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Research About the Influence of Artificial Intelligence Technology on the Development of Ceramic Industry

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Abstract

The artificial intelligence technology is developed by analyzing human being's brain structure, and is already applied in many different fields. The ceramic industry take a significant change thanks to the introduction of new techniques of AI, which brings great market competitiveness as well as enterprise efficiency. Ceramic industry became one of the most typical cases of industry transformation from traditional to modern. The article focuses on this phenomenon and its trend, in order to induce an academic theoretical approach, aiming at achieving a further development on the whole ceramic industry field.

Keywords: artificial intelligence technology, ceramic industry, intelligent management and industry, market effect

1. Introduction

Artificial intelligence technology was introduced and developed in 1950s, which is an important sign of the development of human society, continuing changing the human being's living style as well as thinking pattern. The new AI technology promotes the social development by technology innovation, which will also affect people's behavior and mind. On the other hand, the AI technology revolution will affect the industry area and structure, which has great strategic significance. It is no doubt that AI technology becomes one of the most important motivations on global science and technology revolution and industry transformation. Compared to other field, the benefits from AI technologies in manufacturing industry are more effective and general, especially on improving the productivity and reform the industry structure.

Ceramic industry is one of the industries which has most benefits from the import of AI technology. The main benefits of this are the optimized utilization of ceramic materials, improvement of product quality, monitoring and management of production process, and marketization farming in product marketing.

2. Academic Theory of Artificial Intelligence in Ceramic Industry

Ceramics are one of the sign products of China, as well as one of the most important components of Chinese traditional culture. Ceramic products are widely used in daily lives, so ceramic industry is an important basic industry about Chinese economy.

Normally, the ceramic industry includes daily-use ceramics, construction ceramics, industrial ceramics, art ceramics, new-structure ceramics, biometric ceramics, and electric ceramics.

The application areas of ceramics include broadcasting, television, communication, navigation, electronic area, aeronautics, metallurgy, mining, chemical industries, high-frequency heating, etc.

Artificial intelligence has developed for decades, which rely on algorithm to complete a series of missions, aiming at simulating and expanding human brain's function and help people finish complicated works, and belongs to computer science subject.

Along with the fast development of big data, could platform, mobile networks and robotics, artificial intelligence have a brand-new approach with the combination about technologies mentioned above, and then plays an important role in basic industry and high-level development. (Gu, Xianfeng, 2016) AI technologies have significant performances in different types of recognition algorithms, robotic control, and text processing. With the help of deep learning and neural networks, AI algorithm can handle tasks that people are not able to finish accurately and analysis, forecast situations that needs massive calculations.

The connections between ceramic industry and AI technology will be aiming at “learning” and “calculation”.

First of all, AI can help to select and reform ceramic materials to achieve higher quality in order to fit different types of application situation. Secondly, AI will help to finish complicated craft process in order to maintain equal qualities with massive production. Thirdly, AI can monitor and manage the whole manufacture process, which will help to improve the whole efficiency by import better process control, as well as create a safer environment. Finally, AI can also help to analyze and forecast the marketing behavior, in order to provide proper pricing strategy by calculating massive data collected from internet and markets.

All functions above can be generalized into an academic theory expression: in one part, AI technologies will be applied in varieties sections of ceramic industry process, even expanded into non-industry sections; on the other hand, the specific idea applied into ceramic industry will be automation structure, computer vision, data mining, deep learning, and virtual reality.

3. Detailed Artificial Intelligence Application in Ceramic Production

3.1 Ceramic Material Development

Normally, the selection of ceramic material is based on the experiences by workers who spent long time in the field. A suitable material needs a great amount of trials and errors, which is a great waste in resources and time. After the application of scientific experiments, the development of new ceramic material became faster, but there are still many spaces for improvement can be achieved by the import of AI.

In 1990s, computers were first introduced into development of material formula. Generalized Leverage Rule, Linear Programming, Successive Linear Regression Analysis, and Pre-homogenization Technology are widely applied into ceramic material selection. Related computer programs such as an integrated software of Optimization Calculation of Ceramic Body and Gaze Formula. (Gao, Liming, et al., 1996)

Another route to material revolution is about ancient ceramic material analysis and application. Since the history of ceramic production in China is over 10,000 years, and the skill of handmade ceramic crafts are so advanced that even nowadays researchers can find them undamaged after unearthing. The information in the ancient ceramic products will help us to develop new formula of ceramic materials. The application of AI can help to analysis ancient ceramic crafts and art without damaging them. Moreover, the ratio of composition in those ceramics will be more accurate than the research and analysis done by human.

AI technologies can also be applied into ancient ceramic crafts repairing. For heavily damaged crafts, neural networks and deep learning system can help to generate missing parts, which human may not able to draw, and repair them by high-accuracy 3D printing. In addition, AI can analyze the existing material composition of ancient crafts and select exactly the same material to make the repairing, and produce parts with complex shape easily.

AM technology is one of the most widely used technology in ancient relics repairing, which is heavily relying on artificial intelligence. Machine learning is implemented into the AM tech, so the 3D printing machine can generate parts needed with high accuracy and quality, as well as apply correct ceramic materials. (Wu, Yanfang et al., 2021)

3.2 Appearance and Manufacture Crafts

The traditional ceramic products are mainly handicrafts; therefore, the appearance and manufacture skills are individualized and subjective, which means the craftsman will handle the whole process. Ancient Chinese are trying to inject their moods and thinking into their handicrafts. This tradition is inherited in nowadays ceramic industry. Most of the ceramic products are designed by craftsman, and then send into assembly line to batch production.

If the production procedure wants to be completely unsupervised, the appearance design must be taken into account. Machine learning in computer vision make the unsupervised design process possible. By massive amount of learning about existing high-quality ceramic crafts, AI can generate new ceramic designs automatically, which thanks to generative models such as diffusion model. Designs generated by these models will be a fusion of different preferred elements collected from internet and other sources, which will pander to most of the consumers and therefore increase the sales volume.

However, the computer-generated models may lack of details because of the algorithm, and some of the designs are even unjustified. so, it still need development in order to achieve supplementary level of details to satisfy the increasing demand of exquisite products by consumers.

3.3 Production Monitoring and Management

The tradition process of ceramic production needs to be supervised by human from the beginning to the end. AI technologies can supervise the process without the intervention of people. One of the most difficult parts for human to supervise is the kiln firing. Workers need to monitor the fire level carefully in order to get a perfect ceramic production. After applying the fuzzy logic technology and computer vision, AI can monitor the kiln firing process with the same strategy that human will do in this section, and manage the fire level with a more accurate operation. Computer vision sensor will monitor the color of the material and the temperature in the kiln, and the fuzzy logic will generate an optimized plan about the firing process, then the electric control kiln will change the fire to a proper level correspondingly. (Hu, Guolin & Zhong, Guiquan et al., 2008)

Other process during the production can be monitored and managed in the similar way. In one word, the AI system can take over the producing process without continuous control by people and will finally generate a full-automatic industrial chain.

3.4 Product Sales and Market Development

Other than production process, sales and market will also affect the development of ceramic products. All the investment in ceramic industry will become a waste if there is not matched market. To avoid this happening, AI technologies are also imported into marketing analysis process. It can be assembled into the marketing system and handle the analysis sections. AI can provide detailed supply and demand relationship information by collecting data from the existing markets, which will help the factories to increase or decrease the amount of production. In addition, big data collection and analysis can generate a trend of preferred designs and styles in a period of time, so ceramic industries can change their production line in order to make popular products and increase profits.

4. Conclusion

The ceramic industry is one of the main modern industries in China, which helps to create great amount of wealth for Chinese citizens. Therefore, the development of ceramic industry is important for the development of the whole country.

AI technologies have many unique advantages, so they are always on the top list of industry applications. The requirements in ceramic industry development are intelligent and efficient, which is quite suitable for AI technologies, which actually push the whole field forward quickly.

AI technologies still have blind area in ceramic production, such as poor interpretability, difficulty in ethical alignment, weak cognitive reasoning ability (Liao, Beishui, 2022), and high use and maintain threshold. In addition, the difficulty of data collection, lack of core technology, low enterprise level, and lack compatible AI facilities will also affect the development of AI application in ceramic industry. Fortunately, these issues may be solved by the upgrade of AI technology and the development of social productivity, which is foreseeable.

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