APPLICATION D'UNE MÉTHODE DE CLASSEMENT PAR LA LOGIQUE FLOUE À LA CONCEPTION PRELIMINARIE DE MÉCANISMES

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1 - INTRODUCTION

About fuzzy logic

- Considerable growth in various domains
- Still underestimated in mechanical engineering

Our work

- Integration of fuzzy logic in a general mechanical design system

2 - NATURE OF THE PROBLEM

Purpose:

- Improving our existing general mechanical design method
- Use of fuzzy logic

The proposed method provides a list of mechanical solutions which comply with given specifications.

A 3 step method (Fig. 1):

1. Scanning of the mechanical solution domain
2. Elimination of candidates which do not meet the design rules
3. Sorting of the remaining candidates by preference order

3 - FUZZY ALGORITHM

Good:

- Calculating the fuzzy comparison matrix is easy to implement in a "fuzzy sorting" method for step 3.

Example:

- Two mechanical solutions A and B must be compared (Table 3)

- Each one made of two stages (respectively: A1; A2; B1; B2)

- Each stage is evaluated according to two criteria (criterion C1 and C2).

- Five quality classes are used, each one being defined by a triangular shape membership function (Fig. 4).

- The number of quality classes might be increased for bigger problems.

4 - FUZZY COMPARISON PRINCIPLE

Comparison between two solutions A and B is done through the following steps:

1. Each solution is evaluated according to each criterion.
2. Then solutions are compared by criterion.
3. Finally, all the comparisons are raised up in a global comparison meaning.

5 - PHASE 1 : Evaluation of each solution according to a criterion

Quality evaluation of the constitutive stages of solution A according to criterion C1 (Tab. 4). We then use Mandani definition [FOU94] for the AND connector.

We next compare each degree of comparison A to B which is a triangle, in Tab. 5.

The membership functions of the goals are calculated (Fig. 4).

6 - PHASE 2 : Comparison of the solutions for each criterion

Five degrees of comparison between solutions are defined (Tab. 6).

The existing ordering method = classical multi-criterion ordering method (Fig. 2).

As for the quality of the resulting set (that is to say the good ordering of solutions, see Table 7) it is similar in both cases.

7 - PHASE 3 : Final comparison

Combining the various comparisons (one per criterion) in a unique one:

Reasoning: "If there is superiority according to C1 and inferiority according to C2 then there is equivalence". This can be translated into:

\[ \text{If } (B > A) \text{ and } (A < B) \text{ then } (B = A) \]

Thus, for instance, we can see from Table 11 that there is a 63% probability that B is superior to A according to C1 and 76% according to C2.

8 - COMPARATIVE EXAMPLE

Comparison between the traditional ordering method with a fuzzy version:

As we did not want to bias the subtle distinctions contained in the expert database, we chose to use a seven quality degree representation (instead of five for the examples). Of course, the choice leans to a heavier computational load.

9 - CONCLUSION

Undeniably, fuzzy logic suits perfectly the representation of qualitative information, such as those used at the beginning of a design process. The fuzzy algorithm previously described gives correct results, similar to those obtained with the traditional method. It is more satisfactory for representing expert knowledge and to fit well to ordinary human expression.

However, these qualities are obtained at the cost of heavier computations.

References


Fig. 1

Fig. 2

Fig. 4

Table 3

Table 9

Table 11