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Research Article

Synesthetic Design of Digital Elderly Products Based on Big Data

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With the development of digital information technology, digital products have been integrated into people's lives. The advent of the era of big data and the application of artificial intelligence have greatly accelerated this process. However, the increasingly high-end technology of these digital products brings more and more complex operations. The use and operation of these digital products have become a huge problem for the elderly who have a low level of acceptance of digital products or even a little out of touch. The purpose of this article is to study the influence of synesthetic design of digital senior products based on big data on the development of digital senior products. This article first understands the current problems in the development of digital elderly products and the design concepts and design processes of these digital elderly products through questionnaire surveys and market research. Then, this article analyzes the importance of synesthesia design for digital product design for the elderly through literature research and related product design cases. Then, this article combines the application of big data technology and complex intelligent system to carry out the synesthesia design of digital elderly products, the most important of which is to use the image recognition technology of complex intelligent system and intelligent voice interaction technology to achieve the synesthesia effect of these product designs. Finally, this paper uses the mathematical model of maximum utility and some statistical methods to analyze the effect of the product synesthesia design experiment in this research. Studies have shown that synesthesia design can maximize the utility of digital products for the elderly. This result is more than 95% confident in statistical analysis. Therefore, synesthesia design plays an important role in the popularization and development of digital elderly products in the elderly consumer groups.

1. Introduction

1.1. Background and Significance. Today's society is rapidly entering the stage of population aging. The food, clothing, housing, and transportation of the elderly have become a social issue that cannot be ignored. Digital products and services for the elderly have also entered a new stage of development. In the era of big data, digital products are popular among young consumers. With the application and development of big data and artificial intelligence, digital products have begun to take new steps towards the elderly. Different from the traditional digital products for the broad masses of young people, digital products for the elderly need to take into account the different sensory experiences of the elderly and the special psychological emotions of the elderly. The five senses of vision, hearing, touch, smell, and taste of the elderly are weakened with age and decline in body organ functions. Therefore, the synesthesia design of digital products for the elderly has become an important factor in the development of digital products for the elderly.

The application of big data and complex intelligent systems can better realize the synesthesia design of digital elderly products. At present, the development of digital elderly products is encountering huge difficulties [1, 2]. The most important reason is that these digital elderly products are still difficult to use and operate for the elderly and cannot meet the real needs of the elderly. Studies have proposed that interactive, personalized, and emotional design of digital products for the elderly should be based on the physical and psychological characteristics of the elderly, and digital product design should be carried out from the perspective of emotional care for the elderly. This design concept and method fully consider the emotional appeal of the elderly and provide caring and warm services for the elderly [3, 4].

However, due to the complex and profound psychological emotions of the elderly, and lack of a large amount of data support, the accuracy of emotional analysis and grasping for the elderly is not high, so the application is not wide.

1.2. Related Research at Home and Abroad. For digital product design in the era of big data, a lot of research and discussions have been conducted at home and abroad, and considerable achievements have been made. Lin et al. conduct empirical research on the concept of sustainable development product design from the perspective of big data through experiments on designing digital products combined with big data and market sales surveys. Studies have shown that sustainable development is an important scientific and reasonable product design concept in today's era [5]. However, due to the single product of experimental design, it cannot represent all digital product design situations. Li et al. studied digital products and service models in the era of big data and optimized the design of some free digital product samples. Experiments have proved that consumers have a higher degree of acceptance for free digital products [6]. This is the psychological function of consumers, but consumers simply use them and do not trust these free products. Kong carried out digital media product design based on human-computer interaction technology, which is an important application of artificial intelligence in digital product design [7]. This research is of great significance for the realization of human-computer interaction. But for some special consumer groups such as young children and the elderly, there are limitations such as difficulty in truly realizing human-computer interaction. Su et al. proposed a model for automatically interpreting synthetic metaphors, which can learn the semantic knowledge of features and simulate cross-modal semantic similarity to achieve cross-type synesthetic connections between the same perceptual methods [8]. However, although this model can consider semantic knowledge and reflect cross-modal relationships, it cannot further classify and apply these cross-modal relationships.

In foreign countries, the research on big data and synesthesia has penetrated various fields. Hagtvedt and Brasel conducted three eye movement experimental studies on the comprehensive cross-modal correspondence between sound frequency and color brightness. Studies have shown that this comprehensive cross-modal correspondence between sound frequency and color brightness can automatically guide visual attention [9]. It is a pity that the research results have not been applied to product design. Nagaraj et al. introduce new digital and physical tools to identify internal and even team internal patterns of the design process. These digital tool products can evolve into multiple forms to meet the needs of different designs in the design process [10]. However, because these digital tool products are highly targeted, it is difficult to popularize the majority of user groups. Through experiments, Neckar and Bop found that word color associations are closely related to psychopathological symptoms such as anxiety, depression, mental retardation, and traumatic stress symptoms. Experiments have shown that this is caused by an abnormal experience in another unstimulated way caused by stimulation of one sensory or cognitive pathway [11]. To put it simply, it is a neuropsychological disease caused by synesthesia, just like what people call "the wrong line of nerves." Lipscomb proposed the product synesthesia design based on the perception process, especially the cross-mode experience, and evolved from the discussion of cross-mode influence to a higher-level product design cognitive process [12]. The flaw in the digital product design for the elderly is less applications.

1.3. Related Work and Innovations in This Article. This paper proposes a synesthetic design concept for digital elderly products based on big data, using the parallelism of the five senses of the elderly to synesthesia design for digital elderly products [13, 14]. In the design process, this research uses the data mining technology in big data and the image recognition and intelligent voice interaction technology of complex intelligent systems to realize the synesthesia effect of the product and bring convenience to the elderly to use digital products [15, 16]. In the market analysis of synesthesia design for digital products for the elderly, this article also conducts market research and statistical analysis. Through the utility maximization model in product economics and mathematics, the utility of the synesthetic design of digital elderly products and the popularity of elderly consumers are analyzed. The synesthesia design of digital products for the elderly is to design the product functions in parallel through the synesthesia of some senses. For example, for old people with poor eyesight, they try to transform the visualization into the form of sound, and for the forgetful elderly, they are reminded to take medicine on time through the combination of auditory and visual sensory perception.

2. Research Method of Synesthetic Design of Digital Products for Elderly

2.1. Utility Maximization Model of Digital Product Design for Elderly. Whether it is a physical product or a virtual digital product, the concept and goal of its product design are inseparable from the realization of maximum utility. In the synesthesia design of digital elderly products, in order to maximize utility, it is necessary to understand the relationship between the quality and demand of digital elderly products. The so-called utility maximization is the process by which consumers meet part of their needs to the maximum extent through the purchased products under their existing conditions [17]. This is the basic means for the product to attract consumers to buy, and it is also the use value that the product must have. In the utility maximization model of digital elderly products, it is assumed that elderly consumers buy digital products at the selling price and the quantity purchased, respectively, as N and S. Before purchasing the product, the disposable income of the elderly is P; after purchasing the product, the remaining asset is D. According to the theory of utility maximization model, the income constraint conditions of elderly consumers can be obtained as shown in

$$D = pn + s. \tag{1}$$

According to the abovementioned constraints and the

knowledge of utility maximization, the utility function ω of the digital products purchased by the elderly consumers can be obtained, where f represents the use value of the digital elderly products:

$$\omega = \omega(f, n, s). \tag{2}$$

Therefore, starting from the economic conditions of the elderly consumers and the use value of the digital products purchased, we can see that the utility maximization model of digital elderly products is shown in

$$\begin{cases} \max \omega(f, fn, s), \\ pn + s = D. \end{cases} \tag{3}$$

In the synesthesia design process of digital products for the elderly, the above constraints need to be lifted according to the actual situation and the needs and interests of the elderly. That is, the income restriction conditions of the elderly are substituted into the utility function of digital products. According to Cobb Douglas's utility number theory, a reference coordinate system that is easy to analyze can be selected. The utility function of digital products can be written in the form of equation (4), where μ is the A4 reference coordinate system and λ, α, and β are all parameters greater than 0 in the reference coordinate system [18, 19]:

$$\begin{cases} \omega(f, n, s) = \omega(f, n, D - pn) = \mu f^{\alpha} n^{\beta} + \lambda(D - pn), \\ \mu > 0, \lambda > 0, 0 < \alpha < y, 0 < \beta < 1. \end{cases} \tag{4}$$

After obtaining the utility function of digital elderly products, since the quality, product price, and product quantity of similar products on the market are single, elderly consumers can only purchase one of these products to obtain its use value. Therefore, in order to maximize the utility of digital products purchased by elderly consumers, the number of products must meet the first-order condition in

$$\frac{\partial \omega}{\partial n} = \mu\beta f^{\alpha} n^{\beta - 1} - \lambda p = 0. \tag{5}$$

According to the first-order constraint conditions in (5), the optimal purchase quantity n and the actual expenditure pn of digital products for the elderly consumers under the optimal purchase quantity can be obtained:

$$\begin{cases} n = \left(\frac{\mu\beta}{\lambda p}\right)^{1/1-\beta} f^{\alpha/1-\beta}, \\ pn = \left(\frac{\mu\beta}{\lambda}\right)^{1/1-\beta} f^{\alpha/1-\beta} p^{-\alpha/1-\beta}. \end{cases} \tag{6}$$

Substituting formula (6) into formula (4), the utility function in the utility maximization model of digital elderly products can be obtained as shown in

$$\omega(f, n, D - pn) = \mu(1 - \beta)\left(\frac{\mu\beta}{\lambda}\right)^{1/1-\beta} f^{\alpha/1-\beta} n^{\alpha/1-\beta} + \lambda D. \tag{7}$$

When the disposable income D of the elderly consumers is constant, according to the utility function and the partial derivative of the multivariate function, formula (7) can be obtained:

$$-\frac{\partial \omega}{\partial n} = \mu\alpha\left(\frac{\mu\beta}{\lambda}\right)^{\beta/1-\beta} f^{\alpha+\beta-1/1-\beta} n^{\alpha/1-\beta}. \tag{8}$$

Utility reflects the extent to which elderly people meet their needs and interests by consuming digital products or services. It most directly reflects the use value of the product. Therefore, the utility of consumers buying products is closely related to the use value of the products. The use value of a product is actually the ratio of product quality to price. According to the relationship between product use value and quality and price and the partial derivative knowledge of multivariate function, the constraints that need to be met to maximize utility can be obtained:

$$f = \frac{m}{n}, \frac{\partial f}{\partial m} = 1. \tag{9}$$

According to the constraint condition of formula (9), the partial derivatives of the utility function ω of digital elderly products with respect to product quality m and sales quantity n are calculated to reflect the correlation between them:

$$\begin{cases} \frac{\partial \omega}{\partial m} = \frac{\partial \omega}{\partial f} * \frac{\partial f}{\partial m} = \mu\partial\left(\frac{\mu\beta}{\lambda}\right)^{\beta/1-\beta} f^{\alpha+\beta-1/1-\beta} n^{\alpha/1-\beta} > 0, \\ \frac{\partial \omega}{\partial n} = \frac{\partial \omega}{\partial f} * \frac{\partial f}{\partial n} + \frac{\partial \omega}{\partial n} = -\mu\left(\frac{\beta - 1}{\lambda}\right)^{\beta/1-\beta} * \left(\alpha f^{\alpha+\beta-1/1-\beta} n^{-1/1-\beta} + \beta f^{\alpha/1-\beta} n^{-\alpha/1-\beta}\right) < 0. \end{cases} \tag{10}$$

It can be obtained $\partial\omega/\partial m > 0$, $\partial\omega/\partial n < 0$ through the calculation and verification of the above formula. Therefore, when the disposable income of elderly consumers is certain, the utility function of elderly consumers is positively correlated with the quality of digital products they buy and negatively correlated with the price of digital products. In other

words, the improvement of the quality of digital products can promote the demand for digital products of the elderly. The main content of this article is to improve the quality of products through synesthesia design of digital products for senior citizens combined with big data.

2.2. Data Mining of Synesthetic Design of Digital Elderly Products. Because most of the elderly have a very vague understanding of digital products, such as the use of smart phones, when the elderly use digital products brought by electronic devices such as smart phones, they do not know how to obtain the products and services they need or are interested in through operations. The application of big data and artificial intelligence has brought new opportunities to solve this problem. In this paper, the Apriori algorithm of big data is used to realize the data mining of synesthetic design of digital elderly products, and based on this, the association interest degree model is established. The core idea of the Apriori algorithm is to filter the collected data iteratively according to Boolean association rules. It is a data mining algorithm based on recursive thinking. The specific workflow of the Apriori algorithm is to first scan the database and count the occurrence times of each data set or item in the database, generate a frequent itemset from these data sets, and then generate a candidate itemset through a Boolean operation. Then, repeat the above steps to generate a new frequent itemset and candidate itemset each time, and search until candidate itemsets cannot be generated [20, 21]. The Apriori algorithm generates a large number of frequent itemsets and candidate itemsets during data mining, and the generation of Boolean association rules for screening does not involve the participation of elderly consumers. Therefore, this method of digital product data mining not only consumes huge resources but also has low efficiency in data mining, making it more difficult to meet the real needs and hobbies of elderly users. The interest degree association model improves the way of generating Boolean association rules in the Apriori algorithm. The interest association rule is to use the Boolean association rules generated by existing data mining and use mathematical statistics to screen the association interest degree to obtain the value of the association interest degree. Its calculation formula is as follows:

$$\operatorname{corr}(x, y) = \frac{p(x, y)}{p(x)p(y)} = \frac{p(y \mid x)}{p(y)}. \tag{11}$$

The numerator and denominator in the above formula are the probability of the corresponding data set, where $p(y \mid x)$ represents the probability of data set y appearing in the case of data set x and $\operatorname{corr}(x, y)$ reflects the degree of correlation between data set x and data set y; the larger the value of corr (x, y), the closer the connection between the data sets, and the strong association rules of the interest degree $\operatorname{corr}(x, y) \leq 1$ that can be removed accordingly, which can better cater to the needs and interests of users.

2.3. Application of Image Recognition Technology in Synesthesia Design of Digital Products for Elderly. For the elderly, the biggest obstacle to the use of digital products is the understanding and operation of product functions. Even with today's highly intelligent mobile phones, computers, and other digital product devices that have implemented graphical operation interfaces, it is still not possible for the elderly to quickly learn to operate and use them. Therefore, combined with complex intelligent system technology, this paper uses image recognition technology, especially face recognition technology, to facilitate the elderly to use digital elderly products. For example, with the design of a sticky note phone, the elderly only need to click on the corresponding face avatar to make a call when making a call, without having to enter a lengthy phone number.

In order to recognize images, especially human faces, to realize the synesthesia design of senses such as vision and hearing of elderly products, this paper adopts the commonly used Haar-like feature extraction method in face recognition and improves on this basis. This feature extraction method is to find out the three-dimensional position coordinates of similar gray-level distribution in the image based on the principle of gray-level similarity, so as to determine the data feature points of the selected image [22, 23]. But this method is more suitable for feature extraction of static pictures, and the running time and resources consumed in the process of selecting images are too much, so this article uses the method of an integral graph in mathematics to improve it. In the selected image, this paper uses T to represent the sample of feature learning, and the integral graph of similar gray distribution position (x, y) is as follows:

$$tt(x, y) = \sum_{x' \leq x, y' \leq y} t\left(x', y'\right), \tag{12}$$

where $tt(x, y)$ represents the sum of pixels in a similar gray-scale distribution area, and its specific calculation formula is shown in equation (13), where $l(x, y)$ represents the gray-scale sum of the similar gray-scale distribution position (x, y) on the ordinate:

$$tt(x, y) = tt(x - 1, y) + l(x, y). \tag{13}$$

Initialize the sum of gray levels $l(x, y)$ and the sum of pixels $tt(x, y)$ of the similar gray-level distribution area, respectively, and then perform feature extraction on the extracted image once to obtain the integral image of the similar gray-level distribution and then obtain the feature data information of the picture. The improvement of the integral map to the Haar-like feature extraction method reduces the computational complexity of feature extraction and effectively reduces the running time and resources consumed by the algorithm. The calculation formula of the gray sum is shown in

$$l(x, y) = \sum_{y' \leq y} t\left(x, y'\right) = l(x, y - 1) + t(x, y). \tag{14}$$

2.4. Application of Intelligent Voice Interaction Technology in Synesthesia Design of Digital Products for Elderly. In the past digital product design for the elderly, it is still difficult to popularize and promote electronic equipment products such as mobile phones and computers that are already very intelligent

for young people. Although the digital products and services brought by these devices have simple voice communication functions, such as voice assistants, the elderly still have greater difficulties in using them. For example, a mobile phone voice assistant is more like a one-way communication between a machine and the elderly for the elderly, and the language of the elderly is often not recognized correctly due to factors such as confusing accents and illegible words, thus providing the real needs of the elderly.

The intelligent voice interaction technology used in this paper is similar to the image recognition technology, which uses feature extraction to identify the real demands of the elderly [24, 25]. On this basis, this article further introduces the concept of synesthesia design and the application of complex intelligent systems, through the study of visual images and even the psychological and emotional research of the elderly and the synesthesia design combined with the voice assistant to solve the traditional voice assistant's difficulty in identifying the real demands of the elderly problem.

3. Experiment on Synesthetic Design of Digital Products for Elderly

3.1. Research Object. This research experiment is mainly aimed at the synesthetic design of digital elderly products. In this experiment, this article carried out digital products for the elderly such as mobile phones, radios, televisions, computers for the elderly, electronic notebooks, medication aids, electronic alarm clocks, and other digital products for the elderly in leisure and entertainment, communication, medical care, and daily assistance.

For example, in view of the difficulty of dialing on mobile phones of the elderly, synesthesia can be designed through the face and voice. The elderly only need to follow the avatar and voice prompts to make a call without entering a number. This study sets up a controlled experiment to investigate and analyze the market sales of digital products of universal design and digital products for the elderly through synesthesia design and the use of the elderly. This article uses a questionnaire survey to study the opinions of the elderly on these digital products. In this experiment, the elderly volunteers who volunteer to participate in the study are required to have the experience of purchasing digital products and also pay attention to the protection of the privacy of these elderly volunteers and the safety of the use of digital products. In this questionnaire survey, a total of 120 questionnaires were distributed, of which 100 were valid questionnaires, and the effective response rate of the questionnaire reached 83.3%. In order to exclude the influence of other factors, this controlled experiment requires that the basic functions of the designed digital elderly products be consistent. Except for the synesthesia design of the product, the quality of the product and other indicators are at the same level.

3.2. Experimental Design. After understanding the current problems in the design and development of digital elderly products and related research results through literature research and questionnaire surveys, this study conducted a synesthesia design experiment of digital elderly products based on big data. This experiment is divided into four steps. First, collect information and ask the designers of digital elderly products about the design concepts and basic processes of these products. Then, select companies that voluntarily participate in the experiment and research in the design and production of digital elderly products, and set up a synesthesia design group and a control design group to design digital elderly products. Among them, the synesthesia design group adopts the latest big data and complex intelligent systems and other technologies for synesthesia design of digital products, while the control design group is based on general digital product design for all consumer groups. Then, this study takes six months' sales as a cycle to understand the impact of synesthesia design of digital products for the elderly on the market, and the relevant experimental personnel investigate and analyze the sales situation and market popularity of these products. Finally, through the utility maximization model and statistical knowledge, the market research situation is statistically analyzed.

Table 1: Factors influencing the elderly not buying digital products.

Influencing factors	Number	Proportion	Average	IL
No entity	43	35.83%	36.43%	0.4437
Not safe	65	54.17%	53.55%	0.5438
Inconvenient operation	72	60.83%	61.22%	0.8375
Like to buy in store	37	30.83%	31.62%	0.3564
Others	19	15.83%	16.33%	0.2133

3.3. Market Research Data Statistics. In this experiment, SPSS 22.0 is used for data analysis. For the experimental results, the LSD method and Dunnett's method are used for variance analysis. The accuracy and error of the test results are up to $\alpha = 0.05$. α can represent all significant levels between 0 and 1. In the data of the whole experimental group, excluding the influence of other factors, analyze the data under the change of single factor and compare with the average value, and then conduct an error test. For a group of experimental data, the number of data at a factor level to be studied is recorded as m, and the error is MS_E; then, the LSD test formula is as follows:

$$W = \sqrt{\mathrm{MS}_E\left(\frac{1}{m_i} + \frac{1}{m_j}\right)}. \tag{15}$$

In the experiment, according to the different degrees of freedom of the variables, if you want to test the difference between the experimental combination of the group k and the control group, Dunnett's method is generally used for the test. It is a special form of the LSD method, and the formula is as follows:

$$\mathrm{Dunnett} = \frac{\bar{X}_k - \bar{X}_0}{s_E^2}, s_E^2 = \mathrm{MS}_e\left(\frac{1}{m_i} + \frac{1}{m_j}\right). \tag{16}$$

Among them, $\bar{X}_k$ represents the data mean of the experimental group in group k, $\bar{X}_0$ represents the mean of the experimental data of its control group, and MS_e represents the mean

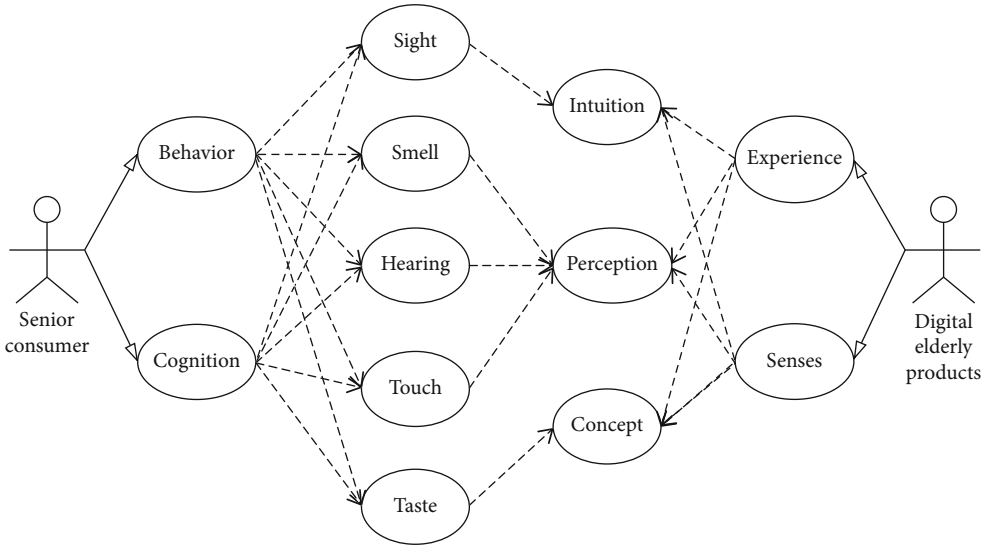

Figure 1: The interaction process between the five senses of the elderly and digital elderly products.

square error. This test method allows multiple comparisons of the mean differences between multiple experimental groups and a control group, used in this study to verify the conclusions drawn from the experimental results.

4. Discussion on Synesthetic Design Experiments of Digital Products for Elderly

4.1. The Reasons Why the Elderly Do Not Choose to Buy Digital Products. In order to understand the purchase of digital products by the elderly, this article uses a questionnaire to analyze some of their basic consumption and the reasons why they do not choose to buy digital products. The specific situation of this survey is shown in Table 1. In the survey of the reasons why 120 elderly consumers are unwilling to buy digital products, 72 elderly consumers indicated that they are unwilling to buy digital products because of difficulty in operation 60.83% of the survey group. This is mainly due to the fact that the operation of traditional digital products relies on a certain cognitive basis for digitization and the ability to read related texts. It can be seen that the synesthesia design of digital elderly products can effectively improve and solve this problem. In Table 1, IL represents the influence of no physical products, low safety, difficult operation, like to buy products in physical stores, and other reasons on the purchase mode and products of the elderly.

According to the survey in Table 1, this article studies and understands the specific process of how elderly users use digital elderly products to obtain the required service experience. As shown in Figure 1, the interaction process between digital products and the elderly is mainly realized through the perception of the five senses. The behaviors and cognition of the elderly are conveyed through sight, smell, hearing, touch, and taste and obtain digital products and services that they need or are interested in through various electronic devices. In the past, digital products are generally designed to provide digital products and services for elderly users and therefore rely on the active perception and operation of elderly users.

4.2. The Influence of Digital Elderly Products under Different Designs on the Purchasing Desire of the Elderly. This paper studies the influence of synesthetic design and traditional universal design of digital products for the elderly on the purchase desire of the elderly through comparative experiments. Here, we mainly introduce the logo design and audio-visual function design of digital products. As shown in Figure 2, this article compares and analyzes the influence of synesthetic design on the purchase desire of the elderly from the color, form, three-dimensional texture of the logo of digital elderly products, and the use of audio-visual equipment, sound, and material. As can be seen from the figure, digital products for the elderly with synesthesia design are obviously more popular with the elderly. As shown in the figure, among the factors that affect the purchase desire of the elderly, the texture and operation of the product, which account for 95.6% and 92.5%, respectively, are the most important factors.

4.3. Sensual Weakening Disability Ratio of the Elderly and the Utility of Digital Elderly Products under Different Designs. In order to study the sales and development of digital products for the elderly, this article first investigates the types of products that elderly consumers mainly buy and the ways and designs of these products. As shown in Table 2, for food, clothing, electronic products, phone bills, water and electricity recharges, and other products, elderly consumers tend to go to physical stores to buy instead of buying digital products or obtaining digital services such as online shopping and recharging through digital products.

According to the survey in Table 2, this article further investigates the sensory weakness of elderly people of different ages and genders and the utility of using digital elderly products. As shown in Figure 3, with the increase of age, both elderly men and elderly women have different degrees of disability. This has created more and more serious obstacles to

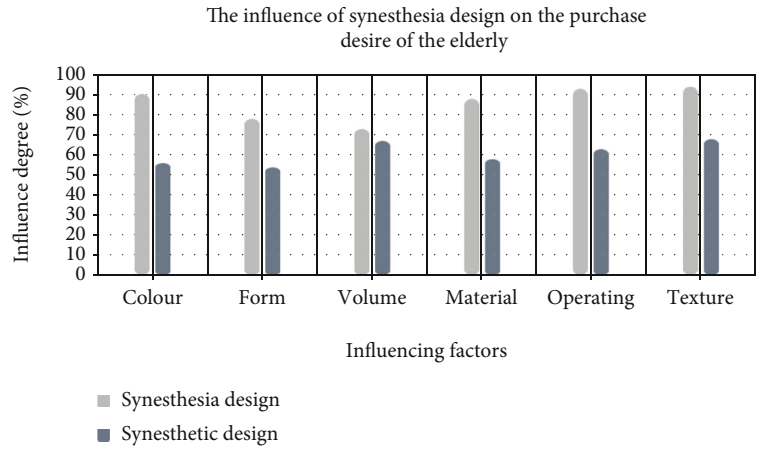

Figure 2: The influence of synesthesia design on the purchase desire of the elderly.

Table 2: Types of products purchased by seniors.

Product type		Number	Proportion	Average	Utility
Foods	Digital product	8	6.67%	7.12%	33.6%
	Physical product	25	20.83%	22.65%	54.2%
Clothes	Digital product	11	9.17%	10.13%	25.4%
	Physical product	49	40.83%	41.25%	62.5%
Electronic product	Digital product	26	21.67%	20.87%	42.5%
	Physical product	35	29.17%	30.12%	68.7%
Recharge	Digital product	39	32.5%	31.26%	66.9%
	Physical product	33	27.5%	28.09%	56.6%
Others	Digital product	37	30.33%	29.97%	44.3%
	Physical product	22	18.33%	19.98%	37.6%

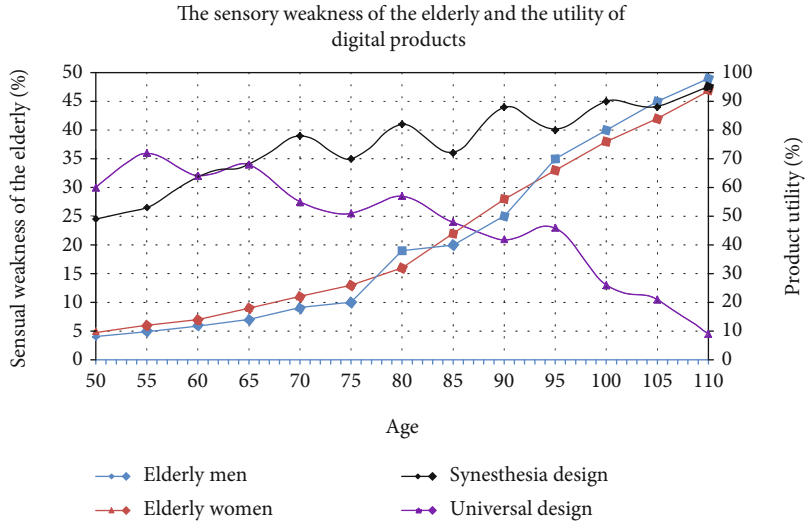

Figure 3: The sensory weakness of the elderly and the utility of digital products.

the use of digital elderly products and also restricted the development of digital elderly products. It can be seen from Figure 3 that before the age of 60, the utility of products designed by the middle-aged and the elderly for whether there is synesthesia design is between 25% and 35%. After the age of 60, the utility of digital products for the elderly with synesthesia design is rapidly improving, reaching more than 95% for the centenarians, which is of great help to them. Under this circumstance, it can be seen that the utility of synesthesia-designed digital products for the elderly is

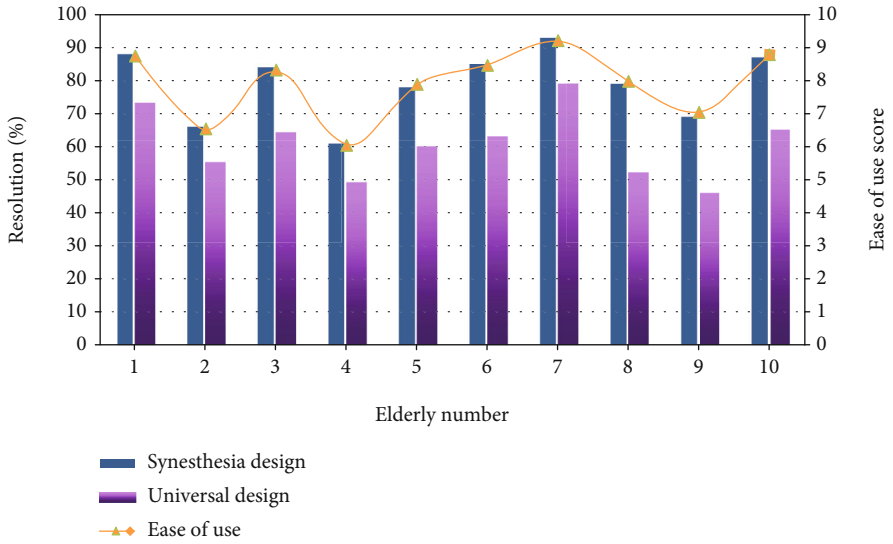

Figure 4: Senior citizens' recognition and ease of use of digital products under different designs.

continuously improving for the elderly with increasing age, while the utility of traditional digital products in these elderly people is rapidly decreasing with age.

4.4. The Recognition and Ease of Use of Digital Elderly Products under Different Designs by the Elderly. Regarding the convenience brought by the synesthetic design of digital products for the elderly, this article mainly analyzes the recognition of these products by the elderly, especially the sound and color. As shown in Figure 4, this article intercepted the survey results of 10 elderly people in the questionnaire for analysis. Among these 10 elderly users, their perception of digital products with synesthesia design is significantly higher than that of digital products without synesthesia design, and the ease of use of digital products with synesthesia design is also higher. It can be seen from Figure 4 that the digital products for the elderly after synesthesia design are obviously more popular with the elderly, and with the growth of age, synesthesia design plays an increasingly prominent role in the market of digital elderly products.

5. Conclusions

This paper investigates the current domestic digital product design and sales for the elderly, discovers some problems in the development of digital products for the elderly, and proposes the concept of applying big data and complex intelligent systems for synesthetic product design. For the sales of digital elderly products, this article adopts the method of quantitative model analysis to compare and analyze the sales data of digital elderly products in the past ten years. Find out the factors affecting the development of digital elderly products from the changes in the sales volume of digital elderly products and the questionnaire survey of elderly consumers. In the survey results, this article found the following problems in the development of digital elderly products. First, the elderly are deeply affected by the development of information technology, such as network fraud, and are more concerned about the safety of digital products. Second, in the process of using these digital products, it is difficult for the elderly to learn how to use and operate these products. Third, in the past, digital products for the elderly were designed according to a certain aspect of the needs of the elderly, and it is difficult to popularize all elderly consumer groups. Fourth, there are still obstacles to the interaction between digital elderly products and elderly consumers. Even smart voice assistants and various image operation interfaces cannot truly realize the human-computer interaction between elderly consumers and digital products.

In response to the above problems, a research on synesthesia design of digital elderly products based on big data is proposed. Through synesthesia design, it can effectively solve the obstacles to the use of digital products and the inconvenience in daily life caused by the weakened senses of the elderly. For example, compared to the traditional string and semigraphical interface of DOS and Windows, the elderly computer stores the main functions in the module through the synesthetic design, so that the elderly originally need to go through visual and brain operations. Transformed into tactile operation, there are also automatic medicine boxes, etc., which can prompt the forgetful elderly to take medicine on time. This is the convenience brought by synesthesia design to the elderly consumer groups.

To sum up, the research on synesthesia design of digital elderly products based on big data has brought great convenience for the elderly to use digital products, which has far-reaching research significance and important market application value. Due to the lack of in-depth knowledge of product synesthesia design and the complicated application of artificial intelligence technology, this research still has major limitations. For example, in addition to the five senses of the elderly, the synesthetic design of digital elderly products can also take into account the emotional and psychological state of the elderly. However, because the psychology and emotion of the elderly are deep and complex, and there is no large amount of experimental data to prove, this article does not consider

the emotional care design of digital elderly products. I hope that the future can extend the "mind" synesthesia on the basis of this research on digital product design for senior citizens.

Data Availability

No data were used.

Conflicts of Interest

The author declares that they have no conflicts of interest.

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