



**ARTICLE**

# Current Status and Development Trends of Chinese Intelligent Furniture Industry

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## ABSTRACT

In this work, the current status, technical capabilities, and development trends of the Chinese intelligent furniture industry were in focus. Based on combining a literature review with field investigations and analysis of major scientific research projects in Zhejiang Province, China, an in-depth overview and discussion about previous experience, features, technologies, products and control methods in the intelligent furniture industry in China were conducted. The key technologies in current Chinese intelligent furniture industry include embedded systems, sensors, short-range wireless communication, artificial intelligence and intelligent interaction techniques. This work also mentions the challenges and opportunities for the industry, pointing out how to innovate and dominate the furniture market in the era of transformation from the traditional furniture industry to intelligent upgrading. The results are proposed to help readers from all over the world to understand the development trend and progress of the Chinese intelligent furniture industry.

## KEYWORDS

Intelligent furniture; industry status; features; key technologies; China

## 1 Introduction

With the rapid development of science and technology, intelligent technologies have been widely applied in furnishings [1,2]. Nowadays, intelligent furniture management system has several functions with respects of emotion analysis, text emotion recognition and emotional models [3]. According to the requirement of users, intelligent furniture can make intelligent decisions and actions [4]. Thus, intelligent furniture is favored by more and more consumers due to its unique convenience and intelligence [5–8].

In China, a reform furniture industry with advanced manufacturing technologies was proposed by the government in 2002 [9,10]. Since then, a system of intelligent furniture technologies was gradually created [11–13], including design principles, steps and theoretical framework of intelligent furniture [14]. Meanwhile, with the emergence of Industry 4.0 in 2013, the key technologies in digital quality control and production in intelligent furniture manufacturing have become the research hotspots [15–17]. Based on the literature review, the ideals and models of manufacturing, response mechanisms and coordinated development of the industrial chain for intelligent furniture in Chinese furniture industry were developed



by Wu et al. [18–20]. Their work revealed that advanced and digital technologies have gradually been integrated into all aspects of furniture design, manufacturing and industrial chain management. Furthermore, the information collection, processing technologies, and customer relationship management in manufacturing intelligent furniture were explored by Xiong et al. [21–23]. They realized the optimization and reconstruction of furniture types, materials, structures and functions, and also indicated that consumers are expecting more intelligent furniture. Therefore, traditional Chinese furniture is gradually becoming subjected to mechanical transmission, sensors, microcontrollers and embedded systems. It creates multiple and interactive relationships in a “human-furniture environment”. Intelligent products have become the main direction and trend for further development of intelligent manufacturing in China [24–26].

At present, intelligent furniture in China is still in its infancy [27]. In 2005, intelligent furniture was gradually studied by some scholars [28]. In 2008, a new bed design concept with modern technologies was proposed to realize its functions [29], and this scheme was integrated with mechanization, digitization, informatization, networking, automation and humanization concepts. In 2009, an idea was also proposed by applying intelligent methods to the design and production of children’s furniture [30]. In 2011, for medical furniture, the concept, requirements and steps of intelligent bed design and construction were clarified, and a complete theoretical framework of intelligent bed was established, which combined embedded systems, sensors and other control theories with technology [31]. Also, in 2011, an intelligent wardrobe was designed to have multi-functions, such as moisture-proof, mildew-proof, disinfection and dress reminder, but the furniture structure and control technologies were dissatisfied by consumers [32]. In 2013, an interactive design theory was used to guide the design of intelligent kitchen furniture, and the office kitchen was proposed to be designed by combining the concepts and methods with building furniture for offices and kitchens [33]. In 2015, the intelligent office was expected by many consumers, and design schemes and theoretical foundations for intelligent offices were created by Yan et al. [34]. Comparing with the theoretical researches on the intelligent furniture by Chinese and foreign researchers, it is obvious to find that Chinese researchers have focused more on the formation of the theoretical framework and intelligent features of a product [35]. The research on how to design and manufacture the intelligent furniture is still limited, especially for the self-adaptation and self-perceived intelligent furniture. However, foreign researchers have mainly focused on the human-computer interaction and settings of furniture product functions based on user behavior analysis [36,37].

In this work, the current status and development trends of Chinese intelligent were in focus, and the influences of government policies and related regulations on the development of the Chinese intelligent furniture industry were also investigated. On the basis of the research results, suggestions for promoting the development of intelligent furniture were put forward. It is hoped to provide scientific guidance for the transformation and upgrading of the intelligent furniture industry.

## 2 Methods

First, the keywords were searched in the China Knowledge Network ([www.cnki.net/](http://www.cnki.net/)), Web of Science ([www.webofscience.com/](http://www.webofscience.com/)) and Engineering Village ([www.engineeringvillage.com](http://www.engineeringvillage.com/)), including intelligent furniture, intelligent home, intelligent furniture manufacturing and intelligent home technology system. Annual data from China Furniture Association’s China Furniture Yearbook [38–42] during the past 5 years and relevant intelligent furniture data from China Customs Network (<https://www.cnfa.com.cn/>) were also analyzed.

Second, based on relevant information from China Intelligent Furniture Manufacturing Summit Forum organized by China Furniture Association and China Forest Products Industry Association (<http://www.cnfpia.org/>) in the past 5 years, and the typical Chinese firms to manufacture intelligent furniture, the

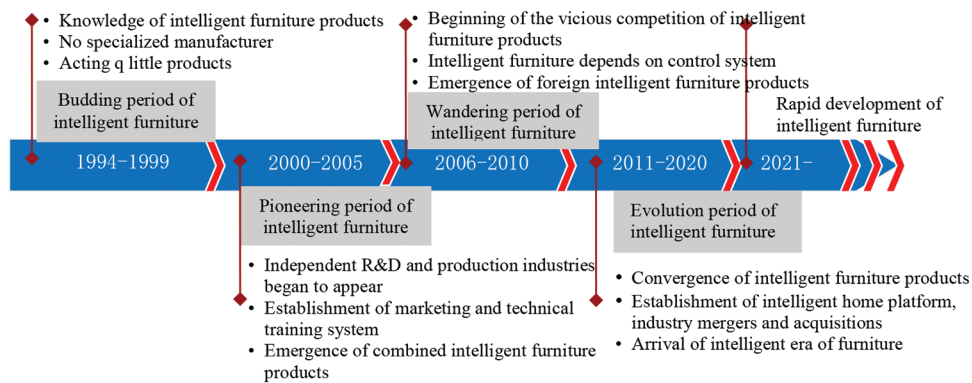
historical development process in intelligent furniture research, design and manufacturing technologies were analyzed.

Finally, as given in the supplement material, the status and development of Chinese intelligent furniture were summarized by combining the results from Zhejiang Province's Key Research and Development Project (2016BSA520915), and Jiangsu Province's Superior Discipline Construction Funding Project. Besides, practical results from the cooperation between Nanjing Forestry University and Dehua Rabbit Baby Co., Ltd. (China) were also employed in summary.

### 3 Main Features in the Development of Intelligent Furniture Industry in China

#### 3.1 Development History of Intelligent Furniture Industry

Based on findings from the surveys on the typical intelligent furniture industries, as well as a literature review, a sketch of the development history of Chinese intelligent furniture industry over the past two decades is summarized in Fig. 1. It can be divided into five stages: beginning, pioneering, wandering, fused evolution and rapid advancement [43].



**Figure 1:** Development of intelligent furniture

Before the 1990s, Chinese furniture manufacturers started to realize intelligent furniture products, but there were no professional manufacturers for them at that time. Some traditional enterprises began to publicize the intelligent furniture concept but without actual actions in productions. Researches about the concept were constrained as ideas [44–46].

In the beginning of the 20th century, there were about one hundred factories that established intelligent furniture Research & Development in China. With the intelligent development of furniture appliances, intelligent furniture has begun to establish the marketing and technical training systems, and intelligent furniture has emerged as a combination of multiple intelligence. Imported intelligent furniture products rarely appear in the domestic market, and the application of intelligent furniture products is still unstable [47]. At that time, the functions of intelligent furniture were exaggerated, and the actual application feedback for the products was unsatisfactory, resulting in irrational enterprise growth, vicious competition, and tremendous user complaints.

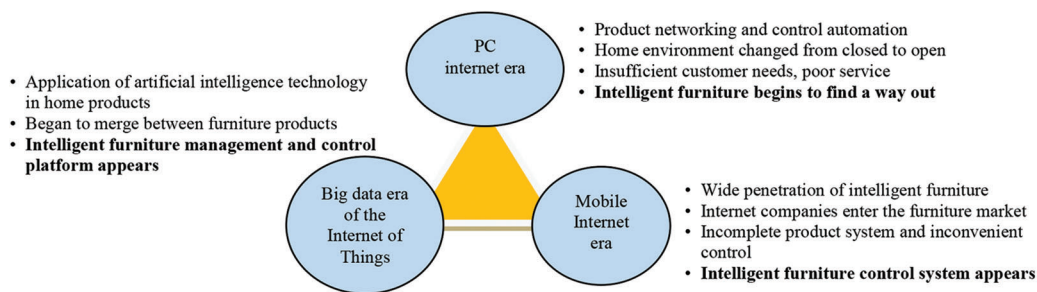
In 2005, intelligent furniture was questioned immensely, which brought a great negative impact on the industry. Therefore, those furniture companies that survived such questions began to change their corporate strategies. Developing intelligent controller systems for furniture products, and the construction of intelligent furniture platforms provided great opportunities for the industry later. Meanwhile, intelligent furniture abroad gradually entered the Chinese market [48,49].

In 2011, Chinese intelligent furniture market began to prosper again. Product types and functions as well as their innovation, exhibited a promising advancement. Forms and amount of intelligent furniture have become more and more abundant, making the industry enter a period of integration and evolution. It is in this period that furniture industry steps into the intelligent era [50].

After 2020, industry merges and acquisitions began to become the mainstream, which resulted in the intelligent furniture industry in China entering a new period of rapid development with new features [51].

### 3.2 Development Features of the Intelligent Furniture Industry in China

Different historical stages of intelligent furniture have their features. The development of the intelligent furniture industry in China is consistent with the times, accompanied by the development of the Internet. As shown in Fig. 2, extensive integration and evolution of intelligent furniture is the most notable feature in intelligent furniture industry. In each Internet era, new forms of intelligent furniture have been constantly proposed after applying new technologies and optimizing previous service forms [52,53].



**Figure 2:** Main features of the Chinese intelligent furniture industry

Before 2010, Chinese internet terminals were predominantly Personal Computers, and the Chinese home environments were gradually integrated into the concept of information flow. Networks are widely used for the traditional mechanized and electrified home appliances transformed into intelligent and digital furniture products, and their controls are mainly automated. During this period, companies working on intelligent furniture paid more attention to the product instead of users' needs, restricting the content and services of online intelligent furniture products. Consequently, they were gradually suffering from marketing gimmicks.

From 2010 to 2014, due to continuous innovations in intelligent hardware and software, mobile internet developed rapidly. At that time, the first generation of online furniture products experienced constant updates, especially the application of audio and video technologies to furniture products. Besides, single wireless intelligent products such as lamps, home cameras and sockets were developed. As a result, intelligent products with simpler operations, remote control methods, fragmented time penetration, and broader space penetration, were gradually accepted by the public. However, intelligent furniture products at this stage still had some problems, such as inconvenient controls, inconsistent communication protocols and incomplete systems.

Since 2014, as internet technology continues to develop rapidly, the era of the Internet of Things and big data has gradually come for the field of intelligent furniture. Specifically, artificial intelligence has brought great impact on intelligent furniture products by making intelligent furniture and device hosting a reality. Chinese intelligent furniture products also began to integrate functions of deep voice interaction, and gradually realized product interconnection and integration within the entire home. Furthermore, intelligent furniture management and control platforms were established. At this stage, intelligent furniture products also had the problem of data entry between platforms, i.e., a data-driven context for intelligent furniture

has begun to form. So far, intelligent furniture industry has stepped into a new period of data-driven development and artificial intelligence.

By investigating and analyzing the current market of intelligent furniture products in China, this furniture is mainly composed of a furniture body and intelligent control. Intelligence control can be divided into four categories: mechanical control, combination control, digital control, and electronic control. Depending on their control system, intelligent furniture products will exhibit different features.

Mechanical intelligent furniture [54] refers to intelligent products such as multifunctional sofa beds, pull-out folding sofas and manual invisible beds, in which a transmission mechanism or a mechanical device is implanted. Functions such as movements, overturns, folding, rotations and stretches, are controlled by a manual controller. Products of this kind are currently available on the Chinese market.

Combination intelligent furniture [55] is intelligent furniture products such as foldable multi-functional tables, mobile combination beds and stretch-fold tables. They can achieve a functional change on the whole or part of the product by rotating, folding, stretching, flipping and moving, which is realized by combination or splitting strategies. Such products are mature in actual manufacturing practice and have been widely implemented in Chinese table and chair enterprises.

There are many types of intelligent electronic furniture, such as electric lifts, intelligent tables, intelligent coffee tables (dining tables) with heating and charging functions, electric intelligent beds and electric remote control flip hidden beds. These products can provide specific functions by implanting mechatronic accessories or advanced electronic products in the furniture body, which are in turn controlled by wired or wireless remote control, motion, light or manual touch.

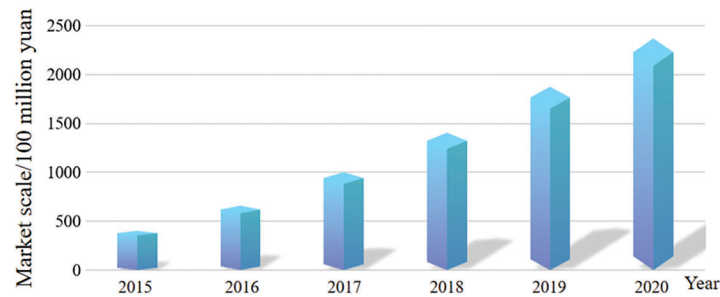
Finally, there are also many types of digital intelligence (Internet of Things intelligence) furniture, mainly including intelligent massage chairs, intelligent beds with sensor intervention, intelligent lockers, intelligent wardrobes and shoe cabinets with dehumidification, deodorization and sterilization functions. In these furniture products, functional controls can be achieved by controlling systems, sensors or other intelligent components embedded in the furniture body by touching, movement, mobile terminals (such as mobile phones, tablets) and wireless networks. This kind of intelligent furniture products realizes its functions by a network center and a data-driven core. Therefore, Chinese factories are still in the stage of design and trial production for these products, which are relatively rare in the Chinese markets.

## **4 Intelligent Furniture Industry and Its Technology Development in China**

### ***4.1 Intelligent Furniture Market in China***

According to the survey, the global intelligent furniture market is expected to grow at an average annual rate of 14% within 2016–2022, reaching \$ 122 billion by 2022. In 2016, the intelligent furniture market in the United States reached 9.7 billion dollars, which is equivalent to 77 billion yuan [56]. New technologies, especially the ones related to artificial intelligence, such as speech recognition and deep learning, and 5G mobile communications, are continuously integrated into furnishings. As a result, intelligent furniture systems continue to prosper with more product categories. The general trend of user market penetration is growing. In the past 10 years, Chinese intelligent furniture industry has grown more than 40% in its scale (Fig. 3), which is expected to reach 198.5 billion yuan in 2019 and 237.1 billion yuan in 2020. However, the penetration rate of Chinese intelligent furniture market remains lower than 5%, falling far behind developed countries like the United States (25%) and the United Kingdom (18%). Therefore, Chinese intelligent furniture industry still has great potential for further development [57].

Although intelligent furniture has a certain market share, it is still not prominent in the current intelligent furniture market. Nevertheless, with the rapid development of technologies and the industry, its share and scale will increase in the near future.



**Figure 3:** Intelligent furniture market in China

#### ***4.2 Development of Chinese Intelligent Furniture Industry***

For the intelligent furniture industry, foreign designers have been at the forefront [58]. For example, an intelligent bed, which was designed with a computer, television and gaming system, becomes a powerful entertainment complex. According to the needs of the users, the intelligently adjustable sofa seats can be raised, lowered and arbitrarily combined into various shapes, and the intelligently adjustable sofa seats can also be used alone or in multiple modules. In addition, it is also equipped with an APP that allows the users to change the height and number of seat or switch between chairs, sofas and beds. Such technology with apparent features of artificial intelligence can also be applied to furniture or other items.

In China, some traditional furniture companies have begun to reform the production and research on intelligent furniture. These changes have led to improvements in the features and technical requirements of intelligent furniture, which have brought different experiences to users. Because the intelligent furniture industry started late in China, all technologies are still undergoing experimental development, and few companies have successfully made established intelligent furniture products. Some traditional furniture companies have gradually started to introduce intelligence in their traditional lines, such as intelligent sofas, intelligent cabinets and dining tables, and intelligent wardrobes and other furniture items. These new products have gradually begun to revolutionize consumers' experience with traditional furniture products.

Intelligent furniture is developed based on the family. In the past two years, cross-discipline cooperation between companies of internet technology, home appliances and real estate developers has emerged. In order to meet the requirement of different consumers, the intelligent furniture industries reform their products based on the information sharing in the entire home environment. Intelligent furniture products have gradually entered an era of digital intelligence (the Internet of Things), using mobile terminals and wireless networks to achieve functional control of the furniture. However, the concept of this cooperation is extremely innovative and practical, and its brand impacting is still low with inadequate technological innovations. Thus, it needs to quickly follow up with the rapid development of Chinese intelligent furniture industry [59].

#### ***4.3 Changes in Chinese Intelligent Furniture Products and Controls***

Chinese furniture companies currently offer three types of intelligent single products, which work by either different connecting products or interacting between different types of products [60]. Intelligent furniture items are mainly developed by traditional furniture companies, and their intelligence level is mainly determined by the control system and information sharing. As these products are subject to protocol issues and common interface problems, their compatibility is always limited. On the other hand, the integration and interaction between different types of products are mainly based on the concept of intelligent life. Taking the overall home environment into consideration, the U+ big data analysis platform was used to incorporate a series of furniture products, such as home appliances, lighting,

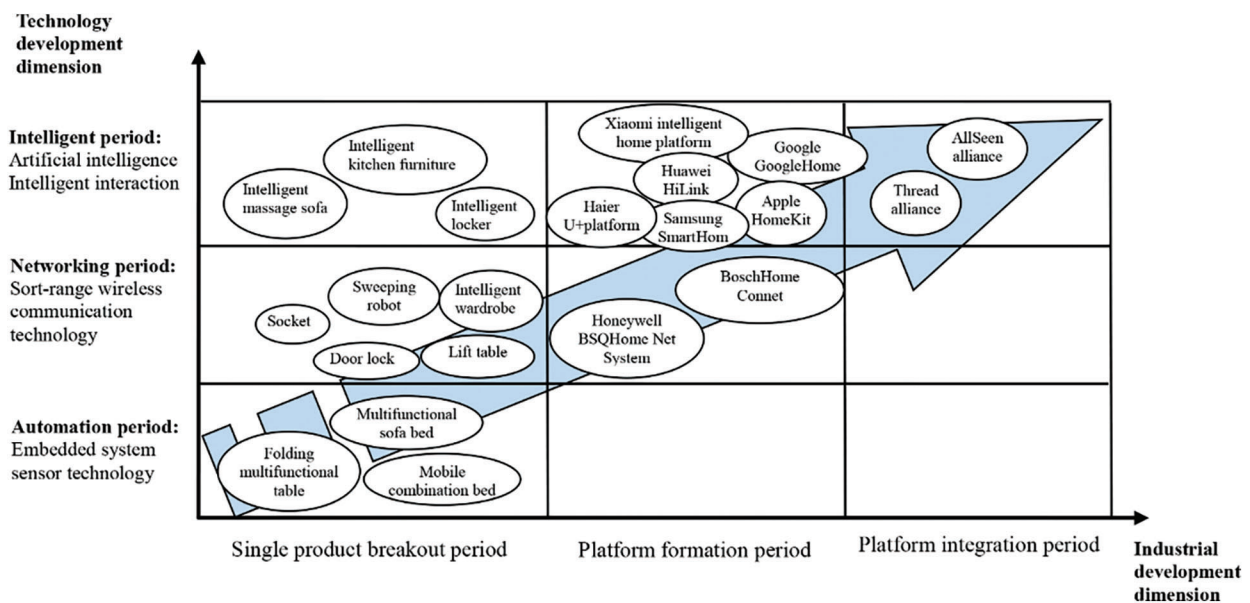
curtains and security systems, and then a U+ intelligent home interconnection cloud was created to connect the entire home in one chain. It can be found that the intelligent furniture products have gradually immersed into every aspect of our life.

Recently, the control system of intelligent furniture has been continuously upgraded. Based on the field investigations, it is found that Chinese intelligent furniture is mainly controlled by mobile phones, which is basically a combination of multiple control strategies. At present, an inductive control strategy is being developed with a basic technical system. However, it is not enough to build intelligent furniture products with fully automated inductive control. Therefore, currently Chinese intelligent furniture companies are working to combine the integration and interaction between different types of intelligent furniture products together [61]. Considering the entire home environment and consumers' living needs, the self-made control system for intelligent furniture products has been performed by implanting sensors on heart rate, moderate, temperature, light pole, distance, etc.

#### 4.4 Technological Development of Intelligent Furniture

According to the literature review, the intelligent furniture technologies of the United States and some European countries (such as Germany and the United Kingdom) have always been leading the world. Technologies of the intelligent furniture industry in China are constantly improving and updating at high speed, especially in the formation and integration of the intelligent furniture product platform.

Fig. 4 describes the different technologies for intelligent furniture, industrial development stages, and typical products, i.e., the automation, networking and intelligent technologies for intelligent furniture are analyzed, and the typical intelligent furniture products with different technologies and industrial development stages were also in focus. Technologies for Chinese intelligent furniture industry are evolving rapidly. Although a fixed technical architecture remains to be established, cross-platform interconnection and interoperability are being built to break the restrictions from independent platforms. Meanwhile, intelligent furniture technologies are a complex interdisciplinary system, and it is difficult to define specific technologies from a single aspect. Based on preliminary research and related literature, common technologies, including embedded systems, sensors, short-range wireless communication, artificial intelligence, and intelligent interaction, are the keys to realizing the intelligent of furniture [62].



**Figure 4:** Different technologies for intelligent furniture, industrial development stages, and typical products

Embedded system, refers to the microcomputer processing systems embedded in the furniture, which can be considered as the “central nervous system” of an intelligent furniture product. In general, the embedded system is composed of support hardware, application software, processors and an operating system. At present, embedded systems have been widely used in intelligent phones, digital cameras, home appliances and auxiliary navigation systems. Thus, the embedded system has led to the innovation of intelligent furniture, and it will be widely used in furniture products [63]. Additionally, the core of the embedded system is the operating processors, which are designed based on user requirements. At present, single-chip microcomputers in embedded microcontrollers have the characteristic of small size, large memory and high performance [64], which occupy a large share in the Chinese intelligent furniture market.

For sensors, they have already been integrated into industrial production, space development, environmental protection and other fields, especially for wide application in the modern technology. Sensors can convert external non-electrical information into electrical signals, then send the signals to furniture products, and finally enable diverse functions. These devices have been widely applied in the field of intelligent furniture [65].

Short-range wireless communication is one of the important technologies of intelligent furniture. The rapid development of intelligent furniture requires more data communication and transmission between intelligent devices. Therefore, short-range wireless communication emerged and quickly became popular in intelligent furniture products [66]. Among all the approaches, Wi-Fi is the earliest in the actual application, and it is commonly used in small appliances. Bluetooth is mainly used in mobile products and is gradually applied to office furniture products after multiple optimizations. Wi-Fi and Bluetooth are suitable for sensing and control scenarios. The biggest advantage of Near Field Communication is the short communication distance, and high security in the home environment, thereby improving the intelligence of furniture.

For artificial intelligence, due to the continuous growth and self-learning of algorithms, artificial intelligence devices with general purposes are still relatively underdeveloped in China. Therefore, it is still a bottleneck problem for further innovation of Chinese intelligent furniture products, even with the rapid development of deep learning and machine learning in China.

Intelligent interaction technologies, it is the core of intelligent control, which has been widely used in intelligent voice interaction. Nowadays, intelligent furniture products in China are mainly controlled by smartphones. However, in the intelligent furniture environment, speech recognition is hard to complete complex tasks. Meanwhile, virtual (augmented) reality is also currently under rapid development, and it is gradually being applied to intelligent escort, security and home entertainment systems in intelligent furniture [67].

In summary, although the technical system of intelligent furniture in China has not been completely improved, with the progress of the Internet, the adoption of advanced technology will promote furniture products to be more intelligent.

## **5 Development Policies and Regulations for Intelligent Furniture Industry in China**

### ***5.1 Development Policies***

According to the relevant data, the Chinese government has been providing a lot of support for the intelligent furniture industry [68]. In the Eleventh Five-Year Plan of China, the Ministry of Information Industry took the home network Research & Design as one of the most critical information industry projects to build an advanced national information infrastructure. In the Twelfth Five-Year Plan of China, intelligent furniture was listed as an important direction for the development of smart products. In 2012, the concept of intelligent furniture was listed as one of the important development directions for science and technology in China, which was jointly confirmed by the Ministry of Industry and Information



Technology, the National Development and Reform Commission, and the Ministry of Science and Technology.

In March 2016, the government work report was published by the State Council, and it firstly showed that “development of the intelligent furniture industry”. The National Strategic Plan for the Development of Emerging Industries was issued by the State Council in December 2016, which is proposed to promote the growth and industrialization of artificial intelligence technologies. In the Thirteenth Five-Year Plan of China, intelligent furniture products were gradually industrialized.

In August 2017, guidelines of “Further Expanding and Upgrading Information Consumption to Continuously Release the Potential of Domestic Demand” was issued by the State Council, the enterprises were encouraged to use an Intelligent furniture “product + service” model for customized application scenarios based on a promotion of new digital home products such as intelligent TVs, speakers and security systems. In December 2017, the Ministry of Industry and Information Technology issued the Three-Year Plan to promote the development of a new generation of the artificial intelligence industry. With the rapid development of the Internet of Things, it was considered as a national development strategy. In 2017, Guidelines of the “Construction of an Intelligent Family Integrated Standardization System” stated that a standard system would be established by 2020 to meet the requirement of the Chinese intelligent family industry based on the Internet of Things. Based on the support of the above policies, Chinese furniture products have realized transformation and upgrading, and it promoted the rapid development of the intelligent furniture industry.

## ***5.2 Relevant Laws and Regulations***

In order to ensure a healthy development of the Chinese intelligent furniture industry, relevant laws and regulations are constantly being modified and optimized. The Chinese government has issued a policy requiring all intelligent furniture products should firstly meet the requirements of traditional safety, including electromagnetic compatibility requirements (China Compulsory Certification), energy efficiency requirements (energy efficiency labeling) and environmental protection requirements (limits of hazardous substances). They also should be integrated into wired or wireless networks to achieve its functions. Therefore, intelligent furniture enterprises and their products must meet the regulations about network information security.

## ***5.3 Regulations on Network Information Security***

With the continuous improvement of people’s attention to network information security and personal privacy protection, China has also learned from some foreign legislation and management experience on network information security. The Cybersecurity Law of the People’s Republic of China promulgated by the Standing Committee of the National People’s Congress was executed on June 1st, 2017. A unified and fundamental law on network information security in China, it aims to enhance the protection of network information and provide the overall objectives and fundamental principles of the network information security. With the law published, the Standing Committee of the National People’s Congress is accelerating the legislative process of regulations of the “Protection of Critical Information Infrastructure Security and Regulations on the Protection of Network Security Levels”. These regulations provided legislative protection of network security for intelligent furniture, thereby protecting them from network stagnation.

# **6 Challenges and Opportunities for Intelligent Furniture in China**

## ***6.1 Challenges for Chinese Intelligent Furniture***

Compared with developed countries, the living environment, intelligent furniture concept and its implementation have their regional characteristics in China. Thus, standards for intelligent furniture are

scarce. In addition, the intelligent furniture companies just started in China. Each company is driven by its own interests to design and manufacture intelligent products. There are no unified technical standards or communication protocols for products, which makes the interconnection and interoperability unavailable for the overall operation of intelligent furniture system. To this end, the guidelines of the “Construction of an Intelligent Family Integrated Standardization System” established a standard system, it can meet the needs of the Chinese intelligent furniture industry, but the executing process is still slow. Particularly, since China entered the World Trade Organization (WTO), all industries in China should be in line with international standards, especially for the intelligent furniture industrial. Therefore, the standardization has become the top priority of Chinese intelligent furniture industry.

As the market of intelligent furniture in China is very comprehensive, all companies want to share it and produce unique products, but no one is truly dominant. As a result, many types of intelligent furniture and control systems have been released, which are mutually incompatible. Once the problem occurs in using process, the customers are hard to find replacements easily. Therefore, the standardization of intelligent products is an urgent task for the development of Chinese intelligent furniture [69]. Meanwhile, with the development of integration technology, Chinese intelligent furniture industry has gradually realized cross-platform interconnection and interoperability. However, to break through the integration barrier among the new technologies, home environments and the production processes of furniture companies, intelligent furniture become gradually independent from core electromechanical and electronic information technologies. To this end, research and innovations for intelligent furniture platformization should be in focus at present.

Traditional products rely on advanced technologies to stimulate consumer demand, thereby developing a new market for furniture. However, in the actual use process, the operation of intelligent furniture is difficult, which will have a negative impact on the user experience. Therefore, for the sake of meeting consumers’ requirements, easy operations should be considered for Chinese intelligent furniture companies in the future. Moreover, the rapid development of the internet and big data technologies has brought convenience to all walks of life, but it also has certain security risks. For example, the wide application of big data in intelligent furniture, it increased the disclosure risk of personal and family information. Therefore, special attention also should be given to how to use the internet and apply big data in the furniture intelligent system without divulging the user’s information for information security. Finally, until now, few Chinese households have used intelligent furniture. Aside from the technical issues mentioned above, price is also a factor that affects consumption. Compared with traditional furniture, intelligent furniture products have made great breakthroughs in both technology and function. Still, they are comparably very expensive, making them hard to be fully implemented in ordinary people’s lives. Therefore, in addition to technological breakthroughs, price control within a reasonable range is helpful for the further application of intelligent furniture.

## ***6.2 Opportunities for Chinese Intelligent Furniture***

The development of wireless network technology provides technical support for intelligent furniture. As described before, short-circuit wireless communication technologies have become the leading technology for the development of intelligent furniture, and these technologies truly impact information and data integration in furniture, thereby realizing the functionalization and intellectualization of furniture. Wireless network not only promotes people’s interaction and use of intelligent furniture products, but also deepens people’s understanding of intelligent furniture products. Therefore, wireless network technologies can promote the development of intelligent furniture industry. Furthermore, the establishment of the big data platform provides a bigger stage for intelligent furniture. Recently, the Chinese intelligent furniture industry is the gradual realization of cross-platform interconnection, and the advancements in internet and cloud services

are pivotal in China and the world. This platform provides a solid foundation for further advancements in interconnection and integration of intelligent furniture.

With the increasing number of the Chinese netizens, Chinese information, data and network connection technologies have entered a brand-new era, directly affecting people's lives. It is speculated that in the next five years, the digital home market in China will become the mainstream, approaching a scale of 100 billion yuan, the growth rate and scale will far exceed the average level, Thus, the potential consumer demand drives the development of intelligent furniture. Furthermore, the Pan-home enterprise is also the key to promoting the rapid upgrade of intelligent furniture. Chinese intelligent furniture products are developed in different forms every year, and traditional household companies have taken the strategy of "intelligence" to build a home system. Subsequently, companies in the fields of Internet, electronics and real estate also joined the ranks of R&D of the intelligent furniture. Therefore, traditional furniture enterprises can take advantage of the Pan-home industry and cooperate with enterprises in other fields to create intelligent home environment, thereby leading to the transformation and upgrading of furniture industry.

## 7 Conclusions

In order to promote the transformation and upgrading of the intelligent furniture industry, in this work, the current status, technical capabilities, and development trends of the Chinese intelligent furniture industry. The main conclusions of this work are as follows:

- (1) According to the analysis of relevant data, information about the status of the Chinese intelligent furniture industry in the world is obtained. It has been found that the intelligent furniture manufacturing is the key for the development of Chinese furniture industry. Meanwhile, the industry in China needs improvement in terms of both theory and manufacturing. In addition, based on the data from China Knowledge Network, Web of Science and Engineering Village, related articles were summarized and analyzed for the development history and main features of intelligent furniture in China.
- (2) The evolution of intelligent furniture products was investigated based on the actual conditions of Chinese enterprises. Changes in Chinese intelligent furniture products, as well as control methods and critical technologies in the development process, were described. Additionally, the advanced technologies, such as embedded systems, sensors, short-range wireless communication, artificial intelligence and intelligent interaction were discussed.
- (3) In order to enable rapid advancements in intelligent home and furniture in China, we discussed the challenges and opportunities. On the one hand, intelligent furniture standardization and information security are challenges for their development. On the other hand, technologies of embedded systems, sensors, short-range wireless communication, artificial intelligence, and intelligent interaction realize the functionalization and intellectualization of furniture, which also bring opportunities for intelligent furniture.
- (4) Facial expression recognition is an important part of affective computing and human-computer interaction for intelligent furniture, and it is a cross-subject in the multiple fields of image processing, pattern recognition, machine learning, physiology and psychology. Thus, intelligent human-computer interaction with tightly linked, highly speedy, multimedia and friendly elements should be focused on high-intelligence of furniture.

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