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Research Article

Design of a Public Cultural Service System for the Elderly Based on Intelligent Computing

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Public cultural services for the elderly are part of the government-led public services for society in order to meet the needs of people's spiritual and cultural life. As the global problem of ageing becomes increasingly serious, the problem of balancing the supply and demand of public cultural services for the elderly has become increasingly serious. How to realize a public cultural service system for the elderly with wide coverage and effective integration of resources has become a pressing problem to be solved. In order to solve the above problems, this article designs a public cultural service system for the elderly based on intelligent computing. Firstly, the problems that lead to the inefficient use of public cultural resources for the elderly are analyzed. Secondly, it attempts to introduce an advanced intelligent computing technology (Cuckoo Search) to build a three-dimensional public cultural resource sharing system for the elderly. Then, the standard Cuckoo algorithm is improved by using chaotic mapping and dynamic step size for the characteristics of public cultural services in order to improve the convergence speed and the accuracy of the search. The experimental results show that the designed system can effectively integrate the grassroots resources of cultural institutions such as libraries, cultural centres, and cultural service centres, verifying its effectiveness and feasibility.

1. Introduction

The right to culture is one of the fundamental rights of citizens. It is an important duty of governments to attach importance to and protect the basic public cultural rights of citizens. With the rapid development of the economy, the people have begun to pursue spiritual satisfaction after satisfying their material needs. People's demand for public cultural services is growing rapidly and is characterised by multilevel, differentiation and personalization. The ageing of the population is a major social issue in the twenty-first century and a major feature of human development in the twenty-first century. With the development of the country's economy and the improvement of people's living standards, the number of elderly people is increasing at an unprecedented rate [1–3]. Under the premise that material living conditions are basically satisfied, the spiritual and cultural needs of the elderly are receiving more and more attention.

The cultural industry for the elderly is an ageing business that aims to meet the spiritual and cultural needs of the elderly. The content of social security is divided into three levels: economic security, service security, and spiritual security [4–7]. Social security for the elderly is an important element of social security. Maslow's Hierarchy of Needs theory gives an incisive overview of the hierarchy of human needs. It is of great significance at this stage to organically combine public cultural services with the cause of the elderly so as to drive up the level of elderly services for the whole society. The construction and management of public cultural services is a process of gradual rise and improvement. Public cultural resources for the elderly are an important support to meet the growing cultural needs of the general public. In this context, it is of great practical importance to make a scientific analysis of the problems in using public cultural resources and to explore new ways of integrating resources.

With the growing differentiation in demand for public cultural services, a single cultural resource is no longer able to meet the cultural needs of the majority of older people, and the integration of public cultural resources has begun to attract the attention of academics. Due to different research perspectives and local practices, researchers have conducted different studies on the integration of public cultural resources. After summarising, current research mainly discusses the integration of public cultural digital resources, the integration of public cultural resources, and the integration of public cultural resource paths [8–11]. The comprehensive use of various current advanced management methods and technologies to optimise the allocation of resources and to develop a reasonable integration plan are key elements in the design of public cultural service systems for the elderly. Currently, most of the public cultural resources management methods and integration schemes are still only in the original fixed manual mode. The low level of automation and informatization has resulted in a public cultural service system that is unable to meet the changing needs of older people. In other words, the existing public cultural service system for older people does not meet the time-sensitive requirements of changing needs. Therefore, the main objective of the design of public cultural services for older people is to optimise the allocation and path of the main resources according to the changing needs in real time.

At present, researchers have applied integer programming, linear programming, dynamic programming, and objective programming methods in operations research to solve a part of representative public cultural resources integration and optimisation problems. However, most of the public cultural resources integration and optimisation problems are NP-Hard problems, so the existing solution methods and strategies are not yet effective in solving the allocation of public cultural resources in real life. For example, the optimal solution algorithm can find the optimal solution to the scheduling problem in polynomial time for a specific optimisation objective, including the branch-and-bound method, mathematical planning method, and dynamic planning method. Kolpakov [12] used the branch-and-bound method to find the optimal solution to the small-scale problem with this objective based on the actual situation of production management with the objective of minimising time cost. For the feasible boundary problem along the positive direction of the gradient, Okon [13] proposed a multiobjective optimal solution for linear programming. Although the optimal solution algorithm can obtain an optimal solution, it requires an infinite exhaustion of the solution space of the problem and is therefore computationally too costly in terms of time. Based on knowledge and experience in solving scheduling problems, heuristic algorithms can obtain suboptimal solutions in a short time, such as goal tracking methods, linear relaxation methods, and domain search algorithms. For example, Güney [14] proposed a linear programming relaxation method for solving sequencing problems, implementing a 2-approximation algorithm based on three certainties. Although heuristic algorithms can construct problem solutions quickly, the quality of the solutions is poor. Heuristic algorithms often require a large number of iterative operations, and the solution efficiency and quality are greatly influenced by the structure of the algorithm and the choice of parameters.

Intelligent computing is a new type of algorithm developed by simulating natural organisms, with features such as self-organization, self-learning, and self-adaptation. The collective movement of groups of animals in nature is a very interesting phenomenon. Each member of a group of animals is an individual, yet all the individuals are able to form a whole. Intelligent computing mainly includes genetic algorithms, forbidden search algorithms, simulated annealing algorithms, particle swarm algorithms, and ant colony algorithms. Intelligent computing is easier than general heuristic algorithms to find suboptimal solutions close to the optimal solution of a problem. Gong et al. [15] proposed an ensemble genetic algorithm for solving interval multiobjective optimisation problems and demonstrated that intelligent computing has faster solution speed and better solution accuracy. Pan et al. [16] proposed a caching strategy for ethnic traditional sports video resources based on intelligent computing. Experimental results show that the ant colony simulated annealing algorithm can improve the hit rate of the content on mobile edge computing servers.

The most important issue in the design of public cultural services for older people is the optimisation of resource allocation and pathways. However, when the number of individual older people is large, the traditional method of manual resource integration consumes a lot of time and effort. In addition, the lack of adaptiveness of the traditional manual resource integration method leads to public cultural resources being restricted to a fixed path, which is inflexible and cannot meet the timeliness in real life. Therefore, in order to solve the above problems, this article proposes introducing intelligent computing [17–20] into the design of public cultural services for the elderly. By simulating the movement behaviour of a large-scale group of elderly people in real time, the optimal location and path of cultural resources can be planned. The Cuckoo Search (CS) algorithm [21–24] is an emerging type of group intelligence algorithm that can imitate the movement behaviour of a flock of birds searching for the best nest location, with strong local and global search capability and convergence speed. Therefore, the CS algorithm is used in this article to simulate the movement behaviour of groups of elderly people.

The main innovations and contributions of this article include the following:

(1) This article introduces advanced intelligent computing technology (Cuckoo Search) to build a three-dimensional system for sharing public cultural resources for the elderly.

(2) The standard CS algorithm is improved for the limited range of optional spaces in public cultural services using chaotic mapping and dynamic step size in order to improve the convergence speed and optimisation finding accuracy.

The rest of the article is organized as follows: in Section 2, the problems in the existing public cultural services system for older people are studied in detail, while Section 3 provides the problem statement and research ideas. Section 4 provides the public cultural service system for the elderly based on an improved CS algorithm. Section 5 provides the simulation results and analysis. Finally, the article is concluded in Section 6.

2. Problems in the Existing Public Cultural Services System for the Elderly

2.1. Inadequate Supply of Public Cultural Resources. Older people use public cultural facilities through cultural institutions such as libraries, cultural centres, and cultural service centres. A statistical survey was conducted on the public cultural resources for older people in a provincial capital city in China, for example. It was found that the service effectiveness of cultural institutions was unevenly distributed in most areas. For example, cultural service centres are too small and not well equipped. In addition, the number of mass cultural and sports activities organized by cultural institutions was less than 10 per year. Although public libraries and cultural centres at all levels have public electronic reading rooms and provide free access to the Internet, the speed of access to the Internet is unsatisfactory, and the facilities are not well equipped. However, the speed of access to the Internet is not satisfactory, and the resources available are very limited.

2.2. Public Cultural Resources Are Too Dispersed. For a long time, public cultural resources for the elderly have been scattered across a number of grassroots departments. Each department uses the public cultural resources it has in its own area to provide public cultural services for the elderly population. The constraints of the administrative system have created a situation where grassroots public cultural resources are too scattered to be effectively integrated, which is not conducive to the full utilisation of grassroots public cultural resources. In particular, the layout of grassroots public cultural facilities is unreasonable.

Firstly, the government deliberately pursues the agglomeration effect of public cultural facilities, resulting in many public facilities being concentrated around local administrative centres. This type of layout planning ignores the service radius of public cultural facilities, which makes it very inconvenient for the public to use public cultural facilities. Due to the rapid development of urbanisation, local administrative centres are located far away from the city centre. Secondly, due to the constraints of construction land conditions, many cultural centres or cultural service centres are built in the corners of cities, towns, and villages. Such a layout is also very unreasonable. It is not convenient for the masses to participate in activities, resulting in the marginalisation of cultural service institutions. In the long run, grassroots cultural service facilities have become ornamental, resulting in a great waste of cultural resources. Finally, the lack of communication and coordination between departments results in a poor layout. The lack of communication between the planning and construction departments of public cultural facilities and their users has led to deviations between the completed public cultural facilities and the needs of the public. This standardised construction planning ignores the actual needs of the users and, to a certain extent, also results in a waste of resources.

2.3. There Is Structural Waste in the Supply of Public Cultural Resources. The structural waste in the supply of grassroots public cultural resources refers, on the one hand, to the lack of coordinated planning resulting in the duplication of the construction of grassroots public cultural facilities; on the other hand, it refers to the inability to effectively match the supply of grassroots public cultural resources with the needs of the grassroots. Both of these aspects lead to low utilisation of grassroots public cultural resources, resulting in a waste of resources. Due to the administrative system, each department is responsible for the construction of public cultural facilities within its own area. This approach to resource planning is a “compartmentalised” construction model. The lack of coordination among all parties involved in the provision of public cultural services has led to the duplication of public cultural facilities and, to a certain extent, to a waste of resources. The imbalance between supply and demand leads to low utilisation of public cultural resources at the grassroots level. Public cultural resources are supplied in a single way, and there is a lack of feedback mechanisms on the needs of the public. The allocation of resources in public cultural institutions does not meet the needs of the public, which ultimately leads to low utilisation of public cultural resources at the grassroots level.

3. Problem Statement and Research Ideas

The group behaviour of animals shows consistency as a whole, but each member of the group is independent, i.e., having a certain freedom of behaviour. The behavioural trajectory of each individual is different. Therefore, due to this specificity of group behaviour, each individual’s motor control is required to have certain random properties in order to make the final simulated group behaviour more natural.

The basic principle of the group intelligence algorithm is to simulate animal evolution and natural competitive behaviour, and it has strong advantages in solving process arrangement and route planning problems. The Cuckoo Search (CS) algorithm is an emerging kind of group intelligence algorithm [25–27] with strong local and global search ability and convergence speed. Therefore, in order to solve the most important problems of resource allocation optimisation in the design of public cultural services for the elderly, this article proposes introducing intelligent computing into the design of public cultural services for the elderly. By simulating the movement behaviour of a large-scale group of elderly people in real time, the optimal location of cultural resource subjects is planned. Collision detection is introduced in the generation of individual movement paths in order to solve the problem of collision between individuals. In addition, the standard CS algorithm is improved with chaotic mapping and dynamic step size in order to increase the spatial range of group behaviour options and smoothly adjust the trajectory curve in order to improve the convergence speed and optimisation accuracy.

4. A Public Cultural Service System for the Elderly Based on an Improved CS Algorithm

4.1. Modelling of Individual Goals for Older People. The system designed simulates the public cultural services as a bird's nest and each individual elderly person as a cuckoo. By simulating the natural behavioural changes of the elderly population, the final birdhouse location is generated that best matches the actual needs. In order to provide a comprehensive view of the individual behaviour of the elderly, an RGB colour space model is used to represent the individual target characteristics of the group. The entropy of the individual image is first analyzed by RGB information $H(U)$.

$$H(U) = E[\log p_i] = -Ep_i \log p_i, \tag{1}$$

where p_i represents the probability of a single letter pixel occurring. The logarithm in the above equation generally takes the value of 2.

The colour degrees are calculated as follows:

$$\frac{1}{|\Omega|}\sum_{p\in\Omega}\left|R_p - G_p\right| + \left|G_p - b_p\right| + \left|B_p - R_p\right|, \tag{2}$$

where $|\Omega|$ is the individual size. R_p, G_p, and B_p are the RGB colour components.

The gradient distribution of individual targets in the population is then represented by a gradient histogram $g(p)$, which is calculated as follows:

$$g(p) = \min\left(\max\left(R_p, G_p, B_p\right), 1.1\right), \tag{3}$$

where 1.1 is the curve truncation value.

Finally, the texture features of individual targets in the population are represented using a grey-scale cooccurrence matrix $P(i, j)$, which is calculated as follows:

$$\begin{aligned} P(i, j) = \#\{&(x_1, y_1), (x_2, y_2) \in M \times N | f(x_1, y_1) \\ &= i, f(x_2, y_2) = j\}, \end{aligned} \tag{4}$$

where $f(x, y)$ represents the input population target of size $M \times N$ and $\#(x)$ represents the number of individuals in set x. i and j represent two different grey-scale values.

4.2. Basic CS Algorithm. A new global search algorithm, called the Cuckoo Search (CS) algorithm, was proposed in 2009 by modelling the behaviour of cuckoos searching for nests to lay their eggs [28]. In nature, cuckoos search for suitable nest locations to lay their eggs in a random way. To simulate the behaviour of the cuckoo in its nest search, first, three ideal states are set as follows:

(1) Each cuckoo lays one egg at a time and chooses a nest at random to incubate it.

(2) In a random selection process of nests, the best nest selected will be retained for the next generation.

(3) The number of available nests n is fixed and the probability of discovery by the nest owner is $p_a \in [0, 1]$.

Based on the three ideal states mentioned above, the updated formula for the optimal path and location of the bird's nest is shown as follows:

$$x_i^{t+1} = x_i^t + \alpha \oplus L(\lambda)\,(i = 1, 2, \ldots, n), \tag{5}$$

where x_i^t denotes the position of the nest of the i-th cuckoo in the t-th literation and a denotes the step parameter. S denotes the random walk step length. To facilitate the implementation of the algorithm, S in this article uses the vegetable dimensional flight formulation [29]:

$$S = \frac{\mu}{|v|^{(1/\beta)}}, \tag{6}$$

where the flight parameters μ and v follow a normal distribution.

$$\mu N\left(0, \sigma_\mu^2\right), vN\left(0, \sigma_v^2\right), \tag{7}$$

$$\begin{aligned} \sigma_\mu &= \left\{\frac{\Gamma(1+\beta)\sin(\pi\beta/2)}{\Gamma[(1+\beta)/2]2^{(\beta-1)/2}\beta}\right\}^{(1/\beta)}, \\ \sigma_v &= 1. \end{aligned} \tag{8}$$

4.3. Improved CS Algorithm. Chaotic mapping [30–32] is the inherent characteristic of nonlinear dynamical system, which is a kind of random process with the certainty of the regular expression. Therefore, it is often used to improve the performance of intelligent algorithms to find the best performance. Therefore, in this paper, the standard CS algorithm will be improved using chaotic mappings. The logistic formulation of the standard chaotic mapping system is shown as follows:

$$y_{n+1} = 4y_n(1 - y_n), \tag{9}$$

where $n = 1, 2, \ldots$ is the state, y_n denotes a chaotic variable, and $y_n \in [0, 1]$.

In order to increase the range of optional spaces for group behaviour and improve global optimisation performance, the current optimal position of the bird's nest in the CS algorithm x_{best} is chaotically optimised:

$$y_1^k = \frac{x_{\text{best}} - x_{\min}^k}{x_{\max}^k - x_{\min}^k}. \tag{10}$$

The above equation is the process of mapping x_{best} to the defined interval [0, 1] of y_{n+1}. The chaotic sequence $y^k = (y_1^k, y_2^k, \ldots, y_T^k)$ is generated by performing T iterations on y_1^k according to equation (10):

$$y_{n+1}^k = 4y_n^k\left(1 - y_n^k\right). \tag{11}$$

Next, the chaotic sequence $y^k = (y_1^k, y_2^k, \ldots, y_T^k)$ is mapped back to the original space by the inverse of equation (11):

$$x^{*k}_{\text{best},m} = x^k_{\min} + \left(x^k_{\max} - x^k_n\right) y^k_m, \quad m = 1, 2, \ldots, T. \tag{12}$$

At each iteration, the adaptation value for each nest is calculated and the best location $x^{*k}_{\text{best},m}$ in each iteration will be selected. The best location $x^{*k}_{\text{best},m}$ is then used to replace a randomly selected nest location in the nest.

In the basic CS algorithm, Levy flight is used to generate a random step size. However, the variation of this step size is very unstable. During the search process, the larger the step size is, the easier it is for the CS algorithm to search for the global optimal solution; however, it reduces the search accuracy and even sometimes oscillates. The smaller the step size, the lower the search speed of the CS algorithm, but the local search ability is enhanced, which improves the solution accuracy. Therefore, the use of Levy flight to generate step size, although random, lacks adaptivity. To address this problem, the step size needs to be dynamically adjusted adaptively according to the search results at different stages, and the relationship between the global search ability and the search accuracy needs to be properly handled.

$$d_i = \frac{\left\| x^k_i - x^k_{\text{best},m} \right\|}{d_{\max}}, \tag{13}$$

where x^k_i is the location of the nest i at the iteration k and $d_{\max}$ is the maximum distance between the best nest location and the other nest locations in the group.

The specific dynamic step adjustment method is as follows:

$$\text{step}_i = \text{step}_{\min} + \left(\text{step}_{\max} - \text{step}_{\min}\right) d_i, \tag{14}$$

where $\text{step}_{\max}$ is the maximum step size and $\text{step}_{\min}$ is the minimum step size. Equations (13) and (14) allow for the automatic adjustment of the dynamic step size.

4.4. Collision Detection Based on NURBS Modelling. In order to prevent collisions between different individuals in a group, a group model was constructed by means of NURBS modelling and collision detection was introduced in order to solve the problem of collisions between individuals. The NURBS model is defined as follows:

$$C(t) = \frac{\sum_{i=0}^{n} \omega_i P_i N_{i,k}(t)}{\sum_{i=0}^{n} \omega_i N_{i,k}(t)}, \tag{15}$$

where P_i represents the position of the surface vertices of the target model, $N_{i,k}(t)$ represents the basis function of the nonuniform rational B spline curve, and ω_i represents the control adjustment weights. The method for collision detection is shown as follows:

$$\text{vel}\,j = \left[\sum_{i=1.i\neq j}^{n} \frac{1}{\text{dist}(i,j)\cdot n}\cdot \text{vel}\,j\right]\cdot S + \text{vel}\,j\cdot(1-S), \tag{16}$$

where $\text{vel}\,j$ indicates the current speed of movement of the detected individual j and $S \in [0,1]$ indicates the weight that controls the degree of aggregation of the group. $\text{dist}(i, j)$ denotes the distance between different individuals.

In order to keep the direction of each individual in the group consistent with that of other individuals, equation (16) only selects the average direction of the neighbouring individuals of the target individual.

$$\text{vel}\,j = \left[\sum_{i=1.i\neq j}^{n} \frac{1}{n}\cdot \text{vel}\,j\right]\cdot S + \text{vel}\,j\cdot(1-S). \tag{17}$$

Finally, to complete the aggregation behaviour, to bring all individuals closer to the centre of the whole cluster, the final calculation of $\text{vel}\,j$ is shown as follows:

$$\text{vel}\,j = \left[\left(\sum_{i=1.i\neq j}^{n} \frac{\text{pos}\,i}{n}\right) - \text{pos}\,i\right]\cdot S + \text{vel}\,j\cdot(1-S), \tag{18}$$

where $\text{pos}\,i$ represents the vector of cluster centres.

4.5. Steps for Planning the Best Cultural Resource Subject. An improved CS algorithm is used to simulate the movement behaviour of large groups of elderly people in real time so as to obtain the best locations for cultural resources. The aim of the planning is to obtain the best locations for cultural institutions, including libraries, cultural centres, and cultural service centres, so as to improve the coverage and utilisation rate of elderly public cultural service resources. The steps for the simulation of movement behaviour of elderly groups based on the improved cuckoo algorithm are as follows:

Step 1: set the number of individuals in the group, the nest location, the initial adaptation value, the maximum step size $\text{step}_{\max}$, and the maximum step size $\text{step}_{\min}$.

Step 2: calculate the fitness function value for each nest in order to obtain the current optimal nest location and optimal value. The individual fitness values fitness are calculated as follows:

$$\text{fitness} = \sqrt{\left(x - g_x\right)^2 + \left(y - g_y\right)^2 + \left(z - g_z\right)^2} - \text{rand}(t), \tag{19}$$

where (x, y, z) is the current position of the individual, (g_x, g_y, g_z) is the 3D coordinate of the cluster target location and $\text{rand}(t)$ is the threshold value. This threshold is needed for distance spacing because the individuals in the group cannot all gather to the final target point but rather surround it.

Step 3: perform chaotic mapping of the current optimal nest and a nest update process using equation (14) to produce a new generation of nest locations, such as cultural service centres.

Step 4: determine whether the stopping condition is met; if so, output the optimal location (e.g., cultural centres) and the optimal fitness value; otherwise, repeat step 3.

Step 5: after obtaining the optimal solution (the central position of the entire cluster, e.g., the library), the individuals in the population are collision detected with all other individuals, and if a collision occurs, then skip back to step 3 until no collision occurs.

5. Simulation Results and Analysis

5.1. Experimental Configuration Parameters. The experiments in this article are divided into two parts: (1) standard function testing and (2) simulation of the planning of public cultural resources. The environment used for the experiments is MATLAB R2016a, PC configuration of Intel 2.4 GHz, 8G RAM, Window 10 operating system. The basic parameters of the improved CS algorithm were set as follows: maximum step size is 1, minimum step size is 10^{-4}, variation probability is 0.5, crossover probability is 0.9, probability of the bird's egg being found by the host is 0.25, and population size is 50. The experiment was conducted to simulate the movement behaviour of a large group of elderly people in real time by the improved CS algorithm so as to obtain the best location and path of the cultural resource subject. The aim of the experiment is to obtain the best locations of cultural institutions, including libraries, cultural centres, and cultural service centres, so as to improve the coverage and utilisation of elderly public cultural service resources.

5.2. Standard Function Tests. The optimal solution performance of the improved CS algorithm was tested using six classical test functions, and the results obtained were compared with typical CS, ASCS [33], and DECS [34]. The maximum number of iterations in the tests was 1000, with 20 runs of each function and a dimension of 30. The variables of the six test functions took values in the range [−5.12, 5.12]. The six classical test functions were defined as follows:

(1) Sphere function:

$$f_1(x) = \sum_{i=1}^{n} x_i^2. \tag{20}$$

(2) Schwefel function:

$$f_2(x) = \sum_{i=1}^{n} |x_i| + \prod_{i=1}^{n} |x_i|. \tag{21}$$

(3) Rastrigin function:

$$f_3(x) = \sum_{i=1}^{n} \left[x_i^2 - 10\cos(2\pi x_i) + 10\right]. \tag{22}$$

(4) Griewank function:

$$f_4(x) = 1 + \frac{1}{4000}\sum_{i=1}^{n} x_i^2 - \prod_{i=1}^{n} \cos\left(\frac{x_i}{\sqrt{i}}\right). \tag{23}$$

(5) Ackley function:

$$f_5(x) = -20\exp\left(-0.2\sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2}\right) - \exp\left(\frac{1}{n}\sum_{i=1}^{n}\cos(2\pi x_i)\right) + 20 + e. \tag{24}$$

(6) Quartic (noise) function:

$$f_6(x) = \sum_{i=1}^{n} i x_i^4 + \text{random}[0, 1), \tag{25}$$

where both $f_1(x)$ and $f_2(x)$ are a single-peaked function. The global optimal solution of $f_3(x)$ is within a steep canyon. $f_4(x)$ has numerous local optimum points. $f_5(x)$ and $f_6(x)$ are both complex multipeaked functions with a large number of local minima. The minimum, maximum, mean, and standard variance of each run were obtained. The results of the comparison of the six test functions are shown in Table 1.

As can be seen from Table 1, when the number of iterations is the same, the improved CS algorithm proposed in this article obtains results that are closer to the global optimal solution when solving for six functions than the other five algorithms. The average fitness value of the improved CS algorithm is improved by 10 orders of magnitude, and the variance is significantly reduced. In particular, for functions f_4 with an infinite number of local optima, both the minimum and average fitness values of the improved CS algorithm reach the theoretical optimum, while the CS algorithm falls into the local optimum. The Schwefel function is a complex single-peaked function and the Rastrigin function is a complex multipeaked function, and other existing algorithms are prone to produce local optimum solutions. The algorithm in this article enters the chaotic mapping and uses its ephemeral nature to improve the search range and accuracy.

In order to directly observe the optimisation-seeking effect of the improved CS algorithm and the typical CS algorithm on the six test functions, the evolutionary curves of the optimal fitness values of the two were compared, as shown in Figures 1–6. It can be seen that the improved CS algorithm has higher optimisation accuracy and faster convergence. In summary, the improved CS algorithm has improved in terms of convergence accuracy and convergence speed compared to CS. This is due to the use of a dynamic step size adjustment method, compared to a typical cuckoo algorithm with random step sizes, thus enhancing the search speed while ensuring global optimisation-seeking capability.

5.3. Modelling the Movement Behaviour of Large Groups of Older People. MATLAB programming was used to implement the improved CS algorithm based elderly group movement behaviour control, and the obtained path data was imported into NURBS software to simulate the crowd animation. The simulation of the elderly gathering group

Table 1: Comparison results of six test functions.

Function number	Algorithms	Minimum adaptation value	Maximum adaptation value	Average adaptation value	Variance
f_1	CS	$2.74E-08$	$1.21E-07$	$5.82E-08$	$5.93E-16$
	ASCS	$1.22E-17$	$7.09E-15$	$4.61E-16$	$1.48E-30$
	DECS	$9.22E-12$	$4.70E-11$	$1.91E-11$	$7.25E-23$
	Improved CS	$1.59E-20$	$9.33E-17$	$2.41E-18$	$1.71E-34$
f_2	CS	$2.32E-03$	$7.19E-03$	$3.91E-03$	$1.00E-6$
	ASCS	$9.32E-10$	$5.71E-09$	$2.22E-09$	$7.28E-19$
	DECS	$5.94E-06$	$7.84E-05$	$4.68E-05$	$2.01E-10$
	Improved CS	$1.45E-11$	$5.13E-10$	$6.47E-11$	$4.95E-21$
f_3	CS	0	$3.30E-26$	$1.07E-27$	$2.21E-53$
	ASCS	0	$1.97E-29$	$8.63E-31$	1.49EE - -61
	DECS	0	0	0	0
	Improved CS	0	0	0	0
f_4	CS	$1.22E-06$	$1.66E-03$	$1.85E-04$	$9.43E-08$
	ASCS	$2.95E-07$	$2.53E-03$	$1.21E-04$	$1.33E-07$
	DECS	$5.12E-13$	$5.14E-12$	$1.77E-12$	$9.97E-25$
	Improved CS	0	0	0	0
f_5	CS	$3.36E-03$	$5.76E-02$	$1.51E-02$	$1.35E-04$
	ASCS	$6.73E-09$	$3.46E-07$	$5.40E-08$	$5.08E-15$
	DECS	$1.94E-06$	$7.19E-06$	$4.04E-06$	$1.26E-12$
	Improved CS	$1.03E-10$	$6.48E-08$	$2.81E-09$	$1.38E-16$
f_5	CS	$3.67E-03$	$4.32E-02$	$2.22E-02$	$6.41E-05$
	ASCS	$3.47E-03$	$2.36E-02$	$1.13E-02$	$1.49E-05$
	DECS	$3.45E-06$	$1.91E-03$	$5.23E-04$	$2.05E-07$
	Improved CS	$7.88E-05$	$3.26E-03$	$8.44E-04$	$4.25E-07$

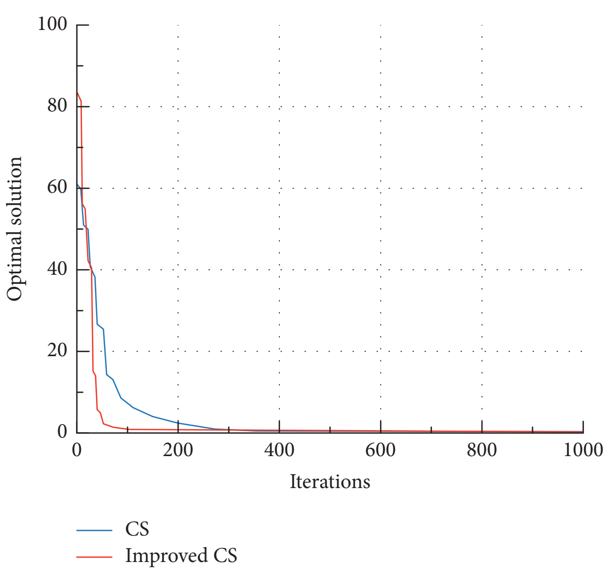

Figure 1: Iteration curve of function f_1.

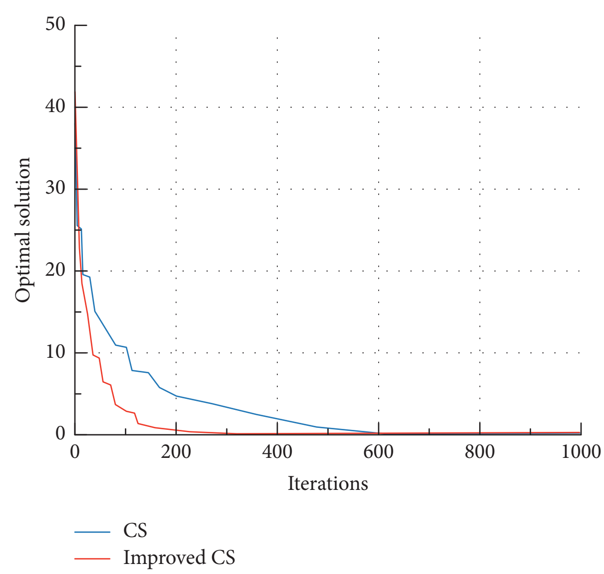

Figure 2: Iteration curve of function f_2.

movement behaviour based on the improved CS algorithm is shown in Figure 7, which verifies its feasibility.

5.4. Examples of Public Cultural Resources Planning. The essence of planning the public cultural resources is the Traveling Salesman Problem (TSP). This is the most basic route problem and a classical combinatorial optimisation problem. The feasible solution to the problem is the full permutation of all vertices. As the number of vertices increases, the corresponding number of feasible solutions increases accordingly. Therefore, public cultural resource planning is an NP-Hard problem. As shown above, the improved CS algorithm is very effective in finding the optimal solution to the continuous function problem. Next, the effectiveness of the improved CS algorithm in public cultural resource planning will be tested. The designed system modelled the public cultural service institution as a bird's

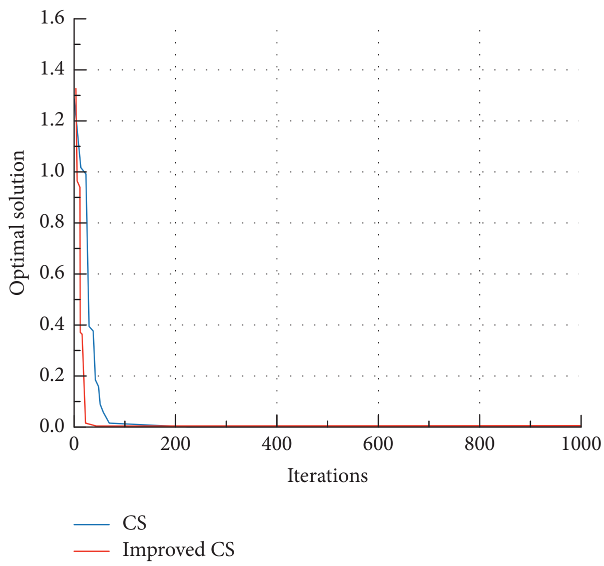

FIGURE 3: Iteration curve of function f_3.

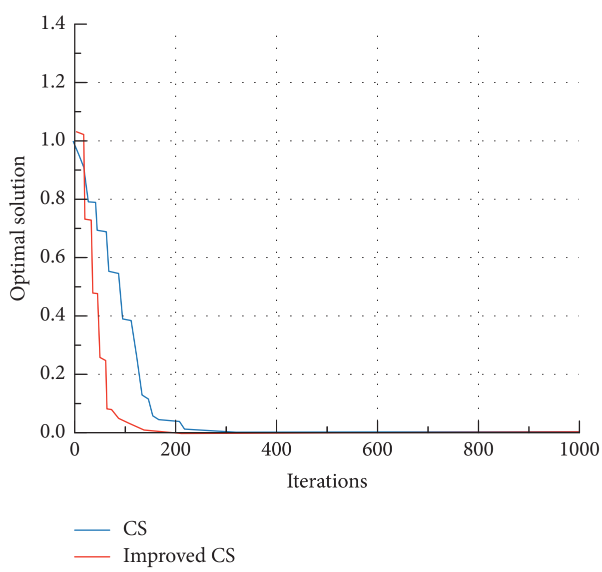

FIGURE 4: Iteration curve of function f_4.

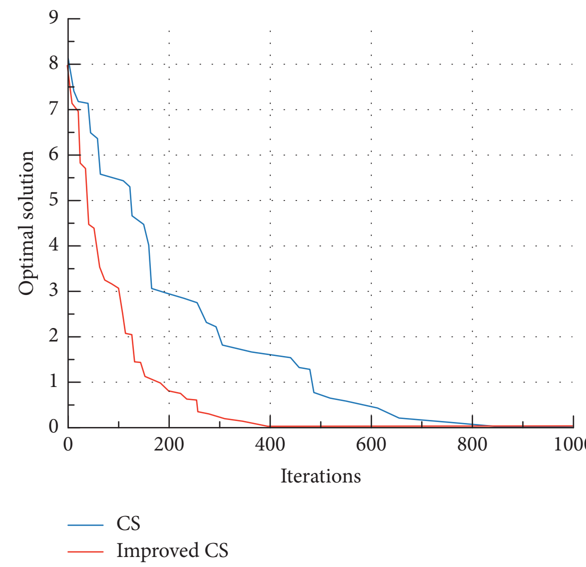

FIGURE 5: Iteration curve of function f_5.

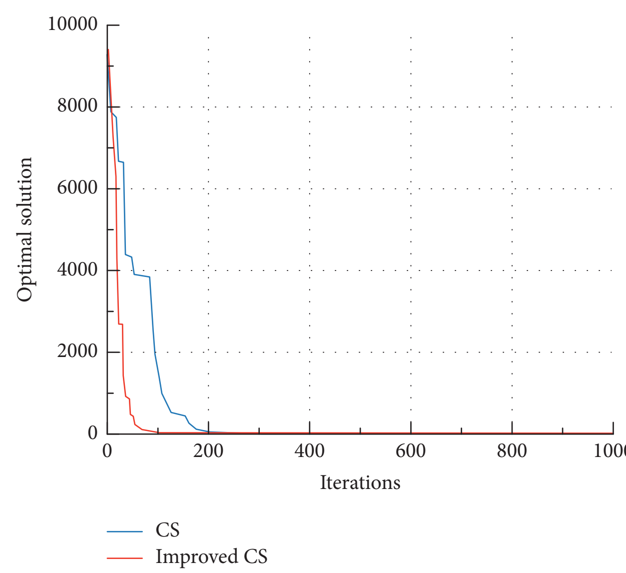

FIGURE 6: Iteration curve of function f_6.

nest and each individual elderly person as a cuckoo. The natural behavioural changes of the elderly population are simulated to ultimately produce the bird's nest location that best meets the actual needs. The location of the bird's nest location is the location of cultural institutions such as libraries, cultural centres, and cultural service centres.

The typical CS, ASCS, DECS, and improved CS algorithms were used to simulate the planning of public cultural resources for the elderly in each of the four cities, and a comparison of the simulation results is shown in Table 2. In City A, there are only 10 public cultural resources for the elderly. In City B, there are 30 public cultural resources for the elderly. In City C, there are 50 public cultural resources for the elderly. In City D, there are only 75 public cultural resources for the elderly.

As can be seen from Table 2, for the very-small-scale problem with 10 public cultural resources, all four algorithms can find the optimal solution. For the problem with 30 public cultural resources, the improved CS algorithm can find the optimal solution. For problems with 50 and 75 resources, the improved CS algorithm obtains optimal values that are closer to the optimal solutions compared to the other algorithms. It can be seen that the improved CS algorithm has better optimality finding accuracy. Finally, the coverage rate and utilisation rate of public cultural service resources for the elderly after using the designed system were counted in City D, and the results are shown in Figure 8.

As can be seen from Figure 8, the coverage and utilisation rate of public cultural service resources for the elderly in City D increased over time after using the designed

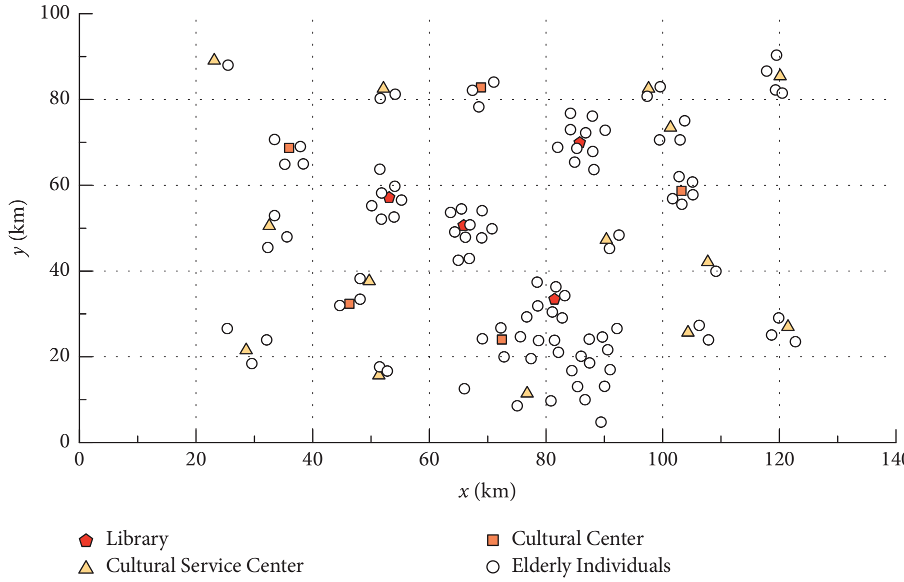

FIGURE 7: Simulation of movement behaviour of older people in congregate groups.

TABLE 2: Simulation comparison of public cultural resources planning.

City number	Optimum solution	Algorithms	Minimum adaptation value	Maximum adaptation value	Average adaptation value	Variance
A	2.6907	CS	2.6907	2.6907	2.6907	$1.43E-30$
		ASCS	2.6907	2.6907	2.6907	$5.23E-31$
		DECS	2.6907	2.6907	2.6907	$6.11E-31$
		Improved CS	2.6907	2.6907	2.6907	$5.82E-31$
B	423.741	CS	719.7529	787.0031	753.4504	442.0143
		ASCS	469.7712	782.6938	677.0514	8162.634
		DECS	499.4739	761.8066	607.7832	6354.7997
		Improved CS	423.741	720.4089	525.0658	6085.8082
C	427.855	CS	982.206	1018.3668	972.1053	564.1535
		ASCS	766.8296	1073.2126	981.7529	2517.9561
		DECS	635.8675	993.1679	904.5333	6125.7093
		Improved CS	510.5747	1040.1288	707.4548	13865.9908
D	594.18	CS	1664.7828	1815.353	1741.3225	1291.9662
		ASCS	1585.4851	1868.9838	1789.8069	2376.4924
		DECS	1568.5247	1775.9432	1707.7098	1795.046
		Improved CS	953.8732	1738.1591	1451.5683	25983.4133

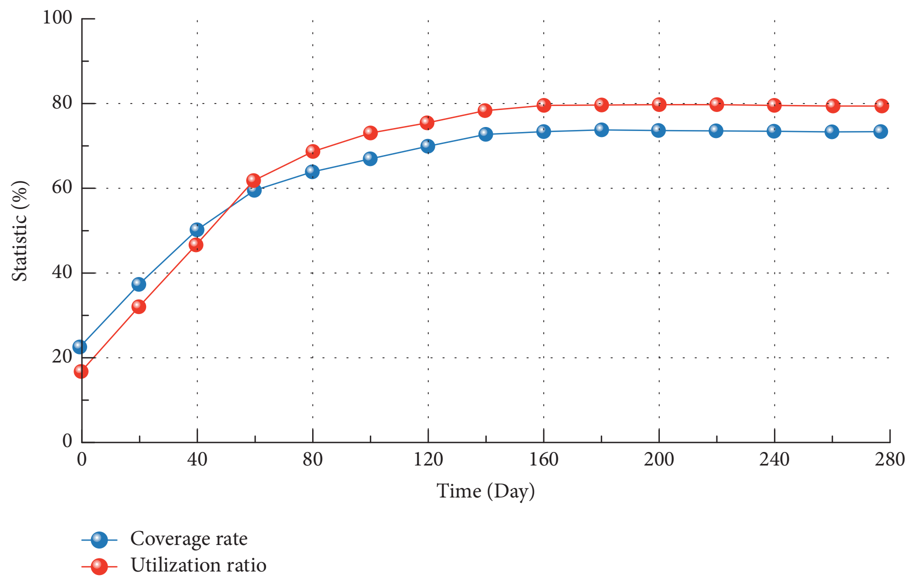

Figure 8: Variation curves of coverage and utilisation rate.

system. At 160 days, both the coverage and utilisation rates reached their highest values of 74.8% and 79.8%, respectively, verifying the effectiveness of the improved CS algorithm in the planning of public cultural resources for the elderly.

6. Conclusion

This article designs an intelligent computing-based public cultural service system for the elderly. Intelligent computing is introduced into the design of public cultural services for the elderly, thus solving the most important resource planning problem in the planning of public cultural services for the elderly. The CS algorithm is used to simulate the movement behaviour of large groups of elderly people in real time to plan the best location and path for cultural resource subjects. Collision detection is introduced in the generation of individual movement paths in order to solve the problem of collision between individuals. In addition, the standard CS algorithm is improved with chaotic mapping and dynamic step size in order to increase the spatial range of group behaviour options and to smoothly adjust the trajectory profile in order to improve the convergence speed and optimisation accuracy. Experimental results from six standard function tests show that the improved CS algorithm is very effective in finding the best for continuous function problems. The experimental results of the simulation with the planning of public cultural resources show that the coverage and utilisation rate of public cultural service resources for the elderly have been increasing with the improved CS algorithm, reaching 74.8% and 79.8%, respectively.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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