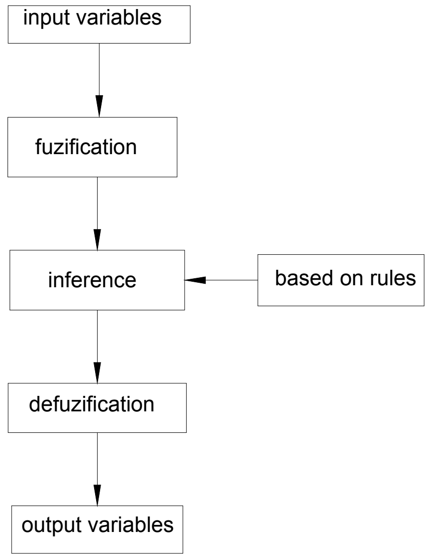

Figure 1. Structure of fuzzy systems

A fuzzy system is based on rules, obtained by the observation of experimental behavior of real system, applied to the linguistic variables [6].

3. CASE STUDY

The manufacturing of piece by a stamp is considered. As the input linguistic variables the rouhness surface of the pieces and burr of the surface are defined. The input variable rouhness is defined in the field of 0.05-0.1 mm and the input variable burr of the surface in the field 1.6-3.2 μm. The output variable is force of stamp and she has values in 64.8-77.28 kN. The values of linguistic variables are presented in table 1.

Table 1 The values of linguistic variables

Variable	Type	Values of the linguistic variables
Rouhness	Input	Rvsmall, Rsmall,Rmedium, Rbig,Rvbig
Burr	Input	Bvsmall, Bsmall,Bmedium, Bbig,Bvbig
Force	Output	Fvsmall, Fsmall,Fmedium, Fbig,Fvbig

The fuzzification is achieved by the affiliation function and the defuzzification will be performed by the weight center method. The Mamdani implication will be used and the rules connectivity will be performed by MAX. The inteference rules are presented in table 2.

Table 2 The inference rules

Force [kN]		Rouhness [μm]				
		Rvsmall	Rsmall	Rmedium	Rbig	Rvbig
Burr [mm]	Bvsmall	Fvsmall	Fvsmall	Fsmall	Fmedium	Fmedium
	Bsmall	Fvsmall	Fsmall	Fsmall	Fmedium	Fmedium
	Bmedium	Fsmall	Fsmall	Fmedium	Fbig	Fbig
	Bbig	Fmedium	Fmedium	Fbig	Fbig	Fvbig
	Bvbig	Fmedium	Fmedium	Fbig	Fvbig	Fvbig

In the figure 2, the input-output graphics for the fuzzy inference system is shown.

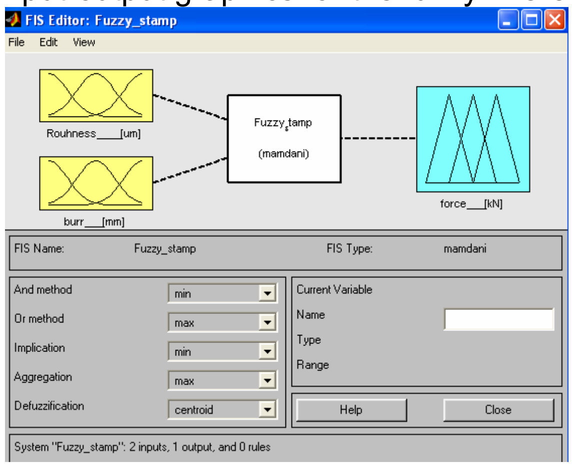

Figure 2. The input-output graphics for the fuzzy inference system

Using the Matlab software, the representation of reference rules (figure 3) and graphical representation of the output-input variables were performed (figure 4).

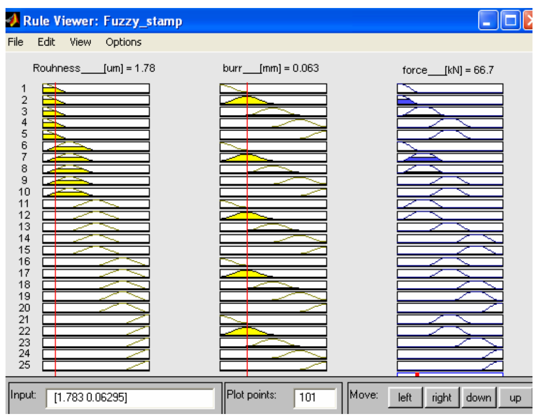

Figure 3. Representation of references rules

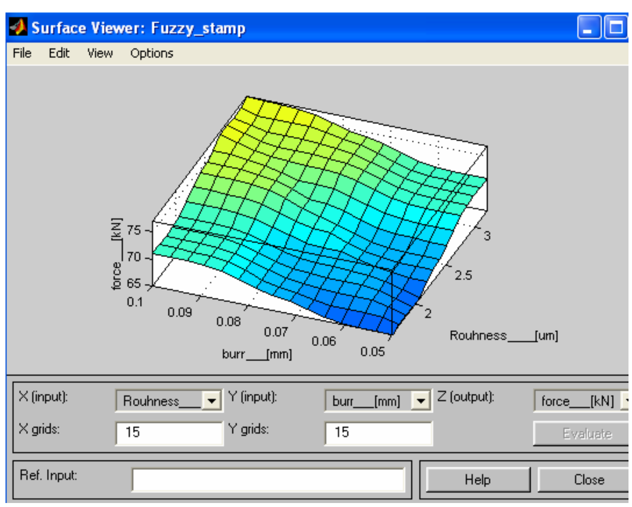

Figure 4. Output-input variables representation

In order to shown how the problems is solved, in figure 4 the input variable rouhness was selected 1.78 μm and the input variable burr was selected at 0.63 mm. The output value force was obtained as 66.7 kN, which lead to a small value of the force, so that quality piece is good and the active elements of the stamp don't need to be reconditioned.

4. CONCLUSIONS

The fuzzy systems are powerful tools in the wear establishing of the active elements of the equipments used in coold plastic deformation process. Using simple mathematical methods, a model is obtained. The flexibility of the model allows the choosing of decisions when the wear occurs.

5. REFERENCES

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