Patent Evaluation Technology used in Automobile Steering Product Development

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Abstract

Automobile steering product development is based on the research basis. By using the existing patent technology as an example is one of the effective ways to realize rapid product development. In this article, through similarity algorithm, the patent technology of car steering screening was selected, and then through the Analytic Hierarchy Process, the patent technology was analyzed to find the most suitable product development, and examples for the development of automobile steering products were provided.

Keywords: Automobile steering; Similarity; Analytic hierarchy process; Patent evaluation

1. Introduction

Automobile steering product development is based on the preliminary studies, and it uses the existing technology for development, which is one of the effective ways to modification and innovate on the basis of instances. Patent technology is the innovation achievement of enterprise technology, as in order to solve technical problems in new product development, it provide effective protection for product development research and technology development. In order to quickly solve the technical problems and also to ensure the product development effectiveness and efficiency, in this article, we select the patented technology instance in the development of automotive steering products, and first select patent related to the development technology from the steering patented technology, then filter out the most suitable product development patent as an example, providing a technical reference for product development.

2. The Preliminary Screening of Automobile Steering Device Patent Technology
2.1. Entity Similarity Factor

Entity similarity factors of auto parts product development projects for the technology and the patent technology is based on the similarity between two parallels exist between them, The similar factor is that two or more entities exist among the common attributes or characteristics. There are numerical differences and these shared attributes and characteristics are known as similar attributes or similar features, all called similar elements. Patent technology preliminary screening aims at identify the similar elements between the two entities. Based on the new product development project, this essay makes a preliminary screening of patent technology by similarity calculation means.

2.2. Similarity Calculation Method
(1) Feature attributes assignment

One case is made up of some feature attributes, a clear similarity calculation method must be decided before the calculation of similarity; Feature similarity refers to the similarity degree between two examples, features, its range from 0 to 1. 0 represents a completely difference, while 1 says a fully consistence. Feature similarity calculation consists numeric, text and so on. Some case feature similarity can be represented quantitatively while the others can not, they can only be described qualitatively. Take the load characteristics as an example, the

load instability characteristics can be considered as constant quantification. If the value of vibration is 1, the value of uniform and stable is 0. According to the smooth degree of actual load, select value between 0-1 to express [1-4].

The expression of quantitative feature assignment has the following method:

$$p_{mn} = \frac{f_{mn} - \min f_n}{\max f_n - \min f_n} \tag{1}$$

In which p_{mn} represents the number n the attribute assignment in the number m example, f_{mn} says the value of the attribute, $\min f_n$ expresses the minimum value and $\max f_n$ means the maximum value.

(2) Instance similarity calculation

Common instance retrieval algorithm has the nearest neighbor strategy, TC similar method, inductive reasoning strategy, intellectual guidance strategies and template retrieval strategy, etc. This article selects the nearest neighbor strategy as similarity retrieval algorithm.

According to the feature attribute assignment algorithm, first calculated each instances' attribute similarity value. The nth attribute similarity of m instance is expressed as P_{mn}, and it stored in the database. According to the users' demand, corresponding to the nth attribute similarity the value is p_n, then the distance between the two is:

$$d_{mn} = |p_n - p_{mn}| \tag{2}$$

The entirety distance between two instances is:

$$d_m = \sum d_{mn} \times w_n \tag{3}$$

The w_n means the nth the weights of attributes value

The similarity between the design problems and cases of m is

$$\eta_m = 1 - d_m \tag{4}$$

Take steering design for example. Steering design requirements and the instance attributes is listed below.

Table 1. Steering design requirements and the instance attributes

Design attributes	Value range	Product development project attribute value	The project instance attribute value
Input power（kw）	0-20	14	15
Input torque（N*m）	0-200	120	120
Center distance（mm）	0-200	100	110
ratio	1-11	2	2.5
Accuracy grade	0-10	7	5
life（h）	0-30000	25000	25000
Profile shape	（Available options）	Involutes	Involutes
Load characteristics	（Available options）	Slight vibration	Slight vibration

According to the above design requirements and the initial value of project example, according to the characteristic value assignment rules, it can be used to solve the

corresponding feature attribute similarity value, at the same time define each design attributes' weight, the result in listed below:

Table 2. Each design attributes' weight

Design attribute assignment	weight	Product development project attribute value	The project instance attribute value
Input power（kw）	0.1	0.7	0.75
Input torque（N*m）	0.2	0.6	0.6
Center distance（mm）	0.1	0.5	0.55
ratio	0.2	0.1	0.15
Accuracy grade	0.1	0.7	0.5
life（h）	0.1	0.83	0.83
Profile shape	0.1	0.67	0.67
Load characteristics	0.1	0.67	0.67

The valuation of the shape of the tooth profile is Setted as 0.67, and the stationary vibration of load characteristic is 0.67. According to the formula, the whole distance of examples is:

$$d=0.1\times|0.7-0.75|+0.2\times|0.6-0.6|+0.1\times|0.5-0.55|+0.2\times|0.1-0.15|+0.1\times|0.7-0.5|+0.1\times|0.83-0.83|+0.1\times|0.67-0.67|+0.1\times|0.67-0.67|=0.04$$

For the design requirements and similarity of project instance is:

$$\eta = 1 - d = 1-0.04=0.96$$

The case is the target instance.

Through the above patent technology and new product development project similarity calculation, screen out the patent technology set that can meet certain requirements, the next step is concentrated os the selection of the optimal one in the patent technology .

3. The Optimal Selection of Steering Patent Technology

In the preliminary screening of patent technology based on the results, how to determine the optimal technology is the key to reuse the patent technology. This article adopts the analytic hierarchy process method for optimal selection of patent technology.

3.1. The Analytic Hierarchy Process Related Concepts

Analytic hierarchy process, it is to point at a complicated multi-objective decision system, making decision of problems into different levels according to the general goals, the son goals, attribute, and the son attribute, plan, the son plan , thus to build up a hierarchical analysis structure model, and then use these to judge matrix calculation of each level based on various attributes's relative weight. The weighted method hierarchical merging, in order to determine the scheme of the total target based the relative weight, so as to determine the order of examples [5-7].

The analytic hierarchy process procedure is as follows:

(1) Define the problem, determine the needs to complete the goal.

(2) From the top (target layer), through the middle layer (criteria) to the lowest layer (scheme layer) constitute a hierarchical structure model.

(3) Structure of a series of each factor to the lower on a layer of criterion. Comparative judgment matrix, and complete the judgment.

(4) Calculation of the biggest characteristic value of judgment matrix, consistency index. If the consistency is unreasonable, make some adjustment.

(5) Level synthesis calculation and calculating results.

3.2. The Optimal Selection of Automobile Steering Patented Technology

Establishment 3 patent technologies s1 s2 s3 that meet similarity requirements after the preliminary selection of the patent technology in setting a product development project , but

what is the most suitable for the product development project patent technology has not been determined. This article uses analytic hierarchy process to select.

3.2.1. Analysis of Problems

The purpose of the hierarchical analysis is the selection of the optimum patent technology through the analysis. The major factors in the investigation of patent technology selection is technology circumvent conditions, patent technology used conditions and the basic requirement of patent technology. The technology circumvent conditions mainly inspects the patent protection condition, technology repeatability and the failure possibility of technology protection; Patent technology mainly uses conditions include technical team condition , hardware facilities condition, capital input conditions, implementation period[8-9]. As is shown in table 3.

Table 3. Evaluation index of the selection of the optimum patent technology

aim	Evaluative aspect	evaluation index
Select the most suitable patent technology A	technology circumvent conditions B1	patent protection condition C1 technology repeatability C2 the failure possibility of technology protection C3
	patent technology reuse conditions B2	technology intended effect C4 technology implementation C5 technology modifiability C6
	the basic requirement of patent technology using conditions. B3	technical team condition C7 hardware facilities condition C8 capital input conditions C9 implementation period C10

Attention:
(1) The technology circumvent conditions B1 refers to the use of the technology that will lead to an infringement, cause the status of the legal dispute.
- The patent protection condition C1 refers to the patent technology protected by law degree.
- The technology repeatability C2 is the repeatability of using a part of the patented technology with original patented technology. When the degree of repeatability is too large, the use of the patented technology should be abandoned. This requires experts to analyze the judgment before the analytic hierarchy.
- The failure possibility of technology protection C3 refers to the possibility of losing the protection of the law of the patented technology in the recent period.
(2) Patented technology reuse conditions B2 is the condition that this patented technology was assumed to use in product development.
- Technology intended effect C4 is the use of this technology to product development in order to achieve the intended purpose of the situation
- Technology implementation C5 is whether difficult, suitable in implementation,and so on.
- Technology modifiability C6 is the adjustment of patented technology to adapt to the status under development purposes.
(3) The basic requirement of patent technology using conditions B3 is the patent protection technology that should be implemented with the conditions of situation, including the technical team condition C7, hardware facilities condition C8, capital input conditions C9, implementation period C10.

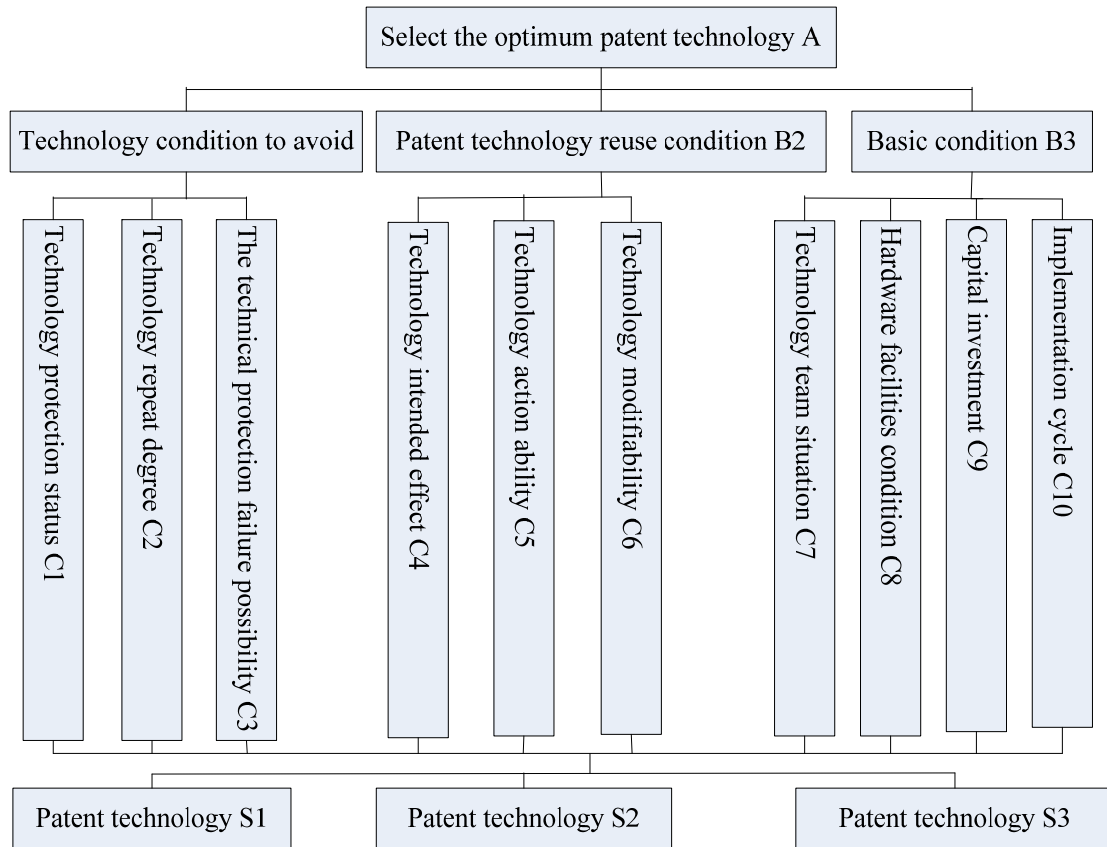Based on the above analysis, analytic hierarchy structure in the Figure 1.

Figure 1. Level analysis structure chart

3.2.2. Structure the second judgment matrix and comprehensive weighted order

In determining the evaluation indexes cases, combined with judgment matrix element quantitative scale regulations, through consulting experts and consultation, obtained the judgment matrix .This paper use the biggest characteristic root method to reach the maximum grounding and relevant character vectors, the feature vector of each value is the corresponding weight [10-12]. Besides, according to the consistency test formula:

$$CR = \frac{CI}{RI} \tag{5}$$

Detect consistency .RI values about the order number of judgment matrix, see chart:

Table 4. Ri's assignment list

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

That in turn all levels single sort judgment matrix calculation results and test results are as follows:

Table 5. A-Bj judgment matrix

A	B1	B2	B3
B1	1	2/3	3
B2	3/2	1	3
B3	1/3	1/3	1

Through the characteristic root method to calculate the maximum characteristic root: λ_b =3.0183, feature vector: ω (2)=（0.3715，0.4868， 0.1417）,and CI(2)= 0.0091 CR(2)=0.0157<0.1,so the consistency test qualified.

Table 6. B1-C judgment matrix

B1	C1	C2	C3
C1	1	3/2	2
C2	2/3	1	3
C3	1/2	1/3	1

Draw the biggest characteristic root: λ_{c1} =3.0735, feature vector: W (3)1=(0.4434，0.3874， 0.1692), and CI(3)1=0.0368　CR(3)1=0.0634<0.1, the consistency test qualified.

Table 7. B2-Cj judgment matrix

B2	C4	C5	C6
C4	1	3	4
C5	1/3	1	2
C6	1/4	1/2	1

Draw the biggest characteristic root: λ_{c2} =3.0183, feature vector : W (3)2=（0.6250，0.2385，0.1365）, and CI(3)2=0.0091 CR(3)2=0.0157<0.1, the consistency test qualified.

Table 8. B3-Cj judgment matrix

B3	C7	C8	C9	C10
C7	1	3	5	2
C8	1/3	1	2	2/3
C9	1/5	1/2	1	1/3
C10	1/2	3/2	3	1

Draw the biggest characteristic root: λ_{c3} =4.0042，feature vector : W (3)3=（0.4869，0.1697，0.0889，0.2545）, and CI(3)3=0.0014　CR(3)3=0.0024<0.1, the consistency test qualified. And according to the formula

$$CR^{(k)} = \frac{CI^{(k)}}{RI^{(k)}}$$

(6)

In overall consistency test:
CI(3)=（0.0368，0.0091，0.0014）$\times \omega$ T(2)=0.0183
RI(3)=（0.58，0.58，0.90）$\times \omega$ T(2) = 0.6253

The total consistency ：CR(3)=CI(3)/RI(3)=0.0293<0.1, solid consistency detection qualified.

Conformance testing rational basis, according to the formula ：

$$\omega_{(3)} = \omega_{(2)} \times \begin{bmatrix} W_{(3)1} & & \\ & W_{(3)2} & \\ & & W_{(3)3} \end{bmatrix}$$

It can be second layers on the general goal for comprehensive weights ：

$$\omega_{(3)} = (0.1647,\ 0.1439,\ 0.0629,\ 0.3043,\ 0.1161,\ 0.0664,\ 0.0690,\ 0.0240,\ 0.0126,\ 0.036)$$

3.2.3. Scheme Layer Judgment Matrix and its Comprehensive Ranking

With the same step before, comparing the program S1, S2, S3 according to different evaluation criteria, building the Scheme layer judgment matrix, and making the consistency judgment. Because of the same principle, the calculation process is omitted, and only the results are given below.

The same steps, the program S1, S2, S3 according to different evaluation standards comparison, construction scheme of layer judgment matrix, and consistency judgment, because the principle of consistency，it omits calculation process, the results are given in Table 9.

Table 9. The results of consistency

C1	S1	S2	S3	W
S1	1	1/2	1/2	0.2000
S2	2	1	1	0.4000
S3	2	1	1	0.4000
	CI=0		CR=0	

C2	S1	S2	S3	W
S1	1	5	4	0.6738
S2	1/5	1	1/3	0.1007
S3	1/4	3	1	0.2255
	CI=0.0429		CR=0.0740	

C3	S1	S2	S3	W
S1	1	2	3	0.5396
S2	1/2	1	2	0.2970
S3	1/3	1/2	1	0.1634
	CI=0.0046		CR=0.0079	

C4	S1	S2	S3	W
S1	1	1	1	0.3333
S2	1	1	1	0.3333
S3	1	1	1	0.3333
	CI=0		CR=0	

C5	S1	S2	S3	W
S1	1	3	2	0.5455
S2	1/3	1	2/3	0.1818
S3	1/2	3/2	1	0.2727
	CI=0		CR=0	

C6	S1	S2	S3	W
S1	1	1	1	0.3333
S2	1	1	1	0.3333
S3	1	1	1	0.3333
	CI=0		CR=0	

C7	S1	S2	S3	W
S1	1	1/3	1	0.2000
S2	3	1	3	0.6000
S3	1	1/3	1	0.2000
	CI=0		CR=0	

C8	S1	S2	S3	W
S1	1	1/4	1	0.1667
S2	4	1	4	0.6666
S3	1	1/4	1	0.1667
	CI=0		CR=0	

C9	S1	S2	S3	W
S1	1	1	2	0.4126
S2	1	1	1	0.3275
S3	1/2	1	1	0.2599

C10	S1	S2	S3	W
S1	1	3/5	1/2	0.2116
S2	5/3	1	2	0.4722
S3	2	1/2	1	0.3162

And the total order of the scheme can be concluded like this:

Table 10. The comprehensive weighted order of the scheme

The scheme / Th weights	S1	S2	S3
C1（0.1647）	0.2000	0.4000	0.4000
C2（0.1439）	0.6738	0.1007	0.2255
C3（0.0629）	0.5396	0.2970	0.1634
C4（0.3043）	0.3333	0.3333	0.3333
C5（0.1161）	0.5455	0.1818	0.2727
C6（0.0664）	0.3333	0.3333	0.3333
C7（0.0690）	0.2000	0.6000	0.2000
C8（0.0240）	0.1667	0.6666	0.1667
C9（0.0126）	0.4126	0.3275	0.2599
C10（0.0361）	0.2166	0.4722	0.3162
The comprehensive weight of the program layer	0.3815	0.3222	0.2963

By the above calculation, from the view of comprehensive weight, the weight of the scheme S1, S2, S3 is (0.3816, 0.3221, 0.2963), and the three weights make little difference. This is because the three parts which are the result of initial screening are relatively similar. By Analytic Hierarchy Process, combined with the specific circumstances of the enterprises or even product development projects, and what we need to do is to elect the best one from them. In this example, the best one of the three patents is S1.

By the above calculation, from the view of comprehensive weight, the weight of the scheme S1, S2, S3 is (0.3816, 0.3221, 0.2963), and the difference of the three parts is not too much. This is because the three parts which are the result of the Initial screening are relatively similar. By Analytic Hierarchy Process, combining with enterprises is the specific circumstances of the product development project, and what we need to do is to elect the best one from them. In this example, the best one of the three patents is S1.

4. Conclusion

In this article, we selected the patented technology of car steering screening through similarity algorithm, and then analyzed the patented technology selected by the Analytic Hierarchy Process. We choose the patented technology which is selected to find the most suitable product development in order to provide examples for the development of automotive steering products.

In this article, through similarity algorithm, we select the patented technology of car steering screening, and then through the Analytic Hierarchy Process, we analysis the patented technology which is selected to find the most suitable product development, and provide examples for the development of automotive steering products.

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