Improved Multi Ant Colony Algorithm for Evacuation of Intelligent Venues After Competitions

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Keywords: Post Competition Evacuation, Improved Multi Ant Colony Algorithm, Intelligent Venues, Venue Evacuation

Abstract: With the increase of urban population, the number of buildings is increasing, and the functions of venues are also increasing. Traditional buildings can no longer meet the needs of people's daily travel, life, work and other activities. In this case, the evacuation of intelligent sports venues after the competition is particularly important. This paper mainly focuses on the security problems of intelligent venues after competitions. This paper first analyzes the development status of relevant topics in this field at home and abroad and the actual situation in China, then studies the influencing factors, finally determines the weight value of each element by combining the literature method and the analytic hierarchy process, establishes the evaluation index system, and calculates the comprehensive score function and the prediction results. Test results show that the algorithm can quickly evacuate pedestrians to the evacuation destinations on both sides, and the model of the algorithm has better evacuation performance.

1. Introduction

With the continuous development of the city, people's living standards have been greatly improved, and the requirements for sports venues and sports facilities are also getting higher and higher. As an integral part of the large event buildings, venues and stadiums [1-2]. In the spare time of daily work and study, you need to pay attention to exercise at all times. Therefore, in order to ensure safety, facilitate the use of the masses and reduce losses, it is necessary to design a reasonable, effective and cost-effective emergency evacuation plan to ensure the normal operation of public places and the protection of people's lives and properties. At the same time, it is necessary to formulate corresponding system specifications according to relevant national laws and regulations to create a good and comfortable environment for people without causing fear and behavior out of control [3-4].

At present, many experts and scholars at home and abroad are studying the safe evacuation of intelligent venues after the competition, and have put forward some views, such as the multi ant colony algorithm for fire protection design of scenic spots and buildings around the park abroad. There are also some research results on the back row tourist flow of intelligent venues in China [5-6]. Some scholars have analyzed the changes in the number of passengers when a fire occurs in the city and the distribution characteristics of the density of people in the building, and concluded that the reasonable range of evacuation routes should be selected between large public places and residential buildings. Some scholars pointed out that emergencies should be reported to relevant departments in a timely manner. If the alarm information is not obtained in time, it will lead to the inability to guide and control the flow of on-site personnel. In case of an accident, it is also necessary to quickly evacuate to other areas for handling or evacuation, so as to avoid unnecessary losses to the follow-up population and adverse impact on social security [7-8]. Therefore, this paper improves the multi ant colony algorithm of intelligent stadium evacuation after the competition.

The planning and optimization of emergency evacuations have become focal points of research. Various algorithms and models have been introduced, aiming to provide more intelligent and

  DOI: 10.25236/icceme.2023.023

efficient solutions to this problem. In their 2022 study, XU Lei and colleagues utilized an enhanced ant colony optimization algorithm to intelligently plan fire evacuation routes, making evacuations faster and safer [9]. Concurrently, in 2019, NIYOMUBYEYI, PILESJÖ, and MANSOURIAN proposed an evacuation planning optimization method based on a multi-objective artificial bee colony algorithm. This method takes into account a comprehensive range of factors, resulting in a more thorough evacuation planning [10]. The evacuation issues related to factory layout have also garnered attention from scholars. KHAMIS and the team, utilizing the crowd simulation model and multi-objective artificial bee colony optimization, researched the optimal exit configurations for factory layouts, ensuring a safer emergency evacuation [11]. In another study from 2020, KHAMIS and others explored how to determine the best emergency exit locations using the crowd evacuation model optimization [5]. KABIR and his team, in 2023, delved into multi-objective optimization solutions for evacuation modeling, offering a broader range of choices for evacuation modeling [12].

In this paper, the traditional artificial neural network prediction algorithm and ant colony optimization algorithm are introduced in detail. Combined with the current research status at home and abroad, a new safety emergency plan and scheme based on improved genetic coefficient method, fuzzy mathematics and grey system theory are proposed. Finally, a simple analysis is made on the practical application of this model in large venues, preparing for its subsequent function expansion.

2. Discussion on Improved Multi Ant Colony Algorithm for Post competition Evacuation of Intelligent Venues

2.1. Post Games Evacuation

With the rapid development of China's economy, the people's living standard is improving day by day, and the construction industry is also rising rapidly. As an integral part of urban construction, venues are playing an important role. While people pursue material enjoyment, they neglect the safety problem. With the rapid development of social economy and the increasing urbanization population and traffic pressure, excessive crowd density is likely to cause traffic accidents or mass deaths, which will lead to frequent accidents or casualties that seriously affect the city image, and will also lead to more uncertain factors in the later operation of the venue. In order to avoid potential safety hazards and evacuation difficulties, the shortest walking distance shall be kept as far as possible [13-14] in order to facilitate passengers' escape during the design of buildings. But this may lead to danger. Therefore, we should take into account the safety factors and the harm caused by the building itself to personnel, and also pay attention to whether the fire fighting facilities can be used normally and whether the automatic fire alarm system, emergency call and emergency lighting indicator and other working conditions are affected. In addition, it is also necessary to ensure that the evacuation passage is unobstructed and convenient for people to evacuate from the evacuation path, and try to avoid secondary station crossing at the stairway or elevator entrance. In order to better protect people's lives and property from being infringed, meet the needs of residents and promote social harmony and stability, architectural design activities need to take into account various factors (such as building structure design and use functions) and various emergencies (such as fire or other major accidents causing personnel evacuation), so a large number of people will gather in the venue during operation. In cities, due to the continuous improvement of people's living standards, the requirements for building functions are also getting higher and higher. The venue designers, managers and relevant staff should make reasonable and effective evacuation plans after analyzing and judging the actual situation and specific problems on site. In case of large accidents or emergencies, we can arrive at the scene in time and take appropriate protective measures. At the same time, we can quickly control the fire in case of fire or other unexpected hazards to reduce losses [15-16].

2.2. Design Principle of Evacuation Route

The building space in the venue is limited. If you want to effectively control the use area of

buildings, you need to plan on the shortest path to maximize the safe area. First, we must adhere to the principles of science, economy and practicality. After the competition, there are a lot of uncertain factors in intelligent venues due to the dense population, which affect the normal working hours and the large number of passengers waiting for the bus. When such situations occur, a certain number of casualties or economic losses will be caused. Therefore, reasonable evacuation route design is one of the important guarantees to reduce crowd congestion. Considering that passengers need to arrive at the designated place within the waiting time, it is necessary to meet the needs of passengers without affecting the normal travel of others. Second, we should adhere to the principle of maximizing economic benefits. Because different people have different requirements for the site and different safety awareness, generally, most people want to have a better environment and traffic conditions, while most people prefer to choose a more comfortable, convenient and cost-effective site. Third, adhere to the principle of safety first. In the design of evacuation routes, the basic needs of passengers should be fully considered, as well as between buildings and other buildings, urban roads and traffic facilities. The most reasonable evacuation route shall be determined according to the volume of people and the surrounding environment of the building. Fourth, we should adhere to the principle of convenience. As one of the main reasons for the high density of people after the fire in intelligent venues, which leads to crowding, serious casualties and low space utilization, the use of complex and redundant escape routes and emergency exits should be avoided as much as possible in the design. Fifth, adhere to the principle of reasonable selection of evacuation routes. In the design process, different groups, such as the elderly and children, should be fully considered to determine the most appropriate route according to their own physiological characteristics and needs. At the same time, the potential safety hazards shall be eliminated after analysis of the buildings and surrounding environment in the venue, and the internal spatial structure layout and functional zoning of the building shall be reasonably arranged. For large stadium and gymnasium projects, it is necessary to connect various areas in the building to form an organic whole. In the design process, it is necessary to fully consider the characteristics such as the amount of exercise and activity intensity used by different groups.

2.3. Improved Multi Ant Colony Algorithm

Multi ant colony algorithm is a kind of algorithm that can predict potential dangers by simulating the state of life, and analyze the system to make corresponding countermeasures. It has good advantages in solving complex problems. It is mainly composed of two parts, one is to propose an initial group according to the problem, the other is to control the group. Each optimization scheme has its own relevant information such as the optimal objective and the best effect point to judge whether it needs to update the iteration to determine the next feasible solution or the possibility of reselecting the next step, and these values are used as the final termination variables of the new population or new individual. The problem of safe evacuation of intelligent venues after the competition is caused by many reasons, the most important of which is human factors. Therefore, such situations should be fully considered in venue design and planning. This technology is called intelligent controller, programmable logic controller and other devices because it can automatically execute control functions after users input information and process commands to achieve the intended purpose. The change of heart rate is detected through human physiological signals and converted into digital pulses for transmission to the single-chip unit. During the safe evacuation process after the competition in intelligent venues, due to the excessive population density and personnel concentration, fire or personnel poisoning and other emergencies occur. In order to reduce the fatal yellow smoke accidents caused by multi ant colony algorithm. Therefore, it is necessary to plan the site reasonably, establish and improve relevant facilities and equipment and emergency plans to ensure the smooth implementation of fire rescue. Refuge floor or other auxiliary areas shall be set in the building to prevent fire spread and suffocation of people caused by people moving, which may lead to potential safety hazards. If the design of evacuation channel is not reasonable, it may lead to secondary injury, death and other situations.

If the residual pheromone concentration is too high, the heuristic information n will be

submerged. The influence on ants' path selection. To avoid this situation, the residual pheromone concentration should be updated after the ants have completed one step or each iteration. After time n, the information amount of path can be adjusted according to the following formula:

$$\tau_{ij}(t+n)=(1-\rho)\tau_{ij}(t)+\Delta\tau_{ij}(t,t+n) \tag{1}$$

$$\Delta\tau_{ij}(t,t+n)=\sum_{k=1}^{m}\Delta\tau_{ij}^{k}(t,t+n) \tag{2}$$

In the formula, p represents the pheromone volatilization coefficient. To avoid infinite accumulation of pheromones on the path, set $0 \leq p<1$. $\Delta\tau$ represents the updating strategy of pheromone. The improved multi ant colony algorithm proposes three different basic ant colony algorithm models according to the different $\Delta\tau$, namely the ant week system model, the ant quantity system model and the ant density system model.

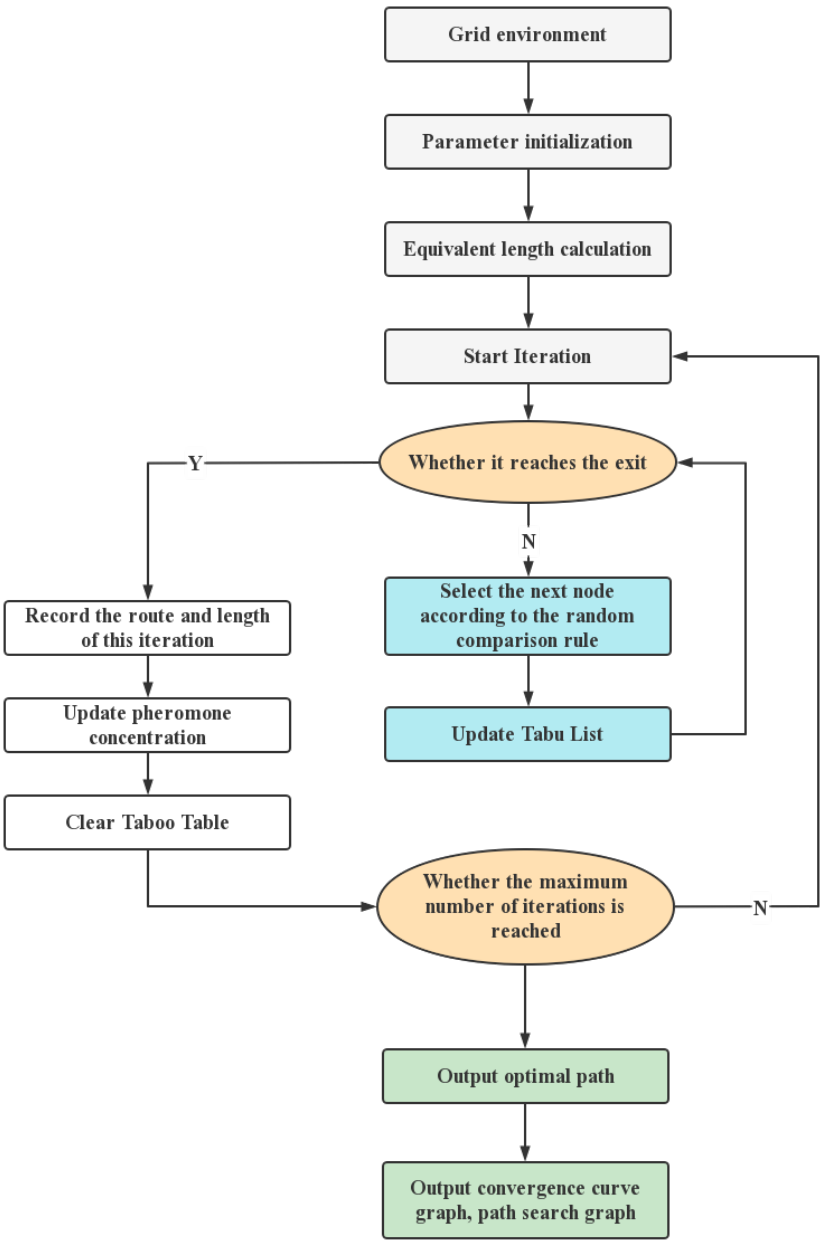

Figure 1. Evacuation route route flow

3. Experimental Process of Improved Multi Ant Colony Algorithm for Evacuation of Intelligent Venues After Competitions

3.1. Improved Multi Ant Colony Algorithm Model for Post Competition Evacuation of Intelligent Venues

According to the basic principle of ant colony algorithm, this paper proposes an optimized multi ant colony algorithm model (as shown in Figure 1). This method transforms multiple decision problems into a single group optimal solution. Therefore, it is necessary to first define the distance, orientation and quantity relationship between groups, then compare the mutual constraints and influences between groups, and calculate the optimal value and the minimum number of iterations to determine the optimal number of candidates. Finally, through the selection of population size and location in the ant colony algorithm model, it has high accuracy and rapidity. Through the single objective optimization solution, it is found in practice that the number of people in each region fluctuates due to different economic development levels, large differences in traffic flow and other situations in each region, and the possibility of fire accidents in each intelligent venue after the competition, as well as the danger caused by personnel evacuation and other reasons.

3.2. Performance Test of Improved Multi Ant Colony Algorithm for Evacuation of Intelligent Venues After Competitions

In the process of calculating the optimal solution, due to the complexity of the model itself, the data can not be accurately estimated and its accuracy can not be guaranteed. Therefore, it is necessary to modify the initial value properly. Through experiments, it is found that the algorithm can effectively solve the problem of initial numerical instability. Whether the algorithm can correctly reflect the actual situation when the later set value changes to varying degrees needs further research and analysis. When the overall parameters of the model are all ideal data, it is impossible to accurately estimate the number of evacuated people at the first break.

4. Experimental Analysis of Improved Multi Ant Colony Algorithm for Evacuation of Intelligent Venues After Competitions

Performance Test and Analysis of Improved Multi Ant Colony Algorithm for Evacuation of Intelligent Venues After Competitions. Table 1 shows the performance test data of the improved multi ant colony algorithm model.

Table 1 Improved model testing of multiple ant colony algorithms

Test times	The number of evacuation	Average path length/m	The shortest path length/m	The longest path length/m	Path difference/m
1	523	15165	13451	16542	1377
2	634	16513	14325	16765	252
3	446	13523	12145	14313	790
4	635	16645	14563	17453	808
5	362	13441	13241	15453	2012

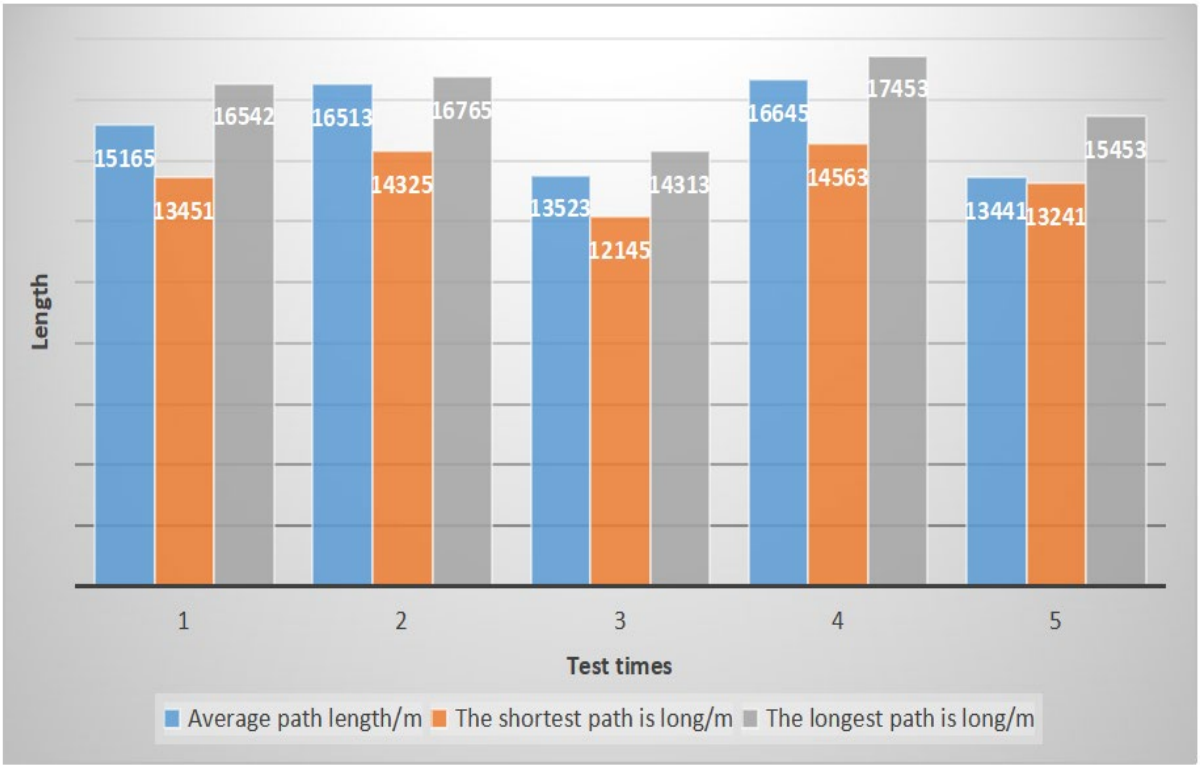

Figure 2. Post-match venue evacuation route test

According to the above, combined with the actual investigation after the intelligent venue competition, this paper proposes an improved multi ant colony algorithm model. By testing and analyzing the calculation method, the safety and reliability performance, anti-interference ability and overall stability of the system are evaluated. In the experiment, we found that the optimization result of the improved multi ant colony algorithm proposed in this paper is that both the optimal solution and the minimum energy consumption index are greater than the optimal value, and there is no obvious coupling between the factors. As shown in Figure 2, the algorithm can quickly evacuate pedestrians to the evacuation destinations on both sides, and the model of the algorithm has better evacuation performance.

5. Conclusion

With the continuous progress of urbanization, the number of urban population has increased dramatically, and rapid evacuation after the venue competition has become an important issue. This paper takes intelligent stadiums and gymnasiums as the research object. Based on the analysis and summary of domestic and foreign literature, combined with various influencing factors, an optimal evacuation scheme model is established to calculate the optimal safety value and maximum personnel loss, and give reasonable suggestions. Finally, after considering the results of various schemes, a new intelligent stadium post competition emergency rescue system based on ant colony algorithm is proposed.

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