Simulation and analysis of a large police reasonable scheduling model

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Abstract. large police scheduling model is the key to ensure the smooth progress of the police work. In view of the traditional large police reasonable scheduling model, invulnerability and robustness is not good, the paper presented a large police reasonable scheduling model based on the Internet of things technology. In the process of police scheduling, RIFD technology is combined with GPS technology to achieve automatic data acquisition for police vehicle in remote and real-time, utilization efficiency maximization of police vehicles is used as the objective function to establish the model of scheduling, particle swarm optimization algorithm is adopted for the nonlinear objective function to find the optimal solution and obtain scheduling strategy. The simulation experiments show that, with the large police reasonable scheduling model for police vehicle scheduling, can effectively improve police vehicle utilization efficiency, shorten the response time, ensure the response speed.

Introduction

In the aspect of city security, police officers play a crucial role [1]. Therefore, a large police reasonable scheduling model need to be established, and allocate police resources reasonably [2]. In the process of large police reasonable scheduling, the most commonly used means of transportation for police officers on duty is the police vehicle, thus, the core of large police reasonable dispatch is how to optimize the operation of police vehicles [3].

With the advent of intelligent bionic swarm algorithm, using the bionic group combined with PID control strategy, and applying to large police reasonable scheduling model, can improve the scheduling efficiency [4,5]. Common bionic swarm algorithms such as bats algorithm, birds algorithm, firefly algorithm, ant colony algorithm and bee colony algorithm [6-8]. But with the increasing of security incidents and lacking of the police staff, scheduling efficiency of a large police scheduling model is not ideal [9,10].

Aiming at the disadvantages of the traditional algorithm, a large police reasonable scheduling model based on the Internet of things technology is proposed. In the process of police scheduling, RIFD technology is combined with GPS technology to achieve automatic data acquisition for police vehicle in remote and real-time, utilization efficiency maximization of police vehicles is used as the objective function to establish the model of scheduling, particle swarm optimization algorithm is adopted for the nonlinear objective function to find the optimal solution and obtain scheduling strategy. The simulation experiments show that, with the large police reasonable scheduling model for police vehicle scheduling, can effectively improve police vehicle utilization efficiency, shorten the response time, ensure the response speed.

Police vehicle location and tracking based on the RFID

In the process of building a large police reasonable scheduling model, positioning and tracking for police vehicles is the most critical part, the current police vehicle positioning technology generally use GPS technology, this technique has high positioning accuracy, all police vehicle can be located, but this technique requires expensive equipment to support, higher operating costs, it is difficult to achieve the promotion for a large area.

RFID technology is an important branch of Internet of things, it is easy to install in all environments, has a strong adaptability and accuracy for data collection. This technique, also known as electronic tag technology, when the tag into the magnetic field range, began to accept RF

signal of reader, through induced current to obtain chip information, or by tag to send FM signal at a certain stage, the related data can be acquired after decoding received data. RF card and reader can utilize two-way data communication, installed in a police vehicle to ensure diffraction capability and anti-collision function of signals.

In this paper, radio frequency technology is used with GPS technology, to achieve real-time data acquisition and positioning for police vehicles in traffic scene. The receiver is installed in the part of the police vehicles, police vehicles equipped with GPS devices is able to obtain position data of police vehicles equipped with RFID accurately, by its position and measured RFID position, to calculate the GPS error, through the wireless IEEE802.11 protocol to release to police vehicle around.

In the large police scheduling process, the tracking for police vehicle is mainly composed of recognition, GIS recognition module, position display system. The data of module is in real time random changes process in the police vehicle scheduling system of stronger nonlinearity, if only rely on the precise mathematical model, it cannot be completed, thus, this paper designs a large police reasonable scheduling model based on particle swarm optimization algorithm, iterative update technology based on particle swarm optimization algorithm is approximating the nonlinear model gradually, so as to find the optimal solution of the optimized scheduling system.

Large police scheduling model based on particle swarm optimization

In this paper, during the police vehicle scheduling process, assuming police vehicles to start the task from the corresponding public security organs on time, police vehicles arrived at the emergency site safely, and completed the mission without the phenomenon of retention. Assuming s,T,t represents the time that security incidents occurred, time that police vehicles stuck on road congestion, parking time after arriving at the place where security incidents happened. t_0 is the time when a police vehicle receive the task, after a lot of data test, the following formula is established:

$$s(t,T)=\begin{cases}1,0<T<2\\-1/3T+5/3,2<T<5\\0,T>5\end{cases} \tag{1}$$

$$420\le t+t_0\le 540 \tag{2}$$

$$960\le t+t_0\le 1080 \tag{3}$$

The three equations above refers to the constraint formula when the duty rode is in congestion, in non peak period, the police vehicle scheduling evaluation function meets the following formula:

$$s(t,T)=\begin{cases}1,0\le T\le 6\\-1/4T+5/2,0<T\le 10\\0,T>10\end{cases} \tag{4}$$

$$t_0\le t_0+t<420 \tag{5}$$

$$540<t_0+t<960 \tag{6}$$

$R(t,j,T)$ is the time of duration for security incidents waiting for treatment at time t and position j, there is:

$$F(X)=\int_0^{t_m}\left[\sum_j\int_0^{T_x}R(t,j,T).s(t-T,T))dT\right]dt \tag{7}$$

Assuming that the i particle's position is $X_i=(x_{i1},x_{i2},...,x_{in})$, the flight speed of particle for space optimization is $V_i=(v_{i1},v_{i2}...v_{in})$, $P_i=(P_{i1},P_{i2},...,P_{in})$ represents the optimal position of itself of whole particle swarm in space optimization and $G_i=(G_{i1},G_{i2},...,G_{in})$ represents the optimal position of space groups of whole particle swarm, the particle swarm updates the position

according to the following formula:

$$V_{id}^{k+1} = wV_{id}^{k} + c_1 r_1 (pb_{id}^{k} - x_{id}^{k}) + c_2 r_2 (gb_{d}^{k} - x_{id}^{k})$$
$$X_{id}^{k+1} = X_{id}^{k} + V_{id}^{k+1} \quad (8)$$

The first part of the above formula describes updating formula of the particle itself, the second formula is the particle collaborative learning in the big picture, and this ability reflects the society of particles. Solution space of particle is the scheduling rule of large police reasonable dispatch model in some area, in specific, it is the frequency of each public security organs on duty and the time period.

Police vehicles scheduling has high non-linear characteristics, in PSO, without too much parameter adjustment, parallel computing can be achieved, during iterations of optimization, some particle forms a operator after continuously updating, the operator always maintains a good position, the accuracy of the individual convergence and convergence speed can be improved through supporting role of the operator.

The distribution calculation of particles is placing particles representing different police scheduling plans in different containers, the peer group is used as the way to divide a particle swarm into q sub groups, *ppes* exchanges *gbest* and synchronization information regularly, *gbest* of sub groups are received by all *ppes*. Subgroup chooses a *gbest* from position in the adjacent container group to replace the *gbest* of itself. Cycle time of replacement can be reduced according to the decreasing sequence of index, the initial value is $N_g / 2$, then change to $N_g / 4$, in the beginning searching stage, the diversity of the population is higher, the local search ability of this phase is more important than the global search capability, after *ppes* works independently for long time, the *gbest* value in different processors will appear, which is an important stage for turning to global convergence. The particle in a plurality of containers updates of collaboration, so as to ensure the obtained scheduling rule is the optimal solution in the solution space.

System analysis

In order to test the performance of the proposed algorithm in the realization of a large police reasonable scheduling, simulation experiment is needed. Setting up a duty coverage area of public security organs as $500\text{m} \times 100\text{m}$. In the public security organs duty coverage area, respectively, using the traditional algorithm and the proposed algorithm to conduct experiments for 100 times, by calculating the average value after 100 times of simulation, the comparison results of police vehicle passing time under the state of road congestion with the traditional algorithm and proposed algorithm was obtained, and the comparison result of on duty rate within the specified time was also shown as below.

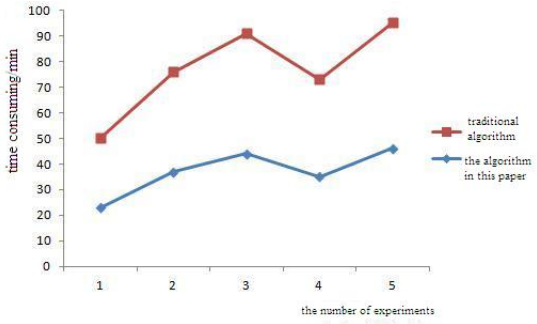

Fig. 1 Comparison of the passing time

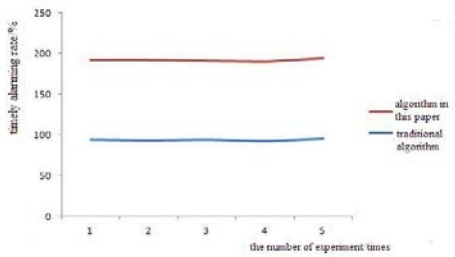

Fig. 2 comparison of on duty rate within the specified time

Analyzing the figure above, it can be seen that using the proposed algorithm, compared to the traditional police vehicle scheduling method, has more powerful traffic capacity, the passing time was greatly shortened, the rate of the police on duty was significantly enhanced within the specified time, the police dispatch was more reasonable, which shows the superior performance of proposed method in achieving police dispatch.

Conclusion

In view of the traditional large police reasonable scheduling model, invulnerability and robustness is not good, the paper presented a large police reasonable scheduling model based on the Internet of things technology. In the process of police scheduling, RIFD technology is combined with GPS technology to achieve automatic data acquisition for police vehicle in remote and real-time, utilization efficiency maximization of police vehicles is used as the objective function to establish the model of scheduling, particle swarm optimization algorithm is adopted for the nonlinear objective function to find the optimal solution and obtain scheduling strategy. The simulation experiments show that, with the large police reasonable scheduling model for police vehicle scheduling, can effectively improve police vehicle utilization efficiency, shorten the response time, ensure the response speed.

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