

Technology Maturity Forecasting of Thermostat based on Patent Analysis

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ABSTRACT: Technology forecasting plays a fatal role for enterprise survival and development. Technology maturity of thermostat is predicted with the TMMS and patent data algorithms. Radar plot is drawn to indicate the evolutionary potential for the further improvements of thermostat. It is pointed out that thermostat will be getting more dynamic and smaller with the help of radar plot.

KEYWORD: radar plot; thermostat; technology forecasting

1 INTRODUCTION

Vehicle and engine technology has make a great progress with the development of traffic life, at the same time, the cooling system as an important subsystem of vehicle and engine, also plays a important role[1]. The thermostat is used as a core component of automobile cooling system, pressure drops to adjust the bypass pipeline, thereby regulates the flow of cooling liquid in tank and bypass[2]. Thermostat ensures the normal work of fuel consumption, reliability etc. Its development attracted great attention of the automotive industry. Therefore, to predict thermostat technology, clarifies the technology development trend, accelerates technology development[3]. Breakthrough in thermostat technology is to realize high efficiency, lower consumption of the cooling system, and enhance the overall performance of internal combustion engines. This technology forecasting is drawing more and more attentions world wide[4].

TMMS prediction model is combined with patent data measurement methods for technical maturity forecasting. Technology evolution radar chart is drawn for the analysis of technique evolution trend, which is useful for enterprises to understand product technology maturity, and the product development and innovation trend is found[5].

2 TMMS PREDICTION MODEL

Technology maturity measuring system (TMMS for short) is used to predict technology development trend. G.S.Altshuller based on the investigation and analysis of a large number of patents, found the

product evolution meeting curves, and the product evolution is divided into four periods, i.e. infant period, growth period, mature period and withdrawal period. And research works found the relationships among four index, i.e. technical system evolution model, product performance/ profitability, the patent number and patent grade [6-7].

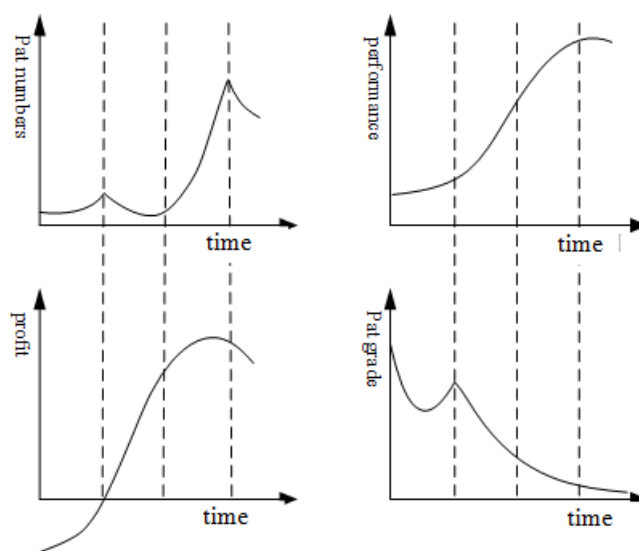


Figure 1. Standard patent prediction curves

The curve shapes changed with four indicators, which can predict the technology maturity, as shown in figure1.

TMMS technology maturity predicting model is based on G.S.Altshuller and Darrell Mann. The patent investigation results are used in the research results, laid down the theoretical prediction basis, where three numbers are introduced, i.e. the patent number (PN), patent level (PL), the number of patent remedy defects (SCP)[8].

The number of patents, patent level make up defects of three standard curves in Figure 2, obviously, the three indicators were derived from a data source, to visit a number of aspects of a problem[9-10].

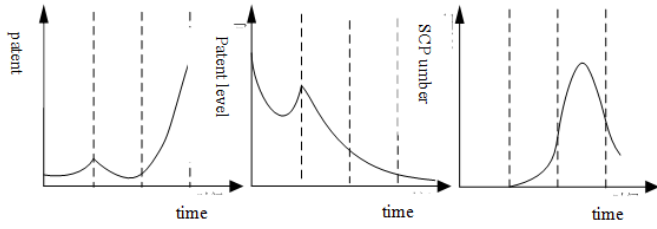


Figure 2 TMMS prediction curve

TMMS system is based on the extremum points of patent technology in the life cycle division characteristic curve, which is divided into seven stages.

The slope of each curve characteristics is combined with SCP feature in the same period, the proportion of patents in the combination gives the forecasting evidence for the technology maturity. Combination of different features in the technology maturity criterion is used for prediction, and it is the core algorithm [11] used in the TMMS system.

Table 1 Product combination maturity prediction

maturity	Pat num cure slope	Pat grade cure slope	MUDPQ cure slope	PMUDP cure slope
Pro-infant	≥ 0	≤ 0		Very few
Post-infant	≥ 0	> 0		Very few
Pre-growth	< 0	≤ 0	≥ 0	less
Post-growth	≥ 0	≤ 0	≥ 0	partial
Pre-mature	≥ 0	≤ 0	≥ 0	most
Post-mature	≥ 0	≤ 0	< 0	most
withdrawal	< 0	≤ 0	< 0	partial

* MUDPQ stands for making up for the defect of patent quantity.

* PMUDPQ, means proportion of MUDPQ in total patents of the same period.

3 QUANTITATIVE MEASUREMENT OF PATENT NUMBER

Quantitative calculation of the number of patents is used in technology forecasting, where. V is the growth rate; α is the technology mature coefficient, β is the technology aging coefficient, and N is the new technology of feature coefficient, the calculation formula is as follows:

$$v = \frac{a}{A} \quad (1)$$

$$\alpha = \frac{a}{a+b} \quad (2)$$

$$\beta = \frac{a+b}{a+b+c} \quad (3)$$

$$N = \sqrt{v^2 + \alpha^2} \quad (4)$$

Where, a , b , c is invention patents, utility model and patent number respectively, and A is the number of appearance patents; the numbers is within 5 years period.

According to the formula in (1),(2),(3),(4), if V is growing up, the technology is in the growth stage, if α is getting smaller every year, then the technology is mature, if β is getting smaller, the technology is in the aging period [12]. In addition, the bigger the N value, it indicated that the new technology features more stronger.

In this paper, TMMS prediction model is combined with the patent number measuring algorithm in the technical maturity prediction. This method reduces the difficulty in data collection, and increases the technology prediction accuracy[13].

The Chinese patent search engine, i.e. SooPat China database is used in this analysis. SooPat Chinese patent data is connected with the State Intellectual Property Office of Internet search database. SooPat is within the Internet patent database, is suitable for the integrating and adjustment for patent data acquisition.

3.1 Patent data collection

"Thermostat" is used for patent search keyword in the patent title, patent data is within 2003-2012. 220, patents are obtained as shown in table 2.

In order to increase the prediction accuracy, three types of patents, i.e. invention patents, utility model patents and appearance patents, are separately collected and classified to calculate four parameters of V , α , β , N , as shown in table 3 [14].

Table 2 summary of classification of patent number

Order	Time	Pat numbers	Patent level	SCP
1	2000	0		0
2	2001	0		0
3	2002	2	1	1
4	2003	0		0
5	2004	1	1	0
6	2005	4	1.25	2
7	2006	3	1.33	2
8	2007	8	1.25	5
9	2008	17	1.18	10
10	2009	17	1.24	12
11	2010	16	1.06	8
12	2011	64	1.09	27
13	2012	88	1.04	33

Table 3 the thermostat Technology V , α , β , N in statistics

year	05	2006	2007	2008	2009	2010	2011	2012
v	1	0.67	0.4	0.44	0.44	0.12	0.38	0.19
α	0.2	0.67	0.29	0.31	0.41	0.18	0.26	0.19
β	1	1	0.88	0.76	1	0.69	0.53	0.31
	1.03	0.95	0.49	0.54	0.6	0.22	0.46	0.27

The TMMS model is used after data collection, the index statistics, select three or four times curve was fitted according to the curve shape, the generated curves are shown in figure 3, figure 4, figure 5.

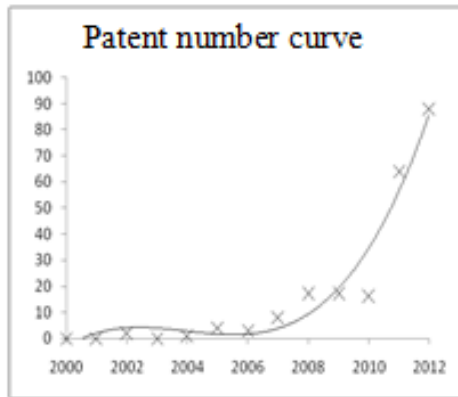


Figure 3 thermostat Patent number curve

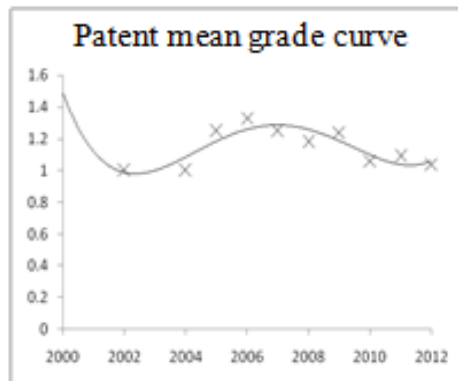


Figure 4 thermostat Patent mean grade curve

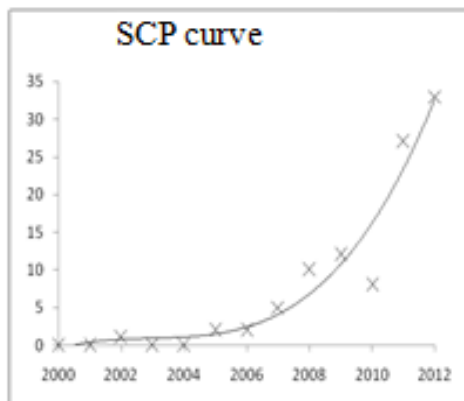


Figure 5 thermostat SCP curve

In order to increase the prediction reliability, data in Table 2 are used to generate the 4 fitting curves in figure 6.

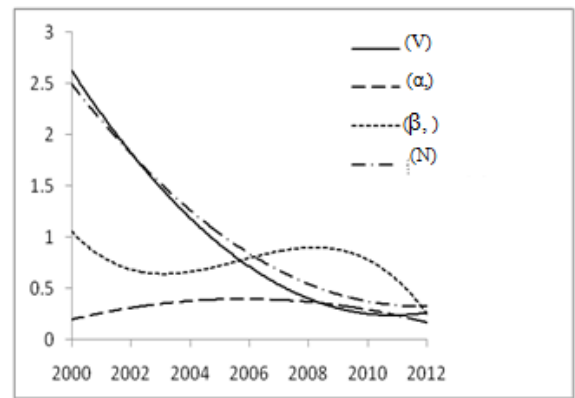


Figure 6. V , α , β , N in the graph

4 TECHNICAL MATURITY PREDICTION

The generated curves roughly gives the development trend for future years, and the patent characteristic curve shows that it is in the mature period, which coincides with the early part of the curve. And from Figure 3, it could be found that V , α , β , N curve decreased in 2008 after the trend observed at the same time, the change trend of the thermostat of these parameters is further corroboration of the technology forecasting method[15].

The above two analysis methods shows that, the thermostat technology of vehicle cooling system experienced in the infant stage, growth stage, has just entered the mature period. This paper adopts the technology of the next evolutionary potential map, description and technical analysis system of thermostat evolutionary status.

5 RADAR PLOT OF THERMOSTAT

The radar plot is drawn from 220 copies of thermostat related patents, research on analysis and generalization is carried out, which can simplify the evolutionary potential trend. In order to describe technology evolution potential routes, radar map is shown in figure 7.

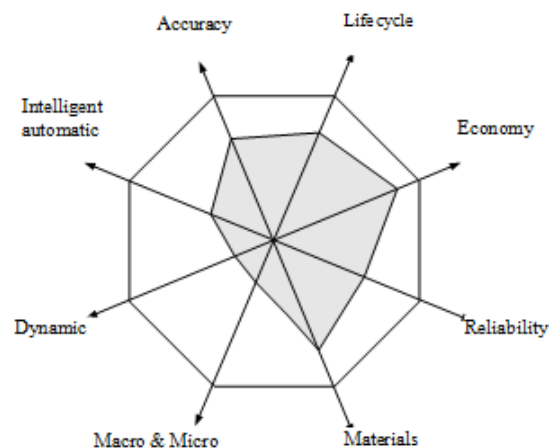


Figure 7 Radar plot of thermostat

According to the evolutionary radar map, five aspects are in full level, i.e. There are little development potentials, but the controllability, dynamic, from the macro to the micro aspects of evolutionary level is still low, can provide guidance for the development of research in technology the lower level. Clearly the potential technology evolution diagram, explain the thermostat technology has great evolutionary potential, can provide guidance for the development of the thermostat.

6 SUMMARY

The TMMS model and the patent quantity measure method is combined to predict auto thermostat technology maturity, reducing the error of TMMS model as the result of some subjective factors when in use, reduces the difficulty of obtaining the data, but increased the accuracy of the prediction results. In addition, the development trend of the application of technology evolution potential map analysis of automobile thermostat technology, is helpful for the formulation of development strategies and thermostat, and the direction of improvement and innovation is to guide the enterprises.

7 ACKNOWLEDGMENTS

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