Prediction of Future Development of Automatic Washing Machine Based on Evolutionary Theory

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Abstract. The development trend of the automatic washing machine is proposed in this paper, totally 3151 copies of patents are studied, with related to the washing machine worldwide. The potential development radar chart is drawn. Nine evolution routes out of eight development patterns are summarized, and six kinds of design schemes are suggested. Finally, an electromagnetic washing machine is conceptualized, the prototype washer can be developed based on the model.

Introduction

The evolution of the washing machine can be divided into three ages, i.e., the mechanical age, semi-automatic and automatic age. The mechanical age is the beginning of the washing machine era, when the machine is not commonly used. However the semi-automatic washing machine is widely used in a half manual/ half electric manner, during this period the washers are rapidly developed.

Altshuller\cite{1} proposed a method to predict the product technology maturity, based on the mass analysis of patents through around the world. Bingquan He\cite{2} proposed a new prediction technology based on the evolutionary theory method from TRIZ theory, and the feasibility of this method is verified by a design example of a MP3 player. Cheng Jung Yang\cite{3} proposed an integration model of TRIZ, CBR and LCA integration model, which is used for green product design; Wang\cite{4} proposed a kind of technical prediction method based on the audit of academic literature as well as patents, and the model is verified and testified.

The automatic washing machine no longer needs human labor, during this period, the drum washing machine, sleeve washing machine, domestic/industry washers etc. are widely used worldwide, where program and control system are introduced in the washing machine. Automatic washing machine consists of 5 subsystems, i.e., drive system, washing system, water supply and drainage system, control system, and vibration control system. Usually, the washing machine consumes huge amount of water, electricity and detergent, generates large noise in the washing process, and vibrate violently in dehydration.

So lower noise, energy saving, environmentally friendly etc. are the design targets for the future washing machine. In the following chapters, the technology evolution trends are talked about in detail.

Data Collection

Totally 3151 copies of authorized patents on the SooPAT web site are related to washing
machine from 1992-2012. 2721 green technology related patents are screened, and analyzed. A patent evolution trend curve is drawn in figure 1 from the data using Microsoft excel.

![Graph showing the number of patents relating to different years.](image)

**Figure 1.** Number of patents relating to different years.

It could be found that, from 1992-2005, there is a gradual increase in the number of patents relating to green design issues, but in 2008, the authorization number began to decrease, does it mean that the green washing machine technology has reached the maturity? The authorizing time span of the patent application is long, so it cannot determine whether the washing machine of the green technology is reaching its peak.

**Evolution Trend of Washing Machine**

**The green evolution route of materials used**

![Diagram showing the green evolution route of materials.](image)

**Figure 2.** Route one evolutionary state.

The evolution route one is shown in Figure 2, the washing machine still used the "composite material", for example, the inner tube using stainless steel is easy to adhere dirt, and full of bacteria, where nano functional materials can solve the problem of pollution. So the washing machine is prone to use functional materials.
Water and detergent saving are also evolutionary trends related to green design of the washing machine. The higher level of the intelligence of the automatic washing machine, the more water and detergent saving. So intelligent washing machine is the next development trend of the washing machine as shown in figure 3.

**The green evolution route of washing machine technology**

Now the washing machine mostly adopts screws, bolts and other rigid connections, it results in the difficulty of dis-assembly. The evolutionary trend should be toward the "connection reduction", which can reduce maintenance costs, improve the material recycling rate etc., the evolution route three is shown in Figure 4.

The first washing machine is used only to wash clothes, not to dry clothes. Then, the double tube washing machine appeared, one tube is used for washing clothes, another is used to dry the clothes. Now these two functions combined into one bucket, i.e. the so-called automatic washing machine.

More and more functions are to be integrated into one machine. Cleaner, more clothes are needed to be washed in shorter times. In the meanwhile, energy saving, water and detergent saving, low noise and vibration etc. are required for the modern washing machine design.

For this ends, a four-bucket washing machine is suggested. One is for the light colored clothing, and the dark clothing, wool clothing, shoes (dry) were cleaned in different cylinders.
The four buckets can work together, or work continuously. This modular management can achieve the purpose of water saving, the evolution of State Route four is shown in Figure 5.

![Diagram 1](image1.png)

**Figure 5. Route five evolutionary state.**

**Green evolution of energy**

Shorten the length of the path of energy conversion, the longer the path of transformation, the more energy costs. In addition, intelligent control of the washing machine is conducive to energy conservation, water and detergent saving.

Simplified route five, now washing machine uses a direct drive motor, to remove the belt driven system, simplified the transmission system and the power system. The evolution route five is shown in Figure 6, reduce the amount of energy conversion, the energy conversion route is as the follows,

Original coal -> thermal energy -> mechanical energy-> electrical energy,
And the reduced energy conversion type is as the follows:
Solar power-> mechanical energy->washing machine;

![Diagram 2](image2.png)

**Figure 6. Route five evolutionary state.**

Solar energy is clean, renewable, although the technology is still in its infancy, but its future is promising.
The evolution route six is shown in figure 7, the current state of the washing machine is controlled by PLC, and the next step development will be toward feedback controlling. Testing of the quality of the clothes, method of feedback to determine the cleaning system (air washing, water washing, water detection etc.), detection of the pH level, gives the feedback to the system, the time and frequency of cleaning is decided.

Green evolution route of the environment

Reduction on noise, vibration, pollutant emission etc., will be environmentally friendly. In addition, the vacuum washing machine is used to reduce the noise.

The evolution route seven is shown in Figure 8, nowadays, the mechanical effects of water is used to clean the clothes, The next step development will be toward "particulate" or "field" effects washing. The vacuum washing machine make use of the "suspended particles", similar to gas boiling effects to clean the clothes. The barrel of the air to make water boiling, and then wash clothes;

The evolution route eight is shown in Figure 9. The ultrasonic washing machine make use of two waves of high and low pressures, which generates air bubbles in water. The air bubbles continue to shock in the process of washing, the pressure rise and mutually squeezed, resulting in a strong ability to clean clothes. Although the vacuum washing machines and ultrasonic washing machines are still in their infancies, the further development are welcomed in future.
The evolution of route eight is shown in Figure 9, the washing machine generally rotates positively and negatively, it is seemingly not sufficient. So next-step washing machine can rotate in many directions/manners, electromagnetic coil is mounted on the top of the washer, in order to produce thousands of micro-waves, vibration are generated, noise is lowered, it is called the electromagnetic washing machine.

Analysis of the evolution of the state from the washing machine. From the nine evolution routes out from the eight technology evolution patterns, the evolution state of the washing machine is summarized in a RADAR chart, as shown in figure 11.
In the above chart, one can find it is far from the limit of the evolution it can reached, and there are great evolutionary potentials in simplification, microscopic, energy conversion reduction, high efficiency fields etc. There evolutionary potentials provide innovative ideas for the green design of washing machine.

**Get the Target Solution**

According to the analysis of the 9 evolution routes of the washing machine and the prediction of the evolutionary potential of the washing machine, the following 6 kinds of green innovative design schemes are suggested.

**Scheme 1.1:** Nano-coating is suggested to put in the inner barrel of the washing machine, the washing machine has self-cleaning function, improve safety, and reduce the amount of the rinse water.

**Plan 1.2:** Make use of feedback devices, improve the level of intelligence, introduce the intelligent detecting devices to find the clothing texture, weight, cleanliness, intelligently determines the rinsing time, the amount of detergent, water use etc.

**Solution 1.3:** Research on the development of the multi-functional integrated washing machines, with the functionality of water/air washing, drying, disinfection, light color wash, dark wash etc.

**Program 1.4:** make use of magnetic field, sound field and other efficient fields etc., the electromagnetic washing machine, do not use the motor drive, the movement is multi-steps, it can realize the silent washing.

**Solution 1.5:** Solar energy washing machine reduced the amount of energy conversion, improve the conversion efficiency of energy, and reduce the discharge of pollutants.

**Plan 1.6:** Ultrasonic washing machine make use of the ultrasonic vibration to remove the impurities in the fiber, to achieve the purpose of quick washing.

**Proposal of the Electromagnetic Washing Machine**

Multi-functional electromagnetic washing machine is shown in Figure 12, the washing machine has 4 washing tubes, two dry-wash tubes, and two water-wash tubes.
No. 1 and No. 2 are water tubes, no1 tube copes with the light colored clothes, water from tube one, is filling to tube two after filtering.
No. 2 tube copes with deep-colored clothes.
No. 3 and No. 4 tubes make use of dry-washing for woolen clothes, each tube has operation panel, No7 is the water washing operation panel, no 8 is of dry washing operation panel, 6 is to observe the water level of the water storage device.

![Figure 12. Conceptual model of the electromagnetic washer.](image)

**Conclusion**
Firstly, the evolution trend of the washing machine is studied in this paper, nine evolutionary routes, out of from eight evolutionary patterns are found. Six target solutions are proposed. Based on the analysis, one multi-functional washing machine is conceptualized. With the advancement of science and technology, these concepts will come into true, and save our environment completely.

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