Hindawi
Mobile Information Systems
Volume 2022, Article ID 1026182, 12 pages
https://doi.org/10.1155/2022/1026182

Research Article

Green Development and Self-Service Payment System of Intelligent Pet Public Toilet Based on Artificial Intelligence

Baojun Wang, Shengquan Wang, Shihao Gong, Xinru Lyu, and Xinyue Zhang

Marine Engineering College, Dalian Maritime University, Dalian 116026, Liaoning, China

Correspondence should be addressed to Shengquan Wang; 2220200780@dlmu.edu.cn

Received 11 April 2022; Revised 16 May 2022; Accepted 23 May 2022; Published 11 June 2022

Academic Editor: Chia-Huei Wu

Copyright © 2022 Baojun Wang et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Controversy about pets such as dogs is also growing, and the public health controversy is the most obvious. In order to solve the public health problem of pets outdoors, meet the needs of pet family pets for outdoor hygiene, and make up for the lack of smart pet public toilets in the market and with the development of artificial intelligence technology, the authors propose that "pet toilets" have been put into use in many cities and the emergence of this new thing is mainly aimed at the substantial increase in the number of pets such as dogs in cities, hoping to better solve the problem of pet dogs urinating in public places in the community and provide a more convenient dog service measure for urban residents. Through a questionnaire survey of 100 random volunteers, it was found that 69 people believed that pet toilets were very necessary for society; therefore, from the perspective of artificial intelligence, the development of smart pet toilets and self-service payment systems has been focused on.

1. Introduction

The transformation of intelligent technology has brought unprecedented changes, traditional products are transformed into data-driven intelligent products, and these intelligent products will have four characteristics: (1) directly connected and interconnected with the cloud; (2) built-in multiple sensors and equipped with intelligent processors; (3) learning with the help of artificial intelligence, speech recognition, and other cognitive technologies; (4) entering the market through an outcome-oriented "product-as-a-service" model [1]. While intelligent products are endowed with different characteristics, the mode of human-machine collaboration has also changed, artificial intelligence technology has subverted people's traditional way of life, work, and interaction, and a new model of human-machine collaboration has emerged as the times require. To this end, consulting firm Accenture has put forward new industry insights in the era of artificial intelligence and formulated six human-machine collaboration models, hoping to reshape the way humans work in the future (as shown in Figure 1).

2. Literature Review

Thanks to the push for the worldwide toilet challenge, more innovative possibilities for toilet design have emerged. Tyagi and Yadav [2] proposed that toilets use solar energy to generate hydrogen and electricity. Bhutta et al. [3] proposed that waterless toilets use nanomembrane technology to convert gray water into clean water. Technological innovation enables toilets to get rid of the need for water and electricity. Marenych et al. [4] proposed to turn waste into treasure while improving the health of the public environment and improving people's quality of life. At present, countries all over the world, especially Japan, attach great importance to the construction and maintenance of toilets. Whether it is home life or public health, Zhang [5] found that intelligent toilets have been widely used in the daily life of Japanese people.

Japan is one of the earliest countries in the world to invest in the development and design of pet toilet products, and its pet supplies market has begun to take shape and become the focus of competition in the pet toilet product market. With the advantages of high quality and low price,

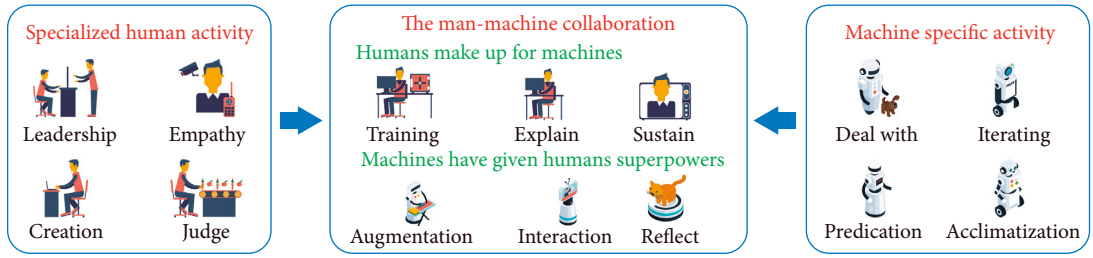

Figure 1: Human-machine collaboration mode.

the pet toilet products of the Japanese Alice brand lead the sales of its products in the world. Its success lies in the focus on product improvement and serialized design, and the products are constantly updated in order to adapt to the ever-changing market. In academia, Uddin et al. [6] studied the life cycle cost of resource-oriented toilet system and traditional toilet system comparatively and carried out an environmental assessment. Alieva [7] conducted experiments on surface resource-based toilet system, which has more advantages for economy and environment; this resource-based toilet adopts forward osmosis technology, which can effectively recover clean water and various trace elements in excrement. Fathima [8] and others combined universal design principles in the Thai environment to investigate and evaluate the accessibility and usability of people with mobility impairments in public spaces and provided a complete design research process, tools, and methodology for reference; finally, a design standard for public toilets that fits the Thai context is obtained. Li and Li [9] developed and evaluated a smart toilet used in emergency camps, and their toilet has ESOS (Emergency Sanitation Operation System), equipped with sensors and ICT to operate efficiently in emergency situations. Yongsoo [10] found that the toilet can save 97% of water resources compared to traditional toilets.

3. Methods

3.1. Smart Toilets. The intelligence in the toilet can be divided into two aspects: intelligent toilet system and intelligent toilet products. The intelligentization of the toilet system is mainly reflected in the integrated public toilet system with integrated services, management, and operation centered on the Internet of Things, big data, cloud computing, and other technologies, automatically adjusting the ventilation temperature control system by monitoring the air quality, temperature, and humidity inside the public toilet. Smart products exhibit a series of capabilities that nonintelligent products do not have, and these capabilities are collectively referred to as product intelligence [11]. Product intelligence includes six dimensions: autonomy, learning ability, responsiveness, cooperation ability, human-like interaction, and personality.

Smart products may exhibit one characteristic that matches these six dimensions or may possess all six at the same time; dimensions are not mutually exclusive and unrelated. When a product embodies intelligence in one dimension, it may also contain attributes that match another dimension [12]. Once a product contains IT components, it has the foundation to equip it with features and functions that match one or more dimensions of intelligence. The innovative development mechanism of smart toilets is shown in Figure 2.

For the construction managers of public toilets, after the introduction of the "Internet +" model, intelligent public toilets can realize the refinement and standardization of toilet management in the region [13]. By building a networked public service platform to communicate with toilet users and through mobile terminals to realize all-round queries and notifications of toilet information, it can improve the humanization level of public services. Building an integrated toilet operation and management system, it is possible to carry out unified control of toilet cleaning and maintainers in the cloud and use intelligent means to achieve scientific and effective monitoring and efficient analysis and summary of various data indicators in the toilet. Under the influence of intelligence, the workload and work pressure of the actual operation and maintenance of toilets in cleaning and maintenance will be reduced; while inefficient repetitive labor is reduced, efficient and targeted maintenance is carried out through instant feedback from the toilet management system and user service platform. Toilet users, construction managers, and maintenance operators interact and restrict each other. A better overall toilet environment with intelligence will promote the improvement of users' civilized toilet behavior and the development of public health culture [14].

3.2. Human-Machine Relationship. The relationship between humans and machines is always evolving, and our interactions with machines have a long history. Historically, technology developed by humans has been a means to an end, and we have always thought of machines merely as tools used to perform desired actions [15]. The technological revolution has had a crucial impact on human history, changing our understanding of technology and our relationship with machines. In recent years, with the continuous development of the level of intelligence, the relationship between intelligent products and users has also changed. The development of intelligent products and changes in human-machine relationship can be summarized into four stages.

3.3. Technical Advantages. In the era of intelligence, technological innovation is changing with each passing day, and

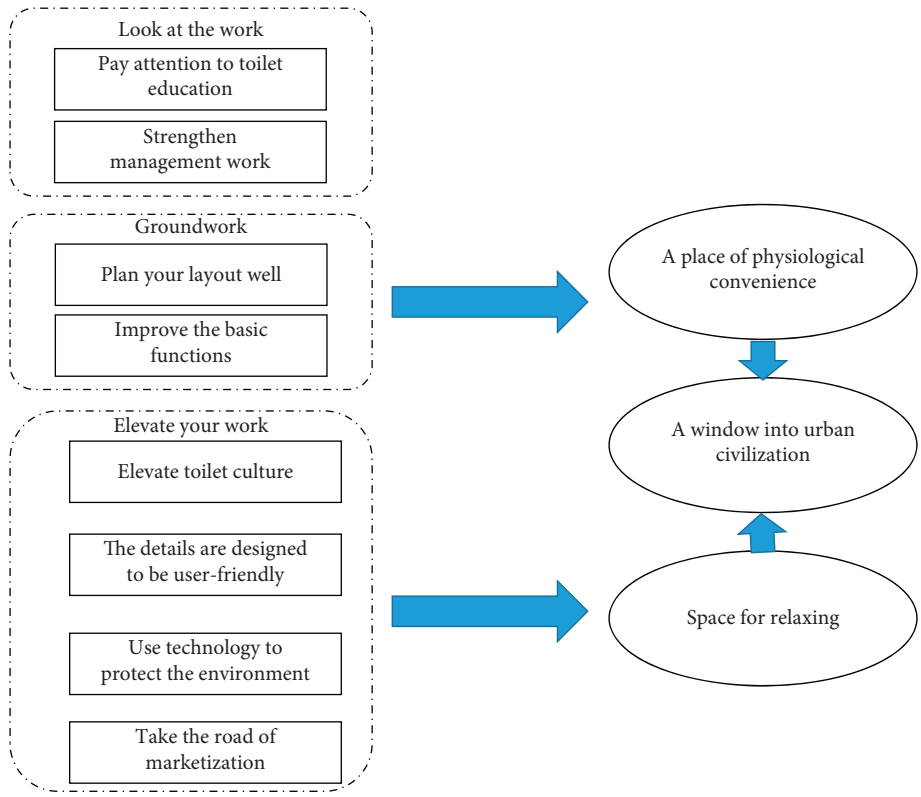

Figure 2: Innovative development mechanism of smart toilets.

the relationship between people and technology is being redefined. Technology plays a pivotal role in people's daily life, every aspect of life reflects the shadow of technology, products that integrate modern technology are regarded as an extension of human beings, and the symbiotic relationship between human and technology is gradually becoming closer [16]. When users no longer passively accept the established products but start to seek new expectations for user experience, some companies still remain complacent and adhere to "technical resistance." The data generated by users themselves cannot be used by themselves, and it is even more unknown what algorithms companies use to analyze user behavior to build user portraits; the user does not have the decision-making power to personalize the choice. When users seek a deeper experience, enterprises need to break the barriers of "technical conflict," open up new production and collaborative application models based on people, and open up a new channel for the intelligent era based on user expectations [17]. The "Accenture Technology Outlook" traces the development of technology in the three years from 2018 to 2020; the trends over the years are the inheritance and extension of past technologies. This outlook will help companies break through the "technological conflict" dilemma and develop a new model of technical collaboration. Technology trends are shown in Figure 3.

As can be seen from Figure 3, the development trend in 2018 is mainly driven by multiple technologies such as artificial intelligence, pan-reality, big data, and the Internet of Things [18]. The popularization and application of these technologies have greatly transformed people's production and living patterns, and users can enjoy zero-distance experience, and from individuals, enterprises, and society, the architecture of intelligent technology and intelligent systems realize the connection between virtual and reality.

4. Results and Analysis

In order to obtain data on consumer demand for a product, it should be collected using the necessary methods. The method for recording consumer needs and how to organize investigator needs is described as follows [19]:

(1) Notes

Handwritten note-taking is the most common method, with one person designated as the primary note-taker and another person focusing on effective questioning. The note-taker should try to capture every word of the client's statement verbatim. After the interview, organize it immediately.

(2) Recording

Recordings can be used during interviews. Although recording is easy, converting the recordings into text is time-consuming. Moreover, the recording of the interview can make the interviewee uneasy.

(3) Video

Video recording can record and observe users who use existing products in the environment and perform multiview video recording of customers in action, which helps identify potential customer

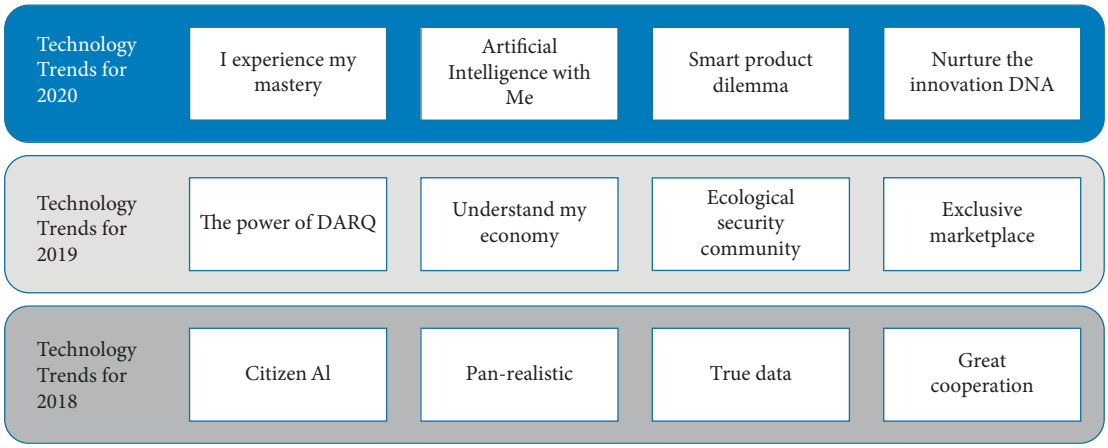

Figure 3: Technology trends.

needs. Video recording is useful for capturing many aspects of the end user's environment [20].

(4) Pictures

Still photos are easy to display and have the best visual quality.

The needs of the investigators are effectively sorted out, and the original data is obtained, usually supplemented by video or pictures. Table 1 shows the summary of user requirements.

Table 1: Summary of user needs.

User	Interviewer
Address	Date
Telephone	Current use
Whether to allow continued research	User type
Questions/tips	User statement
Like the current product	
Do not like the current product	
Improvement ideas	

4.1. Summary of Consumer Demand. The collected requirements are translated and summarized, and the requirements of direct users and potential users are listed, respectively. Direct users do not have aesthetic needs, so they are classified from three aspects: use, health, and psychology [21]. The needs of potential users are summarized and sorted according to the four aspects of use, health, appearance, and psychology, and a table is listed (Tables 2 and 3).

4.2. Design Method. Since there are fewer pet cats than pet dogs, most cats are kept in captivity at home, and cats are not suitable for using public pet toilets, so the public pet toilets we are talking about here are mainly provided for pet dogs [22]. Public pet toilets are also composed of direct users and potential users, the direct users are dogs, and potential users are breeders, cleaners and maintainers, and bystanders, as shown in Figure 4. Different users have different needs and psychological needs for the use of public pet toilets.

4.3. Intelligent Public Toilet System Architecture. In the era of "Internet +," the system architecture of smart public toilets usually consists of the following four levels:

(1) Perception layer includes sensor collection layers of various functions, such as air detectors, infrared sensors, passenger flow counters, and other pieces of equipment to collect various information data in the toilet

(2) The edge intelligence layer collects the signals sent from the perception layer, realizes the identification and judgment of various types of sensor information, and provides two-way information feedback while issuing execution instructions at the platform layer

(3) At the platform layer, the monitoring and analysis of toilet information are completed with technologies such as the Internet of Things, big data, and cloud computing for overall scheduling and planning management

(4) The application display layer visualizes the information data through the mobile terminal

4.4. System Integration Design. When choosing and building a system, the security, economy, and convenience of the system should be fully considered [23] and do optimization in each link. Economy is the consideration factor for the selection of each subsystem scheme, in order to reduce the investment cost and daily operation and maintenance cost of the system, so that the system as a whole has a relative cost advantage.

According to the previous market research, the price of each set of hardware that can be accepted by self-service equipment operators is about 150 yuan, and the annual service fee for each set is about 50 yuan. Therefore, there are certain requirements for system construction investment and cloud module hardware costs and operating costs (as shown in Figure 5, the system uses a rental server, with an annual rent of 10,000 yuan).

Table 2: Summary of direct user needs of pet toilets.

Demand category	Demand translation
Usage requirements	The stability of the components is in line with the habits of animals, the comfortable experience of using the product, the rationality of the space used, and the ability to attract animals
Health needs	Affirmation of sanitary conditions and certainty of health
Psychological needs	Safety and satisfaction of the olfactory experience

Table 3: Summary of potential user needs of pet toilets.

Demand category	Demand translation
Usage requirements	The stability of the components, the convenience of the operation, the durability of the material selection, the simplicity of the structure, the intuitiveness of learning and use, the convenience of maintenance methods, the convenience of disassembly and reorganization, the convenience of transportation methods, the rationality of the space occupied, comfortable experience of product use, multifunctional experience, product flexibility, safety, convenience of position replacement, and efficient operation mode
Health needs	Certainty of hygienic conditions, certainty of health, and environmental friendliness of the materials used
Appearance requirements	The aesthetics of the product shape, the aesthetics of the product color, the aesthetics of the outer packaging, and the coordination between the product and the environment
Psychological needs	The continuity of the brand, the affirmation of the brand, the satisfaction of the olfactory experience, the psychology of user self-satisfaction, the pursuit of fashion, the experience of cultural value, the moral experience of products, and the exclusivity of people themselves are in line with the promotion of taste

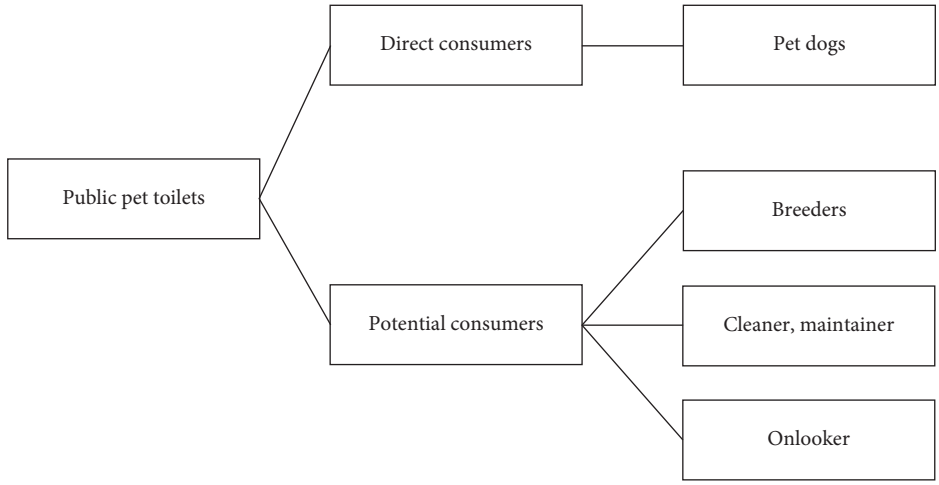

Figure 4: Classification of users of public toilets for pets.

Relying on the explosive development of information technology and the integration of high-tech and traditional industries, the "Internet +" thinking has had a profound impact on the survival mode and industrial structure of enterprises. The establishment of the "Internet +" strategy is motivated by the integration of China's growing economy and Internet services to develop networks, circuits, energy, materials, and even biotechnology to help emerging industries flourish, thereby accelerating economic transformation and role of upgrade. With the help of "One Belt One Road," the government will encourage more Internet companies to expand their radiation scope and energy in the global market. It is expected that, by 2025, "Internet +" will become a new economic model. China has the largest base of mobile phone and Internet users, and the introduction of Internet thinking makes the creation of smart cities possible [24]. In the future, more middle-class urban residents will desire better living conditions and expect their homes and communities to be safer, more convenient, and smarter; smart communities and smart homes will be their preferred answers. As the representative of the city's sanitation image, public toilets are bound to be combined with the "Internet +" model, and intelligent public toilets will be widely used. For toilet managers, the management of all equipment, materials, and maintenance under the Internet of Everything is performed through the cloud for benefit analysis; thereby, the demand model of the entire public toilet system is established (as shown in Figure 6), in order to achieve better operational services and management.

Informatization and intelligence of public toilets: the ultimate goal is to rely on the high integration of modern technology to optimize personnel allocation, reduce losses to achieve scientific and efficient management, create a public restroom with universal and systematic characteristics, and improve the user's toilet environment and toilet experience.

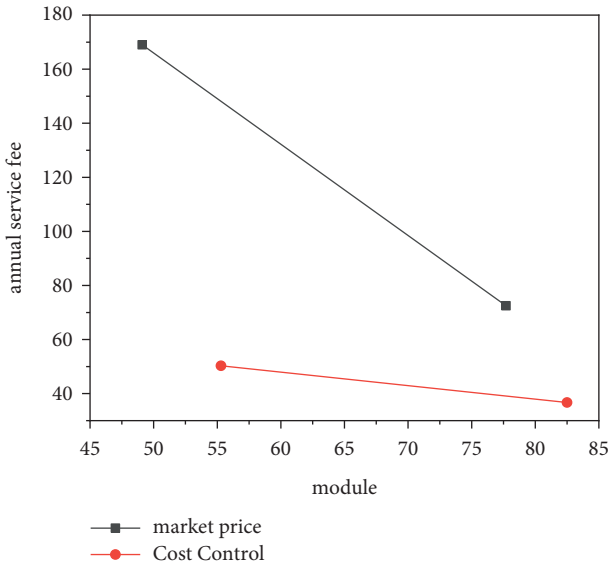

Figure 5: System cost evaluation.

With the help of comprehensive information exchange among toilet users, construction managers, and maintenance operators, combined with the dual attributes of public toilet privacy and publicity, the three parties get rid of the passive mode and realize mutual communication at all levels [25].

In public toilets, the intelligentization of toilet space is the application of the Internet of Things. In public toilets, the use status and queuing status of toilet compartments are displayed on the LCD screen in real time through the Internet of things, so as to improve the convenience of toilet users. Users can also directly check the occupied or unmanned indicator displayed on the toilet seat when queuing and quickly find the vacant toilet seat. In addition to using the status display, the intelligence of public toilets is also reflected in the intelligent regulation of temperature, humidity, and lighting realized by various sensors inside the toilets, through the monitoring of the gas quality in the toilet, the linkage of the exhaust equipment, and the control of the fresh air system, in order to ensure ventilation in the toilet without odor.

4.5. Design and Implementation of the Self-Service Payment System. In this mode, the collection of information needs to be confirmed within a certain period of time, and the time required cannot be less than the time required to reach the gate at a certain speed; that is, the vehicle maintains a certain speed v and enters the parking lot, the distance between the CCD camera at the entrance and exit of the parking lot and the gate is s, the time for vehicle information collection and confirmation is $t1$, the corresponding time for the rise and fall of the gate is $t2$, the time tolerance parameter is $t1$, and the vehicle speed tolerance parameter is $t2$ [26]. In this mode, the information acquisition module must meet the following inequalities to meet the functional requirements, as shown in the following formula:

$$(t_1 + t_2)\theta < \frac{s}{v}\mu. \quad (1)$$

In the mode studied by the author, LPR technology can well meet the nonparking needs of parking lot entry and exit; in the following sections, the working principle, research status, and method comparison of LPR technology will be discussed, and finally, an appropriate method will be selected to realize the requirements of the parking lot in this mode.

4.5.1. Composition and Working Principle. The LPR system consists of two parts: one is hardware support, and the other is software. In short, hardware support mainly includes image acquisition equipment and PC-side computer, and software components include image acquisition system and image recognition system. The working principle of the LPR system is to realize the preprocessing, positioning, and recognition of license plate images through pattern recognition, digital image recognition, and other technologies. Its working principle is shown in Figure 7.

4.5.2. Information Identification in the Self-Service Payment Mode. The parking lot under the self-payment model studied by the authors is mainly suitable for the underground parking lot in the urban CBD area. In the underground parking lot environment, there is fixed lighting and environment, and the currently commonly used license plate location algorithm based on color features can be used. The most used color models in computer technology are RGB, HSV, HSI, and so on. The images obtained from CCD cameras are RGB images [27]. In order to easily capture the color features of the license plate area, the RGB image is first converted into an HSI image, and then the color features of the license plate area are searched in the HSI image to complete the license plate location, as shown in Figure 8.

The main process of this method is as follows: First, convert the color space model, obtain the license plate candidate area through the color feature, and then use the geometric feature to remove the noncandidate area. Second, binarize the image through the color feature edge operator, and then select the closest candidate license plate areas based on the characteristics of the license plate itself. Third, perform edge detection on the HSI image of the candidate area, exclude confusing fake license plate images, and finally obtain an ideal license plate image. Its core principle is to obtain a binarized image by setting the thresholds of H and S of the HSI image and then perform edge detection on the license plate candidate area of the binarized image in order to discriminate between license plate images and fake license plate images [28].

4.5.3. Self-Service Payment Positioning Method

Step 1. HSI is implemented with three basic feature quantities of hue, saturation, and intensity, which reflect the way the human visual system perceives color; therefore, in this algorithm, the collected RGB image is converted into an HSI image for better color image comparison. Therefore, let

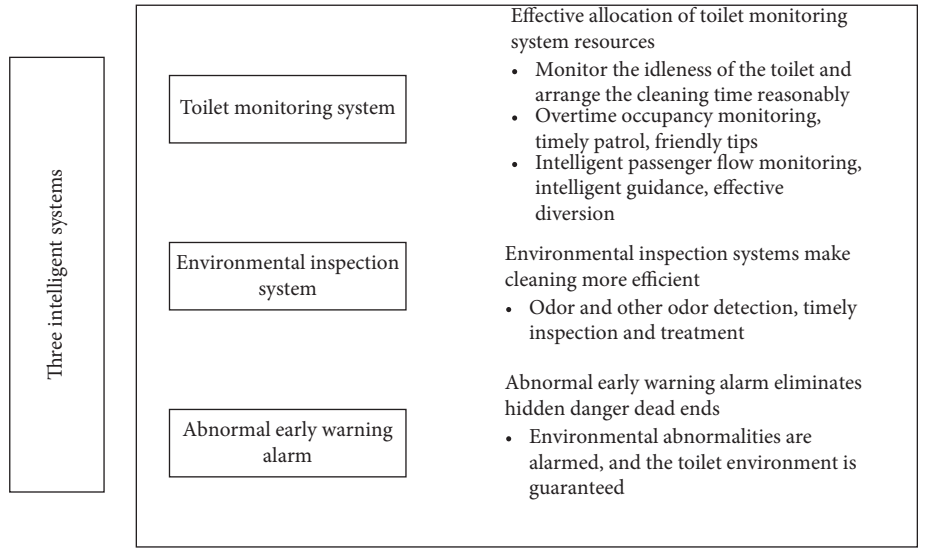

Figure 6: Intelligent public toilet management system.

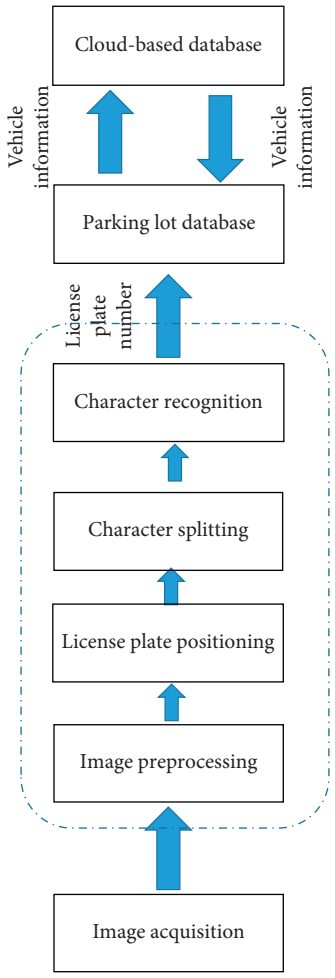

Figure 7: General workflow of the information recognition system based on image processing.

the components of the HSI color model be H, S, and I and the components of the RGB color model be R, G, and B; then, the formulas for RGB conversion to HSI are shown in

$$H = \begin{cases} \theta, & B \le G, \\ 360 - \theta, & B > G, \end{cases}$$

$$\theta = \cos^{-1}\theta\left\{\frac{1/2[(R-G)+(R+B)]}{\left[(R-G)^2+(R+B)(G-B)\right]^{1/2}}\right\}, \quad (2)$$

$$S = 1 - \frac{3}{(R+G+B)}[\min(R,G,B)],$$

$$I = \frac{1}{3}(R+G+B).$$

The range of H represents the value position of the hue on the color wheel. The value range of S represents saturation from R to B range of change. I represents brightness, from black to white. Convert the RGB color image to the image of the HSI color model by equation (3).

Step 2. Obtain the target candidate area of the license plate by setting the constraints of hue H and saturation S. First, set the constraints for H. The basic color of Chinese license plates is blue, so the blue hue constraint is set to realize the segmentation of image color features. Since the image may be disturbed by noise, the blue H component value will fluctuate, so set the blue H component value of the image to blueMinH = 220° and blueMaxH = 220°.

Let the binary image be Bw, the HSI has the same size as the Bw image, and all elements in Bw are 0. Therefore, the constraint condition is formula (3); that is, the constraint condition of the blue component H is satisfied; that is, BW = 1, which is set as foreground white. Settings that do not conform to the blue H component float constraint are black; that is, BW = 0.

$$Bw_{ij} = \begin{cases} 1, & \text{blue\_min}H \le H_{ij} \le \text{bluemax}, \\ 0, & \text{other}. \end{cases} \quad (3)$$

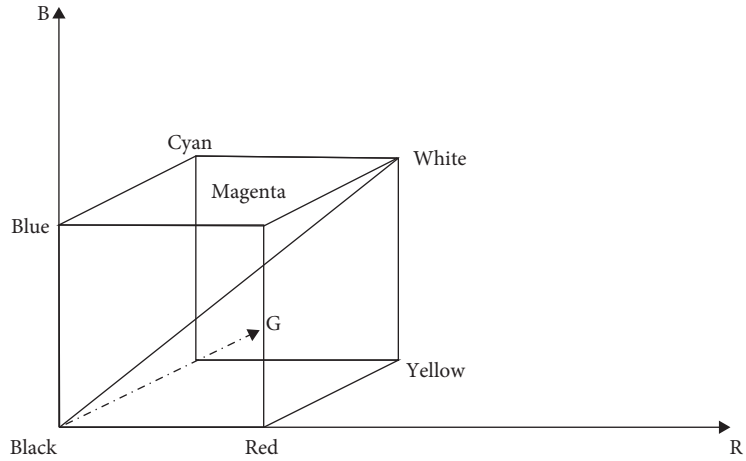

Figure 8: RGB color space model.

Then, use the saturation component S for reprocessing: due to other uncertain reasons, the nontarget area sometimes has the same tone characteristics as the target area; that is, the nontarget area can also meet the requirements of equation (3); therefore, it is necessary to set the saturation specification of the S component to remove nontarget regions. In (4), threshS is the set saturation threshold, and through the balance of the threshold in (4), the pseudolicense plate area that meets the H component conditions is removed.

$$Bw_{ij} = \begin{cases} 1, & S_{ij} \geq \text{threshS}, \\ 0, & S_{ij} < \text{threshS}. \end{cases} \tag{4}$$

Step 3. Precise screening of license plate area. After the threshold correction and binary processing of equations (3) and (4), the color characteristics of the license plate area are further highlighted; however, in some cases, the processed image will also have noise interference, which will generate multiple fake license plate areas. In this method, the shape feature of the license plate image is the height value of the target area.

Step 4. The license plate color is the same as the vehicle color. Use color feature edge detection to screen candidate target regions and reduce the interference of nontarget areas with the same license plate color and vehicle color. Let the image $K(i, j) = (H(i, j), S(i, j), I(i, j))$, where $H(i, j)$, $S(i, j)$, and $I(i, j)$ represent the corresponding color feature components of $K(i, j)$, respectively. The image obtained by edge detection is $K2(i, j)$. A 3×3 window centered on $K(i, j)$ is used to detect a specific color edge, as shown in Figure 9.

$K_{i-1, j-1}$	$K_{i-1, j}$	$K_{i-1, j+1}$
$K_{i, j-1}$	$K_{i, j}$	$K_{i, j+1}$
$K_{i+1, j-1}$	$K_{i+1, j}$	$K_{i+1, j+1}$

Figure 9: 3×3 window.

In the HIS color model, when equations (5), (6), and (8) are satisfied, it is judged as blue. If (7) and (9) are satisfied, it is white.

$$M_{ij} = \begin{cases} 1, & \text{white\_IntensityThresh} > I_{ij} \text{and white\_IntensityThresh} < S_{ij}, \\ 0, & \text{other}. \end{cases} \tag{5}$$

Set the blue and white edge judgment conditions as follows. A blue pixel point is

$$\begin{aligned} &K(i-1, j-1), \\ &K(i, j-1), \\ &K(i+1, j-1). \end{aligned} \tag{6}$$

A white pixel point is

$$\begin{aligned} &K(i-1, j+1), \\ &K(i, j+1), \\ &K(i+1, j+1). \end{aligned} \tag{7}$$

B blue pixels are

$$K(i-1, j-1),$$
$$K(i, j-1), \quad (8)$$
$$K(i+1, j-1).$$

B white pixels are

$$K(i-1, j+1),$$
$$K(i, j+1), \quad (9)$$
$$K(i+1, j+1).$$

Finally, use the area characteristics of the license plate to screen the accurate target area again. The main methods are as follows. Let the total number of white pixels in the blue and white edge image be the calculation definition of the area size, the minimum area of the target area be minA, the maximum value be maxA, and the total number of white pixels be W_t. If the following constraints are met, the target area is determined to be the license plate area, as shown in

$$\min_A \le W_t \le \max_A. \quad (10)$$

Using the above method, first set a certain minA in the license plate image, limit the maxA to a certain range, and then perform Hough transform on all pixels in the image space; finally, all the curves in the parameter space are counted, and the curve corresponding to the most similar curve is the required tilt angle of the license plate image. The advantage of this method is that the noise immunity is relatively good, but because of the huge amount of calculation, a special chip is required to realize the Hough transform, so it is not ideal in practical applications, as shown in Figure 10.

The basic principle of Radon transform is the projection of the image in (ρ, θ) space, and each straight line in the image corresponds to each point of (ρ, θ), as shown in the following equation and Figure 11:

$$\begin{cases} R_\theta(x') = \int_{-\infty}^{+\infty} f(x' \cos\theta - y' \sin\theta + y' \cos\theta)\mathrm{d}y', \\ \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta \sin\theta \\ -\sin\theta \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}. \end{cases} \quad (11)$$

Set a certain value range. After Radon transforms the inclined license plate image, the high gray value part corresponds to the bright spot in the (ρ, θ) space, and the low gray value part corresponds to the dark spot in the (ρ, θ) space, where the projected value of 1θ with the most 0 is the required license plate inclination angle.

In the self-service payment mode, set the response time of license plate positioning as tl, the response time of license plate tilt correction as tc, and the response time of character segmentation time as td; if the character recognition time is tr and the total error parameter is set, the following conditions should be met to perfectly realize the nonstop function of admission, as shown in

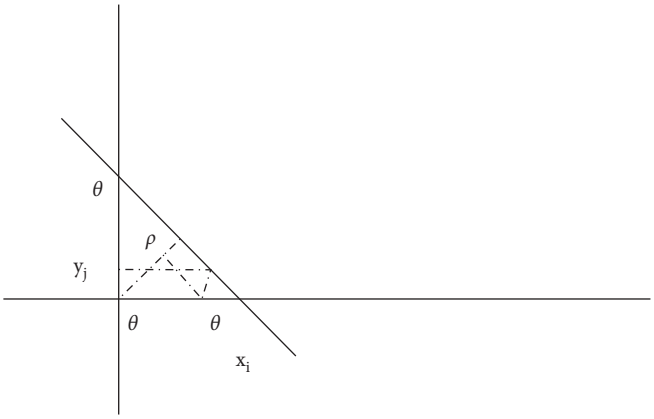

Figure 10: Schematic diagram of point-line duality.

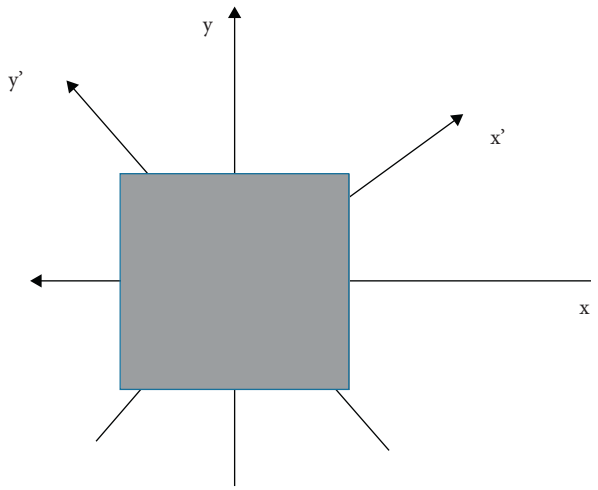

Figure 11: Schematic diagram of Radon transformation.

$$(t_l + t_c + t_d + t_r) < t_1. \quad (12)$$

Among them, $t1$ is the response time of the license plate recognition system, and the fault-tolerant parameters are controlled by the parking conditions. Therefore, when researching and selecting a license plate character recognition method, the first consideration is the response speed, and the second is the recognition accuracy. First, establish a template library for various characters (including Chinese characters, alphabetic characters, and numeric characters). Then, using the established standard template library, compare and match the individual characters obtained in the previous process one by one. Finally, determine the comparative quantitative index, obtain the template corresponding to the optimal value of the quantitative index, and finally identify the characters. The comparative quantitative index is a quantitative index used to reflect the similarity between characters and templates (the calculation method is shown in (13)), and the most similar to the standard template library is the final output result.

$$S = \frac{\sum_{i=1}^{W} \sum_{j=1}^{H} I(\mathrm{i}, j) * T(i, j)}{\sum_{i=1}^{W} \sum_{j=1}^{H} T(i, j)}. \quad (13)$$

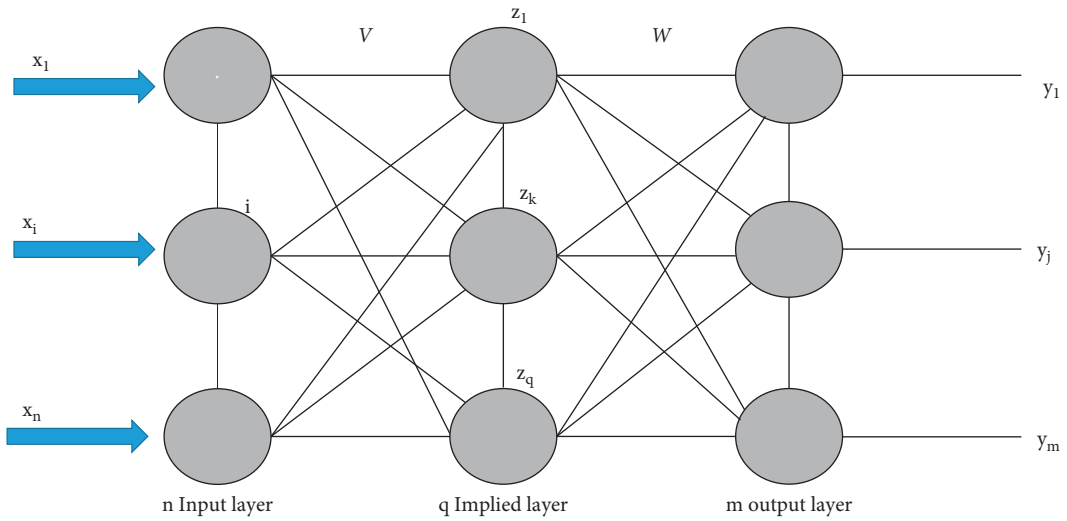

Figure 12: Neural network structure diagram.

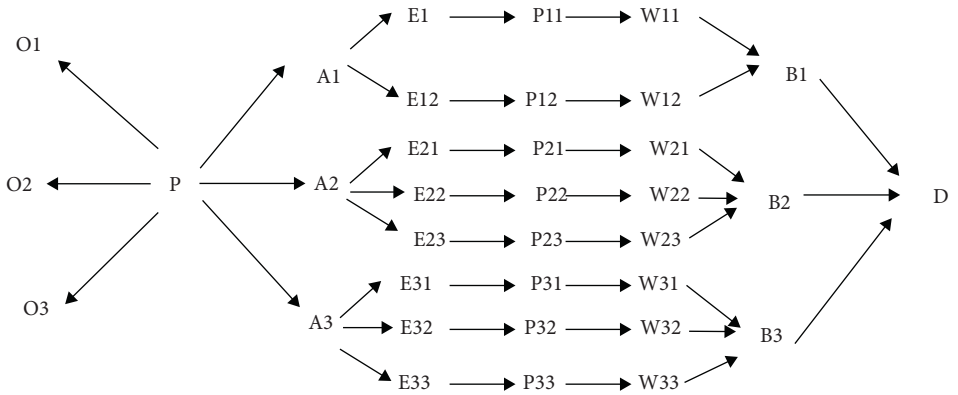

Figure 13: Decision tree model.

This method is mainly divided into two steps: First, extract character features, such as grid features, histogram features, and texture features, and the effect of feature extraction will affect the reliability of later recognition. Second, feature training is the subsequent step of feature extraction. There are two main feature training methods: Support Vector Machines and Adaptive Boosting Algorithms. The feature of the feature recognition algorithm is that it has a good recognition effect, but it requires a large number of training sets, the training time is longer, and the training is larger. The classifier method is widely used in character recognition, and the basic idea is to use a certain classifier model to classify and learn character samples so as to achieve the purpose of character recognition. There are various types of classifiers, such as the Bayes classifier, BP neural network classifier (Figure 12), and decision tree model (Figure 13).

The process of information processing, storing, changing, and querying information data is very tedious, so it is important to design a scientific database; on the one hand, it can ensure the integrity and consistency of the data; on the other hand, it can reduce the loss of data and improve the running speed of the information data module. On the contrary, an unreasonable database will bring a lot of trouble to the parking lot management system; therefore, the design of the database is an important part of the parking lot fee management system in this mode, and the quality of its design will directly affect the function realization of the information processing module. The starting party of peer-to-peer letter release is the parking person, and the parking person obtains the designated number of the parking lot from the LED display of the parking lot; thereby, the mobile phone short message is used to get in touch with the parking lot information processing module. Through this single-line communication, the parking lot sends parking information, fee information, preferential discounts, convenient car-finding routes, and so on to the parkers in the form of text, images, and videos. In addition to communication through GSM short messages, the parking lot uses self-service payment and third-party platforms to send peer-to-peer information to parkers.

5. Conclusion

The use of the proposed method to develop pet toilets provides new ideas for pet product design enterprises and

proves that this method is beneficial to enterprises in designing new products; it can meet the needs of enterprises to open up new markets and at the same time make up for the vacancies in the market and gain competitive advantages. Through the analysis of the current situation of raising pets, three development directions of pet toilets are analyzed from the perspective of environment, namely, domestic pet toilets, public pet toilets, and portable pet toilets. Combining the common methods of portability with the usual carrying methods of different groups, the development and design method of portable pet toilets is constructed. By analyzing the needs of users, it is concluded that the needs of potential users are far more than the needs of direct users, so when developing products, the needs of potential users should be mainly considered. Finally, the public pet toilet is selected as an actual product development case, the combination of theory and practice is a favorable basis for supporting this system, and it is also a demonstration of the feasibility of the design theory. The method improved people's happiness index, as well as people's affection for pets.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

This work was supported by the project in 2020 of the 13th Five-Year Plan of Liaoning Education Science (JG20DB057).

References

[1] P. Rustagi, R. Sroa, P. Sinha et al., "HomeTec software for security aspects of smart home devices based on IoT," *Journal of Cybersecurity and Information Management*, vol. 5, no. 1, pp. 5–16, 2021.

[2] A. Tyagi and S. K. S. Yadav, "Green marketing practices and challenges to indian companies," *International Journal of Trade and Commerce-IIARTC*, vol. 10, no. 1, pp. 95–101, 2021.

[3] A. I. Bhutta, M. R. Ullah, J. Sultan, A. Riaz, and M. F. Sheikh, "Impact of green energy production, green innovation, financial development on environment quality: a role of country governance in Pakistan," *International Journal of Energy Economics and Policy*, vol. 12, no. 1, pp. 316–326, 2022.

[4] T. Marenych, M. Krutko, and A. Kravchenko, "Theoretical and methodological support of investment development of green energy in Ukraine," *Financial and Credit Activity Problems of Theory and Practice*, vol. 2, no. 37, pp. 386–395, 2021.

[5] M. Z. Zhang, X. H. Dong, W.-C Zhang et al., "A comparison of proliferation levels in normal skin, physiological scar and keloid tissue," *Journal of plastic surgery and hand surgery*, no. 1, pp. 1–7, 2021.

[6] N. Uddin, S. Kassim, H. Hamdan, N. Bt, and E. Che, "Green microfinance promoting sustainable development goals (sdgs) in Bangladesh," *ISRA International Journal of Islamic Finance*, vol. 10, no. 1, pp. 11–18, 2021.

[7] I. A. Alieva and V. V. Altunina, "Current trends in the development of a green finance system: methodology and practice," *Sustainable development of the Baltic Sea Region*, vol. 13, no. 2, pp. 64–89, 2021.

[8] J. Shifa Fathima, "Challenge management of banking services - with special reference to virtual banking service challenges," *Shanlax International Journal of Management*, vol. 7, no. 3, pp. 57–66, 2020.

[9] L. Li and H. Li, "Analysis of financing risk and innovation motivation mechanism of financial service industry based on internet of things," *Complexity*, vol. 2021, no. 3, Article ID 5523290, 9 pages, 2021.

[10] Y. Ha, "The effects of shoppers' motivation on self-service technology use intention: moderating effects of the presence of employee," *The Journal of Asian Finance, Economics and Business*, vol. 7, no. 9, pp. 489–497, 2020.

[11] H. Ko and G. Marreiros, "Smart media and application," *Concurrency and Computation: Practice and Experience*, vol. 33, no. 2, 2021.

[12] A. Sharma, A. Vats, S. Shankar Dash, and S. Kaur, "Artificial Intelligence enabled virtual sixth sense application for the disabled," *Fusion: Practice and Applications*, vol. 1, no. 1, pp. 32–39, 2020.

[13] T. Ha and H. Lee, "Analysis on the mobile healthcare behavior using an artificial intelligence based pose estimation," *Journal of the Institute of Electronics and Information Engineers*, vol. 57, no. 1, pp. 63–69, 2020.

[14] H. Abadi and M. Pecht, *Artificial Intelligence Trends Based on the Patents Granted by the united states Patent and Trademark Office*, IEEE Access, vol. 8, no. 99, p. 1, USA, 2020.

[15] A. admin, D. DrPKavitha2, A. Akshaya et al., "A survey on cyber security meets artificial intelligence: AI- driven cyber security," *Journal of Cognitive Human-Computer Interaction*, vol. 2, no. 2, pp. 50–55, 2022.

[16] Z. Lv, L. Qiao, K. Cai, and Q. Wang, "Big data analysis technology for electric vehicle networks in smart cities," *IEEE Transactions on Intelligent Transportation Systems*, vol. 22, no. 3, pp. 1807–1816, 2021.

[17] A. A. A. Ahmed and A. Asadullah, "Artificial intelligence and machine learning in waste management and recycling," *Engineering International*, vol. 8, no. 1, pp. 43–52, 2020.

[18] D. Cui and F. Wu, "The influence of media use on public perceptions of artificial intelligence in China: evidence from an online survey," *Information Development*, vol. 37, no. 1, pp. 45–57, 2021.

[19] J. Lu and H. Bai, "Information usefulness and attitude formation a double-dependent variable model (DDV) to examine the impacts of online reviews on consumers," *Journal of Organizational and End User Computing*, vol. 33, no. 6, pp. 1–22, 2021.

[20] P. K. Shukla, P. K. Shukla, and P. K. Shukla, "I-DMAC: an intelligent DMA controller for utilization - aware video streaming used in AI applications," *Journal of Cybersecurity and Information Management*, vol. 8, no. 2, pp. 60–70, 2021.

[21] C. Chen, C. Chen, C. Xiang, S. Guo, Z. Wang, and B. Guo, "ToiletBuilder: a PU-Learning-Based model for selecting new public toilet locations," *IEEE Internet of Things Journal*, vol. 8, no. 9, pp. 7531–7545, 2021.

[22] Y. Zhu, "Network public opinion prediction and control based on edge computing and artificial intelligence new paradigm," *Wireless Communications and Mobile Computing*, vol. 2021, no. 8, Article ID 5566647, 11 pages, 2021.

[23] Y. Ding, "Performance analysis of public management teaching practice training based on artificial intelligence

technology," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 3787–3800, 2021.

[24] L. Yuan, Z. Xiaofei, and Q. Yiyu, "Evaluation model of art internal auxiliary teaching quality based on artificial intelligence under the influence of covid-19," *Journal of Intelligent and Fuzzy Systems*, vol. 39, no. 6, pp. 8713–8721, 2020.

[25] K. Zhao, W. Jiang, X. Jin, and X. Xiao, "Artificial intelligence system based on the layout effect of both sides in volleyball matches," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 3075–3084, 2021.

[26] G. Liu, "Intelligent English writing system based on fusion of herding effect and artificial intelligence," *Journal of Intelligent and Fuzzy Systems*, vol. 40, no. 2, pp. 1–11, 2020.

[27] W. Choi, "A study on the intelligent disaster management system based on artificial intelligence," *Journal of the Korean Society of Hazard Mitigation*, vol. 20, no. 1, pp. 127–140, 2020.

[28] F. Ullah, A. Bajahzar, H. Aldabbas, M. Farhan, H. Naeem, and S. Bukhari, "An e-assessment methodology based on artificial intelligence techniques to determine students' language quality and programming assignments' plagiarism," *Intelligent automation and soft computing*, vol. 26, no. 1, pp. 169–180, 2020.