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The establishment of machinery product design platform based on case-based reasoning

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ABSTRACT

For Artificial Intelligence (AI) with the development of modern science and technology, mechanical product design has become a major object of study scholars. This article is the research (CBR) approach to reasoning: first forming machinery products categories namely functional parameters, size parameters, create an instance of the database for storage. Then according to the design of the user associated with gray requests to search similar instances in the instance matching library, find a few examples of high similarity. Then use the modified immune genetic algorithm instance, improving t he similarity similar instances, close to the ideal product design to user needs. The obtained results are stored in the instance of the library, expand the instance library. Finally, an example of CNC machine tool spindle design platform established, indicating the effectiveness of case-based reasoning approach.

Keywords: Examples of reasoning; gray correlation; genetic algorithm

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INTRODUCTION

As in recent years the prevalence of knowledge product conceptual design, design for mechanical products is paid more and more attention, in which case based reasoning (Case Based Reasoning, CBR) a design inference algorithm is developed, its principle is to design a successful example of creating the instance base as the basis for reasoning by analogy,, examples from many successful examples of selection and the current user input for the most similar to the selected examples, and can not meet the requirements of case parameters are modified, eventually formed a new design products and stored in the case base. The key problem is the success of the past practice example and experience to solve new problems, which directly design examples by using the old reasoning, thus greatly reducing the workload of acquiring knowledge.

1. Overview and analysis of case reasoning

1.1 Composition of case-based reasoning

A CBR system consists of case base, case retrieval, case modification, matching instance storage four core system, as shown in fig 1.1:

Successful example of storage application in the library, provide problem solving a series of similar examples, is a system for the past experience of new issues summary. According to the customer the description of the problem, the system according to the similarity matching mechanism to search several examples similar to the current problems from the case base of grey correlation, if the instance retrieval to meet the needs of customers directly output the results, or according to the description of system problems of the application of case modification based on genetic algorithm, modified to meet the problem described answers to the retrieval results, and the modified results as a new instance in the case base is expanded in a case library.

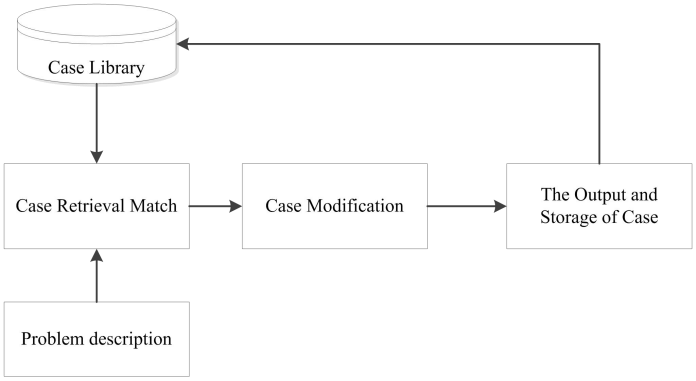


Fig 1.1 The structure of CBR system

1.2 Establishing case base

Case library directly affects the instance seized by matching and efficiency, so creating method in case based reasoning in the case library has become the key and precondition of study. We use the extension method is used to divide the instance, the instance name is M, the feature name is a and three tuple values about M, a, b as shown in formula (1):

$$Q = (M, a, b) \quad (1)$$

Q is the matter element. Because one thing may have multiple characteristics, The case of M have some features like $a_1, a_2, \ldots, a_n$ and The number of the corresponding value is $b_1, b_2, \ldots, b_n$, the multidimensional matter element can be expressed as:

$$Q = \begin{pmatrix} M & a_1 \cdots a_n \\ & b_1 \cdots b_n \end{pmatrix} \quad (2)$$

The spindle as an example we built two databases (1) such as various physical characteristics of spindle and parameters: rotation accuracy, speed etc. (2) the important dimensions and parameters of each spindle has.

1.3 The case retrieval match

The case retrieval matching is described according to the given problem, and use effective search algorithm, the search from the instance database to similar examples. In this platform, the spindle as an example according to the physical characteristics use grey correlation search the most similar case what the users to describe. Retrieval have two aspects (1) To determine the weight. (2) The computation of similarity.

1.3.1 To determine the weight

Because the degree of mechanical products of various parts of different we use weights to distinguish between primary and secondary parts before, the platform adopts variation coefficient method to calculate the corresponding weights of each physical characteristics. The basic procedure of this method is: in the evaluation of the corresponding parts in the system, the greater the difference between the parameters of the parts, it is more difficult to implement parts, so evaluation can reflect the differences of the evaluated object.

1.3.2 The computation of similarity

(1) Normalization

A case feature attribute different numerical has different dimensions, namely, the corresponding number level will vary greatly, for the convenience of calculation, need to be normalized. Specific approach is parametric attributes corresponding to the 0.001 orders of magnitude of *1000, while the 1000 orders of magnitude in *0.001. Through the processing method of the reasonable choice of the dimension above, so that different feature vectors have the same order of magnitude.

(2) Calculation of gray similarity matrix

(3) Grey distance calculation problems in each instance parameters and question

(4) In n-dimensional space, according to the Euclidean distance formula, get the gray distance

(5) In the whole n-dimensional index spaces composite gray similarity problems and examples

By the above steps can be matched to retrieve other dimension parameters of several similar examples and similarity while the output of each instance of the corresponding.

1.4 Modification of case

Search out the similar case can not ensure that each part to meet customer requirements, so we get the similarity examples and give users the principle problem using genetic algorithm modification of case. Modify the steps are as follows:

(1) Select the first four similar examples as the initial population
(2) Choice: The roulette wheel selection
(3) Cross: By using the convex combination of crossover operator
(4) Mutation: Examples of parameters and corresponding adjacent divide two
(5) End condition: Genetic algebra with 100, is the end, not to the (2)

1.5 Examples of storage

After that, we will meet the instance of user requirements for storage, added to the case base for the next call. Storage mode is still in accordance with the case library created division for example.

2 CNC machine tool spindle design case reasoning

Spindle design is an important part of NC machine tool design , selection directly affects the working efficiency of NC machine tool. The relevant parameters related to it are rotary accuracy, speed, power and so on. Case based reasoning method using the successful experience and examples of the design process so as to improve the efficiency of product design based on.

2.1 Create the CNC machine tool spindle case library

In this paper, the CNC machine tool spindle case base is divided into two parts: The main function of case library (Principal_Fuction) and Parameters of case library (Principal_Size) as shown in Fig:2.1 and 2.2

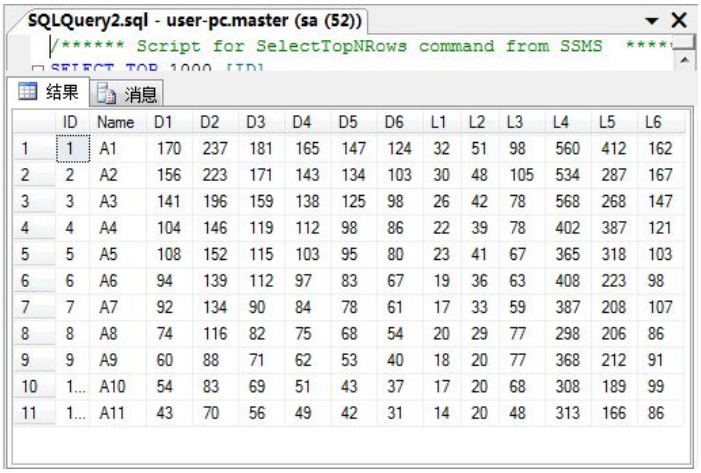
SQLQuery1.sql - user-pc.master (sa (52))

```
/****** Script for SelectTopNRows command from SSMS  ******/
SELECT TOP 1000 [ID]
```

结果 消息

	ID	Name	Accuracy	Speed	Power	Average	InnerDiameter	Overhang	Span
1	1	A1	0.005	2000	32	171	93	83	872
2	2	A2	0.003	2500	27.5	156	78	78	821
3	3	A3	0.0025	2000	23.5	142	70	68	836
4	4	A4	0.003	3000	20.5	112	51	61	789
5	5	A5	0.002	4000	17.6	108	55	63	683
6	6	A6	0.015	3000	13.6	98	44	55	631
7	7	A7	0.001	4500	8.5	89	35	50	595
8	8	A8	0.001	5000	6.7	78	33	49	504
9	9	A9	0.002	6000	5.8	62	26	38	580
10	10	A10	0.0005	8000	3.7	56	23	37	497
11	11	A11	0.002	5000	2.2	48	19	34	480

Fig 2.1 The main function of case library


SQLQuery2.sql - user-pc.master (sa (52))

/****** Script for SelectTopNRows command from SSMS ******/

SELECT TOP 1000 [ID]

结果 消息

	ID	Name	D1	D2	D3	D4	D5	D6	L1	L2	L3	L4	L5	L6
1	1	A1	170	237	181	165	147	124	32	51	98	560	412	162
2	2	A2	156	223	171	143	134	103	30	48	105	534	287	167
3	3	A3	141	196	159	138	125	98	26	42	78	568	268	147
4	4	A4	104	146	119	112	98	86	22	39	78	402	387	121
5	5	A5	108	152	115	103	95	80	23	41	67	365	318	103
6	6	A6	94	139	112	97	83	67	19	36	63	408	223	98
7	7	A7	92	134	90	84	78	61	17	33	59	387	208	107
8	8	A8	74	116	82	75	68	54	20	29	77	298	206	86
9	9	A9	60	88	71	62	53	40	18	20	77	368	212	91
10	1...	A10	54	83	69	51	43	37	17	20	68	308	189	99
11	1...	A11	43	70	56	49	42	31	14	20	48	313	166	86

Fig 2.2 Parameters of case library

The numbered instance name is A_1、A_2、A_3、…、A_{11} .Function parameters corresponding name is rotary precision （ Accuracy ） , speed （ Speed ） , power （ Power ） , average diameter （ Average ） , bore diameter （InnerDiameter）.

2.2 Examples of CNC machine tool spindle retrieval

CNC machine tool spindle design based on case based reasoning .First It needs according to the user input parameters and the corresponding weight value(or the system by default values) as shown in fig 2.3 the case based reasoning interface.

Fig 2.3 the case based reasoning interface

The system uses the default value, when the user input parameters and click the search program as shown in fig 2.4:

Fig 2.4 case retrieval results

As shown in search of similarity of each instance of the corresponding, click each instance will show the selection function and the parameters of the corresponding examples of user-friendly.

2.3 Examples of CNC machine tool spindle modification

According to the instance store user input and case base of comparison will find the difference, which is similar to the example will not meet the needs of users and unreasonable parameters, so the system must be further examples of modified operation. As show in fig 2.5:

The modified instance similarity increased to 0.989, in fact, size parameters, use the matching the most similar case from the case that the parameters of the A2.

2.4 Storage of NC machine tool spindle examples

Modified instance to meet customer demand, fill in the instance name and then click "save examples", a new instance will have saved to expand and enrich the case base capacity, product design to facilitate in the next.

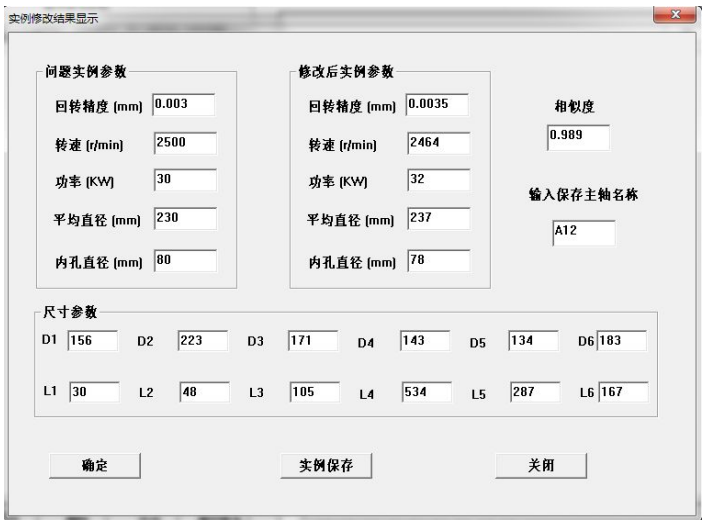


Fig 2.5 case modification

CONCLUSION

In this paper, based on artificial intelligence (AI) design and development needs, and understanding the design of mechanical products, the case-based reasoning (CBR) with the principle and the process, proposed the extension matter-element detailed division of case combining the modified of basing on genetic algorithm with grey correlation matching search. Firstly, successful examples of existing are divided and stored in case base, the design

of user requirements by case-based reasoning matching search to find similar examples, and then to the search does not meet the design requirements of similar cases modification of case, finally, it will be modified with examples of storage. In this paper, through the establishment of CNC lathe spindle design platform to verify the case based reasoning algorithm is effective and practical.

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REFERENCES

[1] Lili Cheng. Research and application of case based reasoning technology and design concept of complex mechanical products . *Nanjing University of Aeronautics & Astronautics,* **2011**.
[2] Jiahong Zheng, Wenju Guo. *Mechanical design and manufacturing*, **2009,** 3: 257-260.
[3] Shisheng Zhong,Tichun Wang,Gang Ding,Lingfeng Bu. *Computer inheritance manufacturing system*, **2008,** 10: 1905-1912.
[4] Tichun Wang, Design of large hydraulic turbine scheme of knowledge reuse technology and its application. *Harbin Institute of Technology*. **2009**.
[5] Dang Luo, Sifeng Liu. *China Management Science* . **2005,** 1:101-106.
[6]Yan Zhang, Shisheng Zhong, Jiang Li. *Journal of Jilin University* . **2009,** 39(2):424-429.
[7] Xiaohui Li, Yanxiu Liu. *Journal of Changchun University* **2006,** .4:68-70.
[8] Ganqing Zhang, Xiansheng Gong. *Journal of Central South University* . **2011,** 42(11):3359-3369.
[9] Guanwei Zhang，Yanshen Xu. *Mechanical design*. **2000,** 5:24-28.
[10] Xin Zhou, Xijuan Liu, Tingxiu Zhong. *Mechanical design*, **2001,** 5:10-19.
[11] Quan Mao, Renbin Xiu. *Research and development of Compute*, **1997,** 34(4):257-263.