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Retraction

Retracted: Camouflage Tasks Planning Method for Group Target Operations Based on the Evolution of Resource Constraint

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] C. Liu, W. Xu, and X. Yang, "Camouflage Tasks Planning Method for Group Target Operations Based on the Evolution of Resource Constraint," *Journal of Sensors*, vol. 2022, Article ID 2613301, 10 pages, 2022.

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Research Article

Camouflage Tasks Planning Method for Group Target Operations Based on the Evolution of Resource Constraint

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Aiming at the problems of too many information points, complex tasks and resources matching, and too many non-inferior solutions in the process of group target operation camouflage planning, a target model and constraint model for group target operation camouflage planning have been established based on improved genetic algorithm. Through the resource constraint adjustment operator and discretization coding, the matching of tasks and resources and the adjustment of task sequence are realized, and the fitness function is constructed to obtain the relative optimal solution. Taking the artillery position group target as an example, the simulation results show that the optimization ability of this method is better than the greedy algorithm. The total time of the generated camouflage task sequence of the proposed method is reduced by an average of 2% compared with the greedy algorithm. The proposed method can assist the commander to carry out camouflage scheme planning and effectively improve the efficiency of operation engineering support.

1. Introduction

In modern information warfare, the battlefield situation is changing rapidly, and the operation rhythm is getting increasingly faster. A correct decision depends on whether the battlefield situation can be dealt with in a timely and accurate manner [1]. On the basis of obtaining a large amount of camouflage situation information, the camouflage commander must pay attention to many points, long lines, and wide areas in a strictly required time in decision-making process. Thus, it is easy to generate space blind spots, and the factors that may lead to incontrollable operation camouflage command increase [2]. The precision and efficiency of the camouflage scheme can hardly be guaranteed by relying on the commander and manual work alone. The compilation and deployment of camouflage forces is the core content of the operation camouflage plan and is the main basis for formulating the camouflage plan. Operation camouflage planning is the key content of the compilation and deployment of camouflage forces. It is the process of matching tasks, resources, and time. It is also affected and restricted by various factors such as camouflage task attribute, resource type, task time limit, and operating environment. With the expansion of the scale and the complexity of the problem, the optimization and decision-making problems of multiple camouflaged objectives are usually involved in the planning process. Therefore, it is of great significance to solve the camouflage planning problem of group targets under resource constraint to realize the camouflage support task.

There are few public studies on the camouflage planning of group targets, mainly on the design and evaluation of camouflage schemes and evaluation selection. For example, Nie Minghua [3] designed and implemented a set of camouflage scheme generation technology and system suitable for military camouflage for the visible light band based on the needs and status quo of military camouflage scheme generation, but the system focused on camouflage technology, mainly the design of camouflage patterns for topography and camouflage equipment. The campaign camouflage scheme generation and effectiveness evaluation system designed by Yang Jumei et al. [4] could assist users to draw up campaign camouflage schemes by simulating the campaign camouflage actions of the camouflage force. The system could analyze and evaluate the camouflage effectiveness of different camouflage schemes. However, the generation of the system camouflage scheme is based on the principle of engineering guarantee, and there is no specific model algorithm. Liu Yang et al. [5] designed a task planning method based on the greedy algorithm under the constraints of visible time and task time for the satellite ground station system task planning problem, but the final result was that several tasks were in a time period without giving a specific start and end time for each task. Bui H et al. [6] studied the development and implementation of U.S. Navy operation resource allocation and scheduling algorithms, and introduced the future operating unit planning module and task scheduling module. They designed an optimization-based scheduling algorithm, but the algorithm was limited by the quantity of task type. From the current research on camouflage planning for group targets, more research is about the camouflage technology, such as automatic generation of camouflage patterns, and less research on optimal matching of camouflage resources and tasks; more research on the design and evaluation of the overall framework of the camouflage scheme, and less research on the generation of specific operation camouflage task sequences; more research on the evaluation of the camouflage effect of the camouflage scheme, and less research on the time-effectiveness requirements of actual camouflage operations; more research on single target camouflage and less research on group target camouflage.

Based on summarizing the previous methods, this paper establishes a target model and constraint model for the camouflage planning of group targets. We design a resource constraint operator based on the genetic algorithm to realize the rational allocation of limited camouflage resources, so that the camouflage resources are evenly distributed over time based on the camouflage support requirements of the group targets. The camouflage planning Gantt chart is automatically generated. The camouflage task time of each target is reasonably arranged to make the entire camouflage plan get the shortest time. In this way, the camouflage resources can be fully utilized during the camouflage action, and assist the camouflage commander to design and generate camouflage plans.

2. Problem Description

Operation Task Planning is the process of planning and designing the process of operations, the arrangement of operation tasks, the use of forces and resources, and the coordinated actions of troops by using scientific planning methods and computer tools for the purpose of realizing operation intentions under many constraints such as operation rules and operation rules [7–11]. The camouflage planning of group targets is a subset of the Operation Task Planning. It is a planning and design process to realize the camouflage engineering support effect, camouflage tasks arrangement, and camouflage resource utilization by using intelligent methods. As shown in Figure 1, the pre-war group target operation camouflage planning is mainly used to assist in the generation of camouflage plans and guide the camouflage units to perform camouflage tasks. It is mainly to receive target characteristics, background data, combat technical requirements, and camouflage measures related to the battlefield situation, and to formulate camouflage plans through intelligent methods. The operation camouflage planning in wartime mainly assists the dynamic adjustment or regeneration of the camouflage scheme. Operation camouflage planning receives operational intentions and operational concepts from the top, and plans targets and camouflage actions for the subordinate camouflage forces. The decision space of group target operation camouflage planning problem is large, and it is difficult to be solved by means of ergodic solution or state search. It is necessary to reduce the dimension of decision space through intelligent methods [12] to find a strategy equilibrium solution.

The actual operation camouflage planning is a camouflage task scheduling problem under resource constraint, that is, a matching optimization problem among camouflage tasks, camouflage resources, and task time under multiple constraints. The final matching result is that a camouflage task is completed by a camouflage resource within a certain time period. Among them, the sequence constraints between camouflage tasks, the conflict of camouflage resource occupation, the ability of camouflage resources to complete camouflage tasks, and the camouflage task duration constitute the main constraints. For the camouflage planning problem of group target operations, the optimization and decision-making of multiple camouflage targets must be comprehensively considered in the planning process. The solution to the final problem is to achieve the overall optimum for all considered objectives. The practical functions of the final solution mainly include the following aspects. (1) Clarifying the camouflage tasks. The camouflage tasks that need to be performed are mainly determined based on the comprehensive analysis of target characteristics data, background characteristics data, camouflage equipment data, and operation technical indicators, and form a camouflage task list. (2) Generating task sequences. It needs to fully understand the criticality and interconnection of group targets and various situations that may be encountered in the process of reconnaissance and confrontation with the enemy, design camouflage actions, and camouflage task processes, in order to provide a basis for camouflage resource allocation and camouflage force coordination. (3) Reasonably allocating camouflage resources. The dynamic mapping of camouflage resources and camouflage tasks is achieved, mainly solving the problems of resource conflict and resource utilization maximization. (4) Coordinating camouflage operations. After clarifying the camouflage task and its execution camouflage unit, required camouflage resources, and task time, the camouflage forces executing each target cooperate with each other, cooperate closely, and complement each other's advantages through coordinating camouflage operations, to form an overall camouflage action for the group targets.

2.1. Basic Concepts. First of all, the basic concepts of camouflage planning for group target operations are clarified:

(1) Camouflage task. Group target are composed of several different types of unit targets, and the number of

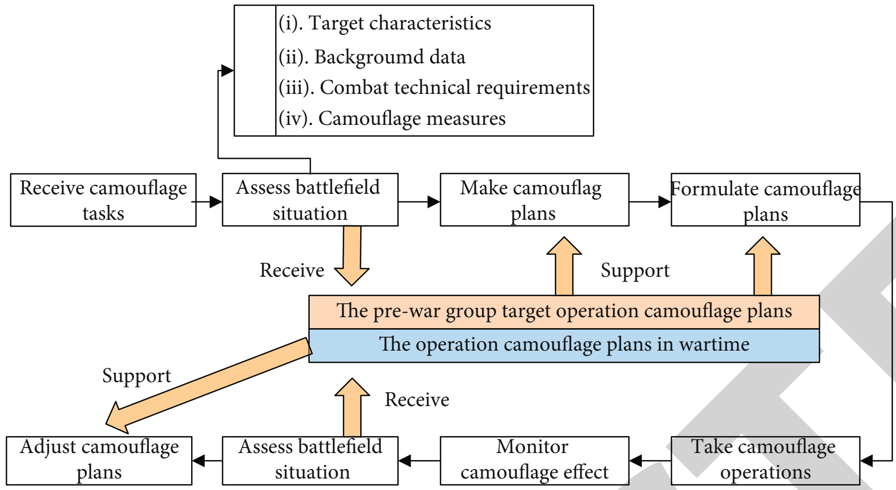

Figure 1: The role of operation camouflage planning.

different types of targets is not unique. Relying on the camouflage task system application database constructed by the previous project, the single target camouflage scheme that meets the requirements of camouflage effect can be queried according to the type of unit target, and the required operation time and camouflage resources meet the requirements of camouflage effect. The number of the unit target's types is d, the number of this type is n_i. The camouflage task of group target is composed of the camouflage subtask of unit target. In order to improve the accuracy of solving the camouflage planning problem of cluster target, the mathematical model of group target camouflage task is as follows:

$$T = \{\{T_i\}, \{t_i\}, \{k_i\}\} \quad i = 1, 2, \cdots n, \\ n = \sum_{i=1}^{d} n_i. \tag{1}$$

T represents the whole group target camouflage task, T_i represents the unit target subtask, t_i represents the time required to camouflage subtasks. k_i represents the resources required to camouflage subtasks. n represents the number of camouflage subtasks. Group target camouflage task is the unit target camouflage subtask, camouflage subtask required time, and resource collection. Each unit target has different military value in the group target because of the role it plays, which affects the camouflage level and resource investment of the unit target. Considering the actual camouflage task, the task serial and parallel situations exist at the same time to ensure the smooth implementation of the camouflage plan. There is a certain correlation between the various targets of the group target, which is different from the simple accumulation of single target camouflage. In fact, all the targets need to be integrated for overall evaluation. The 0th and Vth tasks are virtual tasks, marking the start and end of the camouflage plan, without occupying any time and resource. The time required to camouflage task i is T_i, with the start time as St_i and the end time as Ft_i. All tasks are linked by two constraints, namely, precedence constraint and resource constraint.

(2) Precedence constraint. It means that each task must wait until all its predecessor tasks are completed before starting [13]. Let P be the predecessor task set of task T_i, then for any task $h \in P$, if P has not ended, T_i cannot start. At the same time, considering the camouflage task transfer time constraint t_{zi} between the group targets and the extra time t_{ei} for avoiding enemy reconnaissance during the task execution process, the start time of the next task execution must be greater than the sum of the end time of the previous task, task transfer time and the extra time to avoid enemy reconnaissance

(3) Resource constraint. It means that the number of camouflage resources required to complete these tasks is limited. Camouflage resources include technical forces to implement camouflage, painting camouflage equipment, defilade camouflage equipment, false target camouflage equipment, smoke-generating equipment, and radar jamming equipment. It is assumed that the entire camouflage plan contains K kinds of resources; the number of camouflage resources of this type is m_j. Then, the total amount of camouflage resources is:

$$m = \sum_{j=1}^{k} m_j. \tag{2}$$

The total number of resources used by the task being executed cannot exceed the total amount of existing resources. Judging whether multiple camouflage tasks can be parallelized by resource constraint determines the final generated task sequence style.

2.2. Problem Model. Although each camouflage target of the camouflage planning for group target operation is a part of the group target as a whole, it is a competitive relationship for the limited camouflage resources. It is impossible for applying all camouflage resources to meet only one target, that is, it is impossible to make each camouflage target optimal at the same time. The maximum optimization of each objective can be achieved only through a certain optimization method. After the time of each target and the number of required camouflage resources are determined in the early stage, the sequence of all camouflage tasks is arranged under the condition that the precedence constraint and resource constraint are met, and the start time and end time of each camouflage task are determined. In this way, the total time of the camouflage plan is the shortest. The following mathematical model can be established for this problem.

$$\mathrm{Min}F(i) = \sum_{i=1}^{n} t_i, \tag{3}$$

$$S.T\ St_{i+1} \geq \mathrm{Ft}_i + t_{zi} + t_{ei}, \forall i, \tag{4}$$

$$A = [a_{w,\tau}],\ \sum_{\tau=1}^{n} a_{w,\tau} = 1, \tag{5}$$

$$St_i \geq 0, \forall i. \tag{6}$$

In the above formula, Formula (3) takes the total time of the camouflage plan as the objective function. For the problem of operational camouflage planning, under the condition that the single target in the camouflage plan meets the camouflage effect level given by the superior, optimizing the total time of the camouflage plan is conducive to better coping with the battlefield emergencies, completing the camouflage support task faster and more efficiently, facilitating the deployment of subsequent combat tasks, and better improving the actual combat effect of the camouflage operation planning. Therefore, under the condition of satisfying the requirements of single target camouflage effect, the total time of camouflage operation planning should be minimized. Formula (4) is a precedence constraint, Formula (5) is a resource constraint, A is the $m \times n$ camouflage resource subtask allocation matrix, $a_{w,\tau} \in [0, 1]$; 1 means that the camouflage resource w is assigned to the subtask, and each resource can only be assigned to one subtask, and Formula (6) is a non-negative constraint.

2.3. Solution Space. The solution of the operation camouflage planning problem should include the results of matching each camouflage target resource and the execution time of the task. The solution space model is expressed as:

$$M = (N, k_i, [St_i, \mathrm{Ft}_i]), \tag{7}$$

where N represents the subtask number, k_i represents the number of camouflage resources required by the target, and $[St_i, \mathrm{Ft}_i]$ represents the start time and end time of the target, respectively. Finally, the overall task sequence of the group target is visually represented in the form of Gantt chart. The task T_i occupies the resource k_i in the time period $[St_i, \mathrm{Ft}_i]$. In order to avoid the situation where multiple tasks occupy the same resource at the same time, the solution space is constrained as follows:

$$[St_i, \mathrm{Ft}_i] \cap [St_j, \mathrm{Ft}_j] = \varnothing \quad i, j \subset \Omega_k, \tag{8}$$

where Ω_{k_i} represents the set of tasks that conflict with occupying the resource k_i. Then, there is no situation where the camouflage resources occupied by two targets at the same time exceed the given amount. The solutions in this case are screened so that the final solution complies with the camouflage resource constraint.

3. Algorithm Design

3.1. Steps of the Algorithm. Genetic algorithm (GA) is a search (optimization) algorithm based on the principle of natural selection and natural genetic mechanism. It simulates the evolutionary mechanism of life in nature and achieves the optimization of specific goals in artificial systems. The essence of genetic algorithm is to use group search technology to evolve generation by generation according to the principle of survival of the fittest and finally obtain the optimal solution or quasi-optimal solution [14]. Due to the high complexity of the system and the high timeliness of solving the problem of group target operation camouflage planning, the use of the group search technology in the genetic algorithm can better solve this problem. First, each camouflage task is randomly assigned a priority value, and M tasks are randomly sorted. Next, genetic operator operations such as crossover, replication, and mutation are performed to obtain 2M task rankings. In this paper, a constraint selection operator is designed after the traditional genetic operator. The original sequence of the tasks is adjusted to the sequence that satisfies the resource constraint, so that the serial task sequence is transformed into the coexistence of the serial and the parallel task sequence. This situation is more in line with the actual operation camouflage. The overall flow chart is shown in Figure 2. Next, the design of population initialization, fitness function, and genetic operator will be explained.

3.2. Population Initialization. The GA must convert the representation of the feasible solution of the problem into the representation of the chromosome in the genetic space through coding, that is, the coding process [15]. Coding is the primary problem to be solved when applying the genetic algorithm, and it is also a key step in designing genetic algorithm. The coding method affects the operation methods of genetic operators such as crossover operator and mutation operator and largely determines the efficiency of genetic evolution. At present, the commonly used encoding methods are coincidence encoding, integer encoding, and binary encoding. This paper adopts the priority-based integer encoding method [16]. This method can not only express the constraint relationship between tasks but also express the randomness of task priority. Active on the node

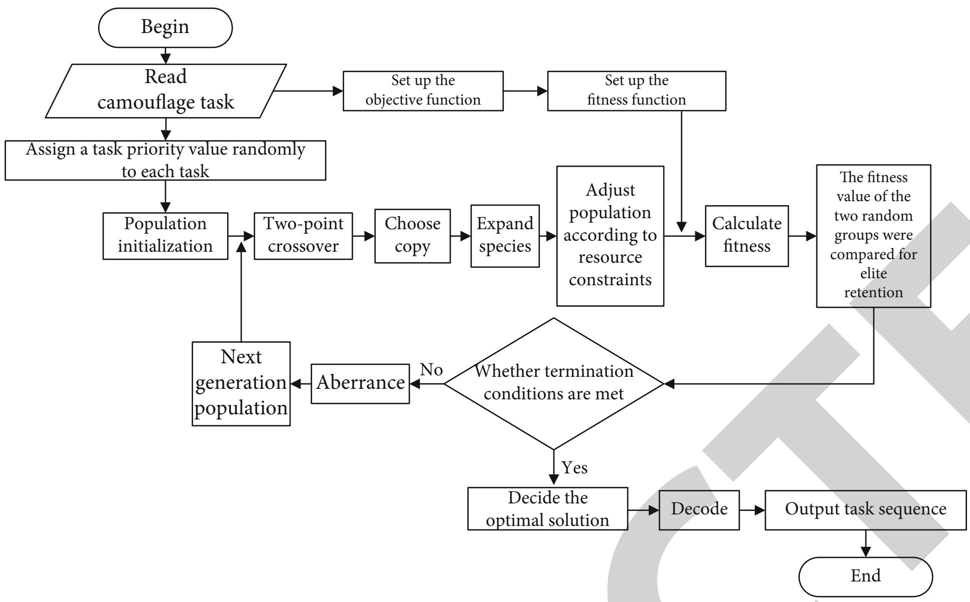

Figure 2: Flowchart of the algorithm.

(AON) single-code network diagram can be used to represent the constraint relationship between tasks.

(1) Adjacency matrix. An AON network graph can be represented in a computer by an adjacency matrix X [17], where its rows represent all the precedence tasks, and its columns represent all the subsequent tasks. As shown in Figure 3, if there are 9 camouflage tasks in a camouflage planning problem, and the precedence tasks of task 2 are task 3, task 4, and task 6, then the numbers of the third row, fourth row, and sixth row of the second column of the adjacency matrix are all 1, with the remaining rows being 0

(2) Random priority chromosome coding. A randomly generated matrix represents the priority of tasks. As shown in Table 1, each task has a unique priority, generating an initial serial task sequence. For group target operation camouflage planning, random priority assignment is more practical. The generated initial population can generate as many random task sequences as possible, improve the local search ability of the algorithm, and prevent falling into local optimum

(3) Generation of the initial population. The initial population is the data basis of the genetic algorithm, and all evolutionary computations start from the individuals in the initial population [18]. In order to get a good initial population, the individuals should be evenly distributed in the solution space as much as possible. Therefore, this paper adopts the randomly assigned task priority value to generate the serial task scheduling sequence

3.3. Fitness Function. The fitness value is the only criterion for evaluating the pros and cons of chromosomes when decoding chromosomes to generate scheduling plans. In the selection operator, it is also necessary to use the fitness value of individuals to evolve the survival of the fittest [19]. In the genetic algorithm, the larger the fitness value, the better, and minimizing the total time of the camouflage plan is the objective function of this paper. Therefore, the objective function needs to be converted into the fitness value function according to:

$$f(i) = \frac{1}{\sum_{i=1}^{n} t_i}, \quad (9)$$

where $f(i)$ is the fitness value of individual i, and $\sum_{i=1}^{n} t_i$ is the total time of camouflage plan.

3.4. Design of Genetic Operators

3.4.1. Crossover Operator. There are three commonly used crossover methods, one-point crossover, multi-point crossover, and consistent crossover [20]. This paper adopts the method of two-point intersection for calculation. First, the crossover probability Pc is given, and Pc determines the number of chromosome crossover individuals in the population. The number is limited to an even number, which is convenient for the next crossover operation. As shown in Figure 4, a random number PP is generated to determine the crossover point, and the crossover position of the parent chromosome is determined by the crossover points a and b. The genes between a and b of the child chromosome 1 are taken from the parent 2, and the remaining genes are taken from the parent 1. Genes between a and b of child

Subsequent tasks

$$\text{Precedence tasks}\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

Figure 3: Adjacency matrix of AON network graph.

Table 1: Random priority table.

Task number	1	2	3	4	…	n
Priority	P_1	P_2	P_3	P_4	…	P_N

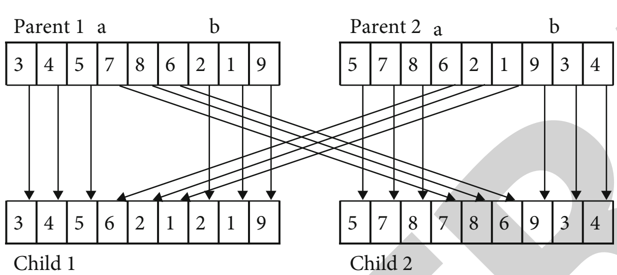

Figure 4: Diagram of two-point crossover of chromosomal genes.

chromosome 2 are taken from parent 1, and the remaining genes are taken from parent 2.

Due to the repeated task sequences in the child individuals after crossover, the genes numbered 2 and 1 in child 1 appear twice, and the genes numbered 7 and 8 in child 2 also appear twice. The task sequence represented by such individuals is obviously not in line with the reality of camouflage tasks. It is necessary to legalize the chromosomal genes after crossover operation. Traditionally, to solve the problem of duplication of child chromosomal genes, genes on chromosomes are compared one by one, and the same genes are adjusted. For the high complexity of the group target operation camouflage planning problem, the algorithm takes too much time for calculation. On this basis, we firstly judge whether there is equality between a and b on the chromosomes of parent 1 and parent 2. If so, we adjust directly at the corresponding position, reducing the number of comparisons one by one, and better improving the efficiency of the algorithm. The legalization operator designed in this paper improves the update speed of the repetitive part of the child chromosomal gene and can generate child chromosomes that meet the actual operation camouflage planning in a faster manner.

Table 2: The number of artillery position unit targets.

d	n_1	n_2	n_3	n_4	n_5	n_6	n
6	12	12	2	4	3	4	37

Table 3: Type and quantity of existing camouflage resources.

k	m_1	m_2	m_3	m_4	m_5	m
5	30	280	200	35	4	52

3.4.2. Selection Operator. The selection operation is the process of selecting excellent individuals from the current population to generate a mating pool [21]. This process reflects the idea of survival of the fittest and survival of the best in nature. In this paper, the elite selection strategy is used to select the operator [22]. In the iterative process, the part of individuals with larger fitness value in the population is retained, and the optimal solution is gradually approached. The specific process is as follows:

(i) Calculate the fitness value of each individual in the population according to the fitness value function

(ii) Randomly sort all individuals and compare the fitness values in pairs

(iii) Copy all chromosomes with larger fitness values to the next generation

3.4.3. Mutation Operator. Mutation operation is to simulate the mutation of certain genes during the process of cell division and replication due to accidental factors such as the environment in the genetic and natural evolution process of organisms. Then, new chromosomes are generated, and usually, the probability of such mutation is relatively small [23]. This is an operator that maintains individual diversity, which can make the algorithm less likely to fall into local optimum. In this paper, the random number mutation operator is used, and the generated individual genes have no genetic relationship with the parental individuals. The specific process is as follows:

(i) Set a mutation probability, when the mutation probability is greater than the generated random number, mutation occurs

(ii) When mutating, a completely new chromosome is randomly generated to replace the corresponding chromosome to realize the update of the population

3.4.4. Resource Constraint Adjustment Operator. After the operations of the above operators, individuals with serial task sequence gene coding information are obtained. However, there are parallel situations in the actual camouflage planning. So, it is necessary to judge whether the amount of resources required by the parallel tasks at the same time meets the resource constraint. The resource constraint adjustment operator designed in this paper is to replace

Table 4: Unit target camouflage task parameters.

Target type	n_1	n_2	n_3	n_4	n_5	n_6
Camouflage measures	ACEF	ACE	ABCE	ABC	AGD	AC
Camouflage resources	m_1:10 m_2:6 m_5:5	m_1:8 m_2:4 m_5:8	m_1:9 m_2:6 m_5:4	m_1:8 m_2:8 m_5:10	m_1:12 m_2:230 m_3:180 m_4:20	m_1:4 m_2:4 m_5:4
Operation time (h)	0.3	0.25	0.2	0.4	0.5	0.1

Population size M =60, number of iterations N =100, crossover probability Pc =0.6, mutation probability Pm =0.2.

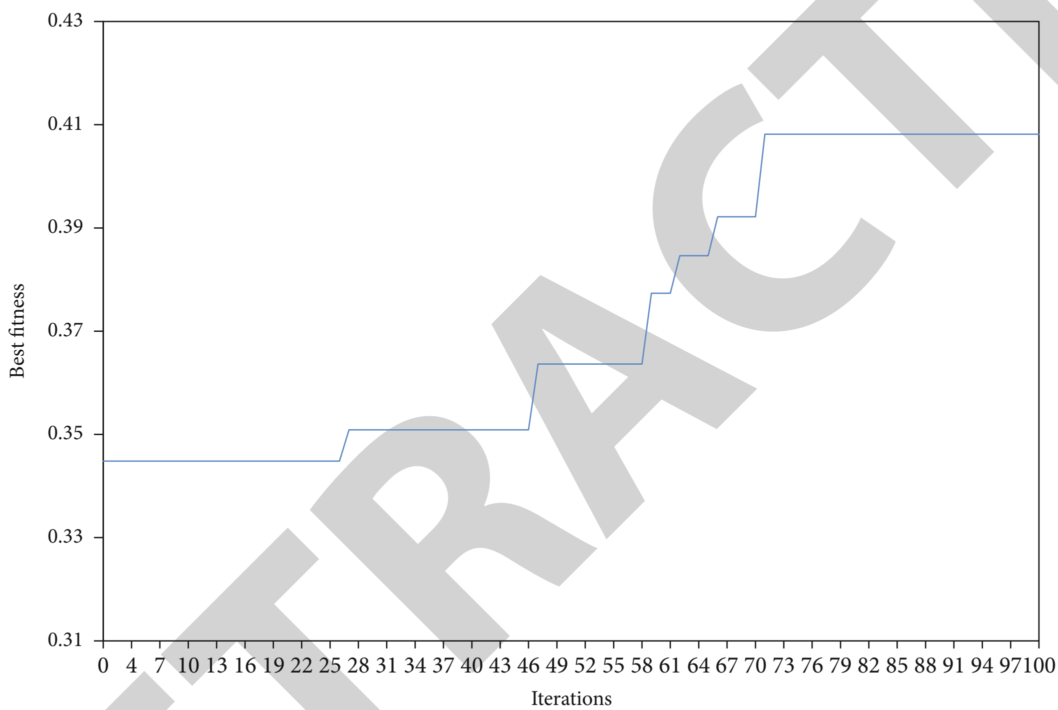

Figure 5: Evolution of resource constraint method generates optimal fitness value curve.

the serial task sequence with the parallel and serial coexisting task sequence according to the camouflage resource constraint. The specific process is as follows:

(i) Determine whether the amount of resources required by a single task satisfies the resource constraint according to the originally generated serial sequence

(ii) If the conditions are met, the task will be pushed into the task sequence and changed to parallel mode, and then judge whether the sum of parallel task resources at the same time satisfies the resource constraint

(iii) If it is not satisfied, release the task sequence, then add the following tasks, calculate the total usage of resources, judge whether it is satisfied, and execute it in a loop

4. Simulation Experiment

In order to verify the superiority of the proposed method for solving the group target operation camouflage planning problem, simulation experiments were conducted, with the greedy algorithm based on multi-source information perception for comparison.

4.1. Figures. Taking the group targets of artillery position as an example, the group target has six types of unit targets: artillery, artillery tractor, command vehicle, ammunition shelter, road, and support vehicle. The number of targets per unit is shown in Table 2. A camouflage unit needs to use screen camouflage A, vegetation camouflage B, pattern painting camouflage C, smokescreen camouflage D, false target camouflage E, acoustic camouflage F, and jamming camouflage G seven main camouflage measures to carry out target camouflage tasks. At present, there are five main camouflage resources: camouflage force, camouflage net,

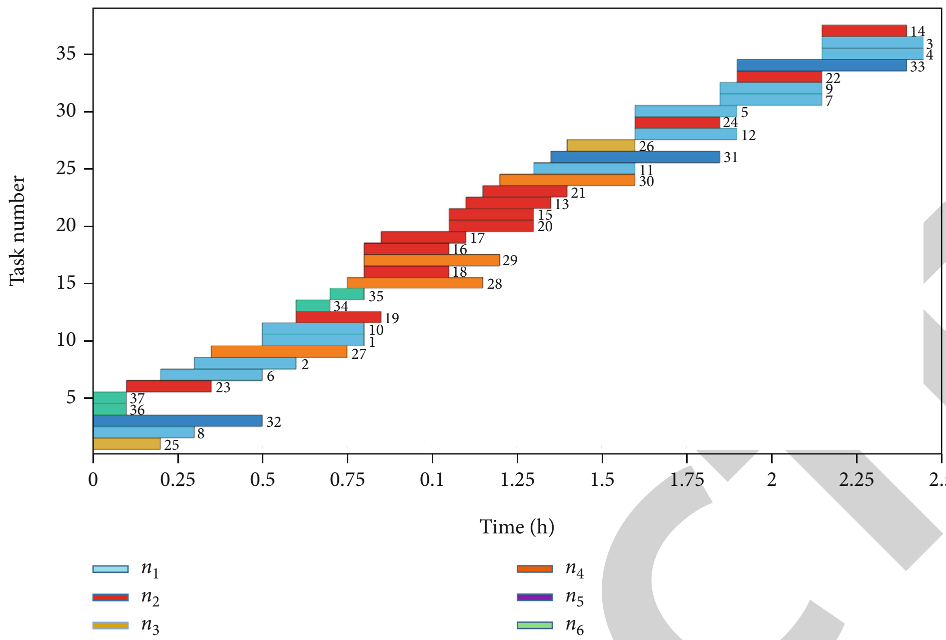

Figure 6: Gantt chart of camouflage task corresponding to optimal fitness.

Table 5: Task sequence table corresponding to optimal fitness.

T_i	$St_i(h)$	$Ft_i(h)$	T_i	$St_i(h)$	$Ft_i(h)$	T_i	$St_i(h)$	$Ft_i(h)$
37	0	0.1	35	0.7	0.8	26	1.4	1.6
36	0	0.1	28	0.75	1.15	5	1.6	1.9
32	0	0.5	16	0.8	1.05	24	1.6	1.85
8	0	0.3	29	0.8	1.2	12	1.6	1.9
25	0	0.2	18	0.8	1.05	22	1.9	2.15
23	0.1	0.35	17	0.85	1.1	9	1.85	2.15
6	0.2	0.5	15	1.05	1.3	7	1.85	2.15
2	0.3	0.6	20	1.05	1.3	33	1.9	2.4
27	0.35	0.75	13	1.1	1.35	14	2.15	2.4
10	0.5	0.8	21	1.15	1.4	3	2.15	2.45
1	0.5	0.8	30	1.2	1.6	4	2.15	2.45
34	0.6	0.7	11	1.3	1.6			
19	06	0.85	31	1.35	1.85			

smoking materials, corner reflector, and camouflage paint. The number of camouflage resources of each type is shown in Table 3. The camouflage measures, camouflage resources, and time required for targets of 6 types of units are shown in Table 4. Due to confidentiality requirement, the data has been declassified.

4.2. Experimental Results and Analysis. Experiment 1: The resource constraint optimization algorithm was used to solve the above artillery position targets and obtain the optimal fitness value curve, Gantt chart for camouflage task and the start time and end time of camouflage subtask.

From Figure 5, it can be seen that the optimal fitness value of the population increases with the increase of algebra, and the larger the algebra is, the more gentle the change of the fitness function value of each generation. When it reaches a certain generation, the optimal fitness value of the population converges, which is the optimal value of the objective function. At the same time, Figure 6 shows the Gantt chart of camouflage task corresponding to the optimal fitness value. The Gantt chart shows the task sequence of camouflage subtasks and tasks that can be parallel at the same time point, and obtains the optimal camouflage plan time under the condition of meeting resource constraints. Table 5 shows the start time and end time of each camouflage subtask and the sorting position in the whole camouflage task sequence, assisting the commander of the camouflage unit to formulate the camouflage scheme and draw up the

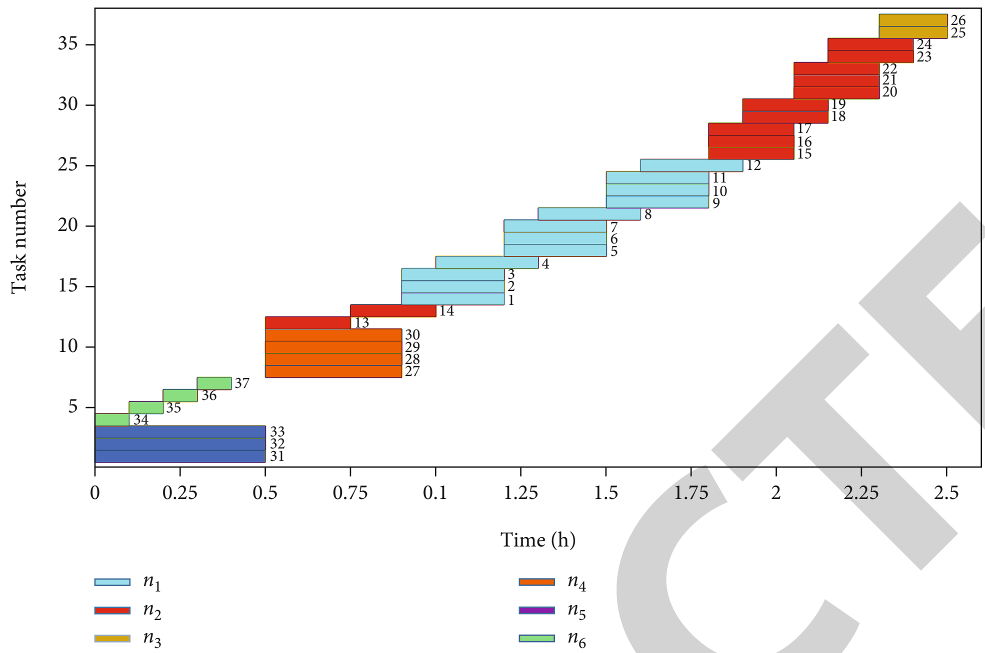

Figure 7: Greedy algorithm generates camouflage task sequence table.

Table 6: Task sequence table.

T_i	$St_i(h)$	$Ft_i(h)$	T_i	$St_i(h)$	$Ft_i(h)$	T_i	$St_i(h)$	$Ft_i(h)$
34	0	0.1	3	0.9	1.2	16	1.8	2.05
33	0	0.5	2	0.9	1.2	15	1.8	2.05
32	0	0.5	1	0.9	1.2	19	1.9	2.15
31	0	0.5	4	1	1.3	18	1.9	2.15
35	0.1	0.2	7	1.2	1.5	22	2.05	2.3
36	0.2	0.3	6	1.2	1.5	21	2.05	2.3
37	0.3	0.4	5	1.2	1.5	20	2.05	2.3
13	0.5	0.75	8	1.3	1.6	24	2.15	2.4
30	0.5	0.9	11	1.5	1.8	23	2.15	2.4
29	0.5	0.9	10	1.5	1.8	26	2.3	2.5
28	0.5	0.9	9	1.5	1.8	25	2.3	2.5
27	0.5	0.9	12	1.6	1.9			
14	0.75	1	17	1.8	2.05			

camouflage plan. The total time of camouflage plan is related to the type of cluster target, that is, the type and number of unit targets in the group target, which determines the input of camouflage resources. Therefore, the total time of camouflage plan is not a simple linear relationship with the number of tasks contained in the cluster target, but a complex functional relationship between the optimized time target when the camouflage effect meets the requirements of reconnaissance threat confrontation.

Experiment 2: The greedy algorithm was used to solve the above artillery position group targets and obtain the Gantt chart for the camouflage task and camouflage task sequence table.

It can be seen from Figure 7 that the greedy algorithm can also solve the camouflage planning problem of group target operation and generate the camouflage task Gantt chart that meets the resource requirements. Compared with Figures 6 and 7, the camouflage task Gantt chart generated by the algorithm proposed in this paper has a greater degree of sorting and discrimination for the camouflage subtasks of the same type of unit targets, indicating that under the condition of limited camouflage resources, it is more conducive to the overall camouflage task of group targets rather than executing the camouflage tasks of the same type of unit targets in turn. According to Tables 5 and 6, comparing the total time of camouflage task sequence solved by two algorithms of artillery position group target, this paper proposes that the total time of camouflage task sequence generated by genetic algorithm based on resource constraint optimization is 2% shorter than that of greedy algorithm. It shows that the proposed genetic algorithm based on resource constraint optimization has better optimization ability than the greedy algorithm.

5. Conclusions and Prospects

Through the above research work, a model for solving the problem of group target operation camouflage planning is established, and a method for solving the model is designed. The proposed method is applied to the camouflage task instance. The method can realize the camouflage planning of the group target under the condition of satisfying the resource constraints, generate the Gantt chart, and reasonably allocate the limited camouflage resources. This makes the camouflage resources have balanced distribution over time according to the camouflage support requirements of the group target. In this way, camouflage resources can be fully utilized during camouflage operations, which can assist camouflage commanders to design and generate camouflage plans. The research results have certain practical significance for the finishing of camouflage support task.

The follow-up work will consider operational camouflage planning under more complex conditions such as reconnaissance strike confrontation and camouflage resource damage, and explore more efficient methods for solving the problem of group target operation camouflage planning to improve the efficiency and adaptability.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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