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Application of Big Data and Artificial Intelligence Technology in Industrial Design

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Abstract

Artificial intelligence and big data technology have entered a new era of rapid development. At home and abroad, artificial intelligence and big data technology are used to assist industrial design from two aspects: (1) ways and means to improve product quality; (2) integrating and connecting various elements of product development. This paper introduces the application of artificial intelligence and big data technology in the field of industrial design. And it puts forward the design scheme of "demand ---- industrial design innovation ---- market ---- demand" based on industrial intelligence and big data technology, aiming at the problems that industrial enterprises are still facing such as interminable R&D cycle of industrial design innovation, lagging product design and lack of sustainable innovation. That is to provide the most targeted demand through the algorithm model and indirectly assist in the prediction of industrial design related decisions, so as to effectively promote the improvement of industrial design innovation ability, help industrial enterprises in the R&D link to save costs, shorten the new product R&D cycle, improve the success rate of product listing, and create practical benefits; at the same time, it also provides a better solution to the major problems of data isolation and low decision accuracy faced by existing domestic and foreign research institutes.

Keywords

Industrial Design, Product Development, Big Data, Artificial Intelligence

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1. Introduction

Product R&D ability is the core competitiveness of industrial enterprises. However, product development process is very complex. Due to the lack of comprehensive quality design and development personnel, it is difficult to carry out product R&D work with technical or management professionals. It is also difficult to make good contact between products and market, especially predictive market, which often leads to significant deficiencies of some links in the development of "Production Generation, Development Generation, and Pre-Research Generation". Industrial design is particularly important to solve this problem. As a professional subject of systematic research Design with Product Development, the innovation ability of industrial design can effectively make up for the development fault of industrial enterprises, and promote the improvement of the R&D strength of enterprises in the social industry. The role of industrial design research in product development can be summarized in two aspects: (1) the ways and means to improve product quality; (2) integrating and connecting the various elements of product development.

Artificial intelligence and big data technology have entered a new era of rapid development. At home and abroad,

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artificial intelligence and big data technology are used to assist industrial design from the above two aspects. Some scholars use relevant data of industrial design: user evaluation data, user use data, user demand data [1], product production data, full life cycle data [2], and use NLP method based on big data and, Naive bayesian machine learning techniques for emotion analysis, Association and classification algorithms [3], artificial neural network, genetic algorithm and artificial bee colony algorithm [4], etc., have successfully identified the most competitive products and features, improved design parameters [5] and operation decision [6, 7], optimized product performance design [8-10], and some domestic scholars have established relevant models based on artificial neural network, genetic algorithm and artificial bee colony algorithm to obtain optimization parameters, effectively reducing Power consumption.

Although the existing research has achieved some results, there are still data islands, and the major problems of low decision accuracy are still unsolved. In this paper, industrial big data is used to build models to intelligently predict the accurate market demand, improve the feasibility of R&D projects of industrial enterprises, and provide constructive suggestions for industrial design in combination with relevant data in various tests conducted in each stage of R&D, assist decision-making judgment during the incubation period of projects, and help industrial enterprises speed up the R&D process.

2. Scheme of Using Big Industrial Data to Improve Industrial Design Ability

2.1. Main Problems Targeted by the Scheme

(1) In the current research at home and abroad, there is a lack of relevant algorithm model for the massive data generated by the testing and iterative process of industrial design and development. The existing model results in low customer acceptance rate and low success rate of the new product.

(2) R&D lacks the sustainable innovation capability, the problem of data island has not been solved, there is no complete comprehensive plan, and the most important three related elements in R&D design are not integrated: demand, R&D design and market. After the R&D innovative products are put on the market, there is no continuous circular improvement.

2.2. Theoretical Basis

In this paper, industrial design innovation is the main object; the development of Internet of things, cloud computing, virtualization and other information technology as well as the construction of multi-node distributed big data platform, which provide conditions for high-performance computing of massive data. Industrial big data can get the cleaned data through preprocessing technology, and then build knowledge base through data mining technology, and then use digital twin algorithm to provide targeted needs and assist decision-making.

2.2.1. Industrial Design

The discipline research of industrial design [11] is oriented to the overall product development, and is a kind of professional behavior that takes the market as the guide and comprehensively deals with the human product coordination relationship. The evaluation criteria of this kind of professional behavior can refer to the key points of American outstanding Idea Award: design innovation, aesthetic expression, environmental protection and the degree of benefit of manufacturers and users, among which innovation is the core, and combined with market requirements, laws and regulations, economic requirements, etc., industrial design is a comprehensive product development behavior.

"Design is a creative activity whose purpose is to build up various qualities for goods, processes, services and the systems they constitute in the whole life cycle" (the definition of industrial design of the International Federation of industrial design). The basis of research includes: physics, materials, ergonomics, human action, ecology and bionics of natural subjects, and economics, marketing, consumer psychology, communication, management, economic law, thinking and creation of social subjects.

The role of industrial design research in product development can be summarized in two aspects: (1) ways and means to improve product quality. The improvement of product quality does not only depend on the improvement of technical level, but also requires comprehensive improvement of products.(2) integrate and contact all elements of product development. Product development needs to integrate a number of related knowledge areas, and carry out a full range of design for the whole process of product planning, manufacturing, testing, experiment, marketing, operation, maintenance, scrapping, recycling, etc.

2.2.2. Data Preprocessing

The data preprocessing is based on the original historical data obtained from the production site, which improves the data analysis and mining are started in the next stage, so it plays a connecting role in data analysis.

Due to the diversity of data collection and transmission

technology, the original data obtained from the production site is often of low quality. The industrial big data collected in practice is not standardized or missing, and may even contain many noise and error, which can not be directly used for analysis. This paper aims at industrial big data, mainly through data preprocessing to solve the problem of data missing and redundant dimensions. Data loss refers to the phenomenon that the whole data information is lost or some dimension data is lost in the time series data; data noise refers to the wrong value in the data, or the outlier that obviously deviates from the expectation; redundant dimension refers to the dimension that has little effect on data analysis, is not important, or has repeated meanings [12]. Data preprocessing cleans the original data for further processing. Common data preprocessing includes wavelet transform and wavelet de-noising. After signal de-noising, we need to extract features. The extracted dimensions include time dimension, frequency dimension and time-frequency dimension, and then select the feature set most relevant to the prediction results.

2.2.3. Knowledge Base

The concept of knowledge base comes from the field of knowledge engineering technology and database technology, and it is the combination of the two. Knowledge base can store, organize and process knowledge and provide knowledge services. It not only solves the problem that the data base management system (DBMS) is unable to express regular knowledge, but also makes up for the shortage that the artificial intelligence (AI) system is unable to retrieve massive data efficiently [13]. The construction of knowledge base lays a good foundation for knowledge management and knowledge service in various fields.

2.2.4. Digital Twins

Digital twin is a set of virtual information structure that describes the potential production or actual manufacturing products from micro atomic level to macro geometric level. The best result of building a digital twin is that any information that can be obtained by testing an actual manufactured product can also be obtained from its digital twin [14].

The construction of product digital twin is a process of reconstruction and digital mapping of the working state and progress of physical entities in virtual space. However, no matter how to perfect the digital twin, it cannot be completely equivalent to the physical products in the real world, but only highly approximate. Therefore, digital twin is not only a representation of physical products, but also a representation of the real world in virtual space.

At present, digital twin is deeply combined with artificial intelligence technology to promote the real-time interaction of integration of information space and physical space, so as to carry out more real digital simulation in the information platform and realize more extensive application. Combining digital twin system with machine learning framework, digital twin system can self-study according to multiple feedback source data, so as to present the real situation of physical entities in the digital world almost in real time, and can speculate and preview the upcoming events. The self-learning of digital twin system can not only rely on the feedback information of sensors, but also learn from historical data or integrated network data. In the process of continuous self-learning and iteration, the simulation accuracy and speed will be greatly improved [15].

2.3. Work Plan

As shown in Figure 1, product R&D and design are based on the design mode of "demand ----industrial design innovation -----market----- demand". The work plan is as follows:

This paper uses cloud computing to solve the problem of real-time storage of big data, and relies on Alibaba cloud service platform to build knowledge base and process data; through data mining and knowledge discovery, machine learning and deep learning, data can be analyzed and mined to understand the process, impact and solution of the problem. By using big data modeling, data information can be built through Module into knowledge, and then use knowledge to understand, solve and avoid problems.

Based on the industrial big data about market opportunities, competitiveness, technical feasibility, expert experience, production demand, etc., it classifies, analyzes and excavates them to establish an algorithm model, which not only directly provides the most targeted demand, but also indirectly assists in predicting the expected success rate of project implementation to assist the R&D personnel in decision-making and product direction modification, and helps to improve the R&D ability. It has been designed and developed through the algorithm model to provide constructive advice in intermediate steps of industrial design, and constantly adjust the design. At last, after small-scale production, product iterative development is conducted based on the user data of product feedback in the market

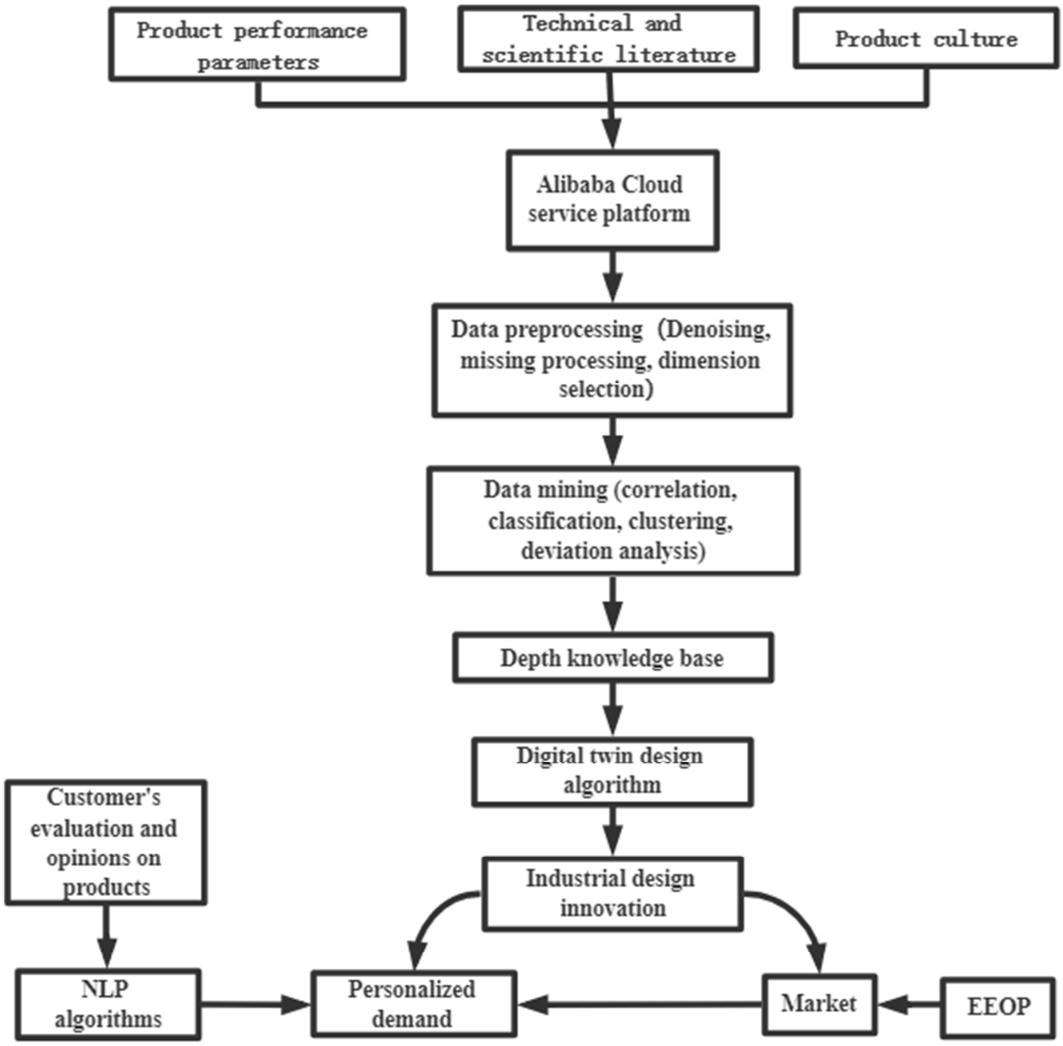

Figure 1. Flow chart of work scheme.

3. Analysis and Discussion

The existing data modeling methods in industry need pollution-free data to model, which is difficult to achieve in the actual R&D innovation. However, the data mining and machine learning technology used in this paper considers that the existence of untrue data is inevitable, and large capacity data can be used to extract robust models to untrue data.

Based on the data of scientific and technological documents, market opportunities, competitiveness, technical feasibility, expert experience and production demand, this paper constructs a model to predict the product development direction of industrial enterprises intelligently on the basis of establishing a complete knowledge base, puts forward the most targeted demand and predicts where the new design opportunities are, which is totally different with the R&D mode of the previous "Copinism " and "Catering to the needs of users". Through the collection, classification, analysis and mining of big data, it provides innovative products that exceed users' expectations and surprise users.

The purpose of this paper is to provide constructive Suggestions on industrial design by combining relevant data of various test results and digital twin algorithm model in various stages of research and development, so as to assist decision-makingl during project incubation. Through multi-dimensional analysis of data, the value of data can be deeply mined, more effective information can be found, product R&D and design problems can be solved, and traditional design patterns and processes can be improved.

4. Conclusion and Prospect

Based on the research goal of using big data and artificial intelligence to improve the ability of industrial design innovation, this paper expounds the research basis and existing problems in this field at home and abroad from the dimensions of various elements of integrated and linked product development, ways and ways to improve product quality, and puts forward a scheme based on "demand ----

industrial design innovation ----- market ---- demand". It can provide reference for the application of big data and artificial intelligence in industrial design.

In this paper, the following aspects need to be further explored: in order to solve the problem of data island, to explore the methods of data collection, classification and analysis mining for the relevant data of industrial design. In industrial design, the accuracy of decision-making is very high, and in each stage of research and development, how to effectively use the relevant data from various test results, it is a key problem for industrial design to provide constructive suggestions by algorithm model.

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