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Intelligent Patrol Route Visualization Design Based on Police Big Data

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Abstract. In recent years, the public security department has insisted on technology to promote the high-quality development of public security work in the new era. It not only builds a three-dimensional patrol and defence system, but improve the level of patrol, defence and control management vigorously. At present, an intelligence-aided patrol system has been initially formed, and video patrols and law enforcement duty supervision have been carried out. However, the application of new technologies and the innovation of policing mechanisms in public security departments still have some problems. For example, unbalanced regional development, insufficient deepening of intelligent applications and insufficient systematization of applications, which greatly restrict the effectiveness of public security patrol and defence in practice. Based on this, our study identifies the crime hotspots in the city through EXCEL data analysis, and identifies them as patrol points. By applying the shortest route algorithm in the genetic algorithm, a precise patrol route is formed. Based on this, the precise patrol route is displayed on a map using a visualization tool and then fed back to the police terminal equipment. This project enables police patrols to be more accurate and patrol routes to be optimized. It improves the police patrol system and provides the basis for the construction of an intelligent patrol system.

Keywords. Patrol routes, planning research, data analysis, genetic algorithm

1. Introduction

1.1. Difficulty of patrolling the grassroots

The purpose of patrols is unclear because intelligence information cannot guide precise strikes and prevention and control. And the scale effect of intelligence information cannot be reflected in patrol work[1]. There're defects in the service operation mode on the grounds of insufficient police force. The current patrol work service mode is generally based on the patrol police as the main body to dynamically control the society.

1.2. Patrol plan is not scientific enough

Our country's current patrol methods are difficult to achieve "all-round" control. At present, among the 1.4 million police in our country, only 60,000 are engaged in street patrols, resulting in a low coverage rate of patrol police and weakening the ability to

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control the society. As is to say, there are loopholes in the patrol scope [2]. This led to the emergence of a patrol vacuum, resulting in more crimes in some areas and out-of-control management [3,4].

1.3. Lack of effective dynamic patrol command system

The patrol command system is an indispensable part of the patrol system, and its modernization level determines the quality of the police patrol. However, so far, the command system of police patrol in our country has unbalanced regional development. And it is difficult to achieve real dynamic patrol command [5]. There are relatively mature patrol mechanisms in developed areas in our country, but in relatively backward areas, the construction of the command system is far behind. The 110 alarm podium is only limited to the issuance of 110 police orders, and does not have the overall command function of police patrols.

2. Accurate patrol route planning research

In this practice, our idea is to use dormant police data, with the help of big data technology, to build intelligent patrol automatic planning model. Through analyzing the public security crime data such as alarm address, crime data, personnel density data, monitoring data, special industry data, etc., data analysis and visualization of massive data, we plan to find high-crime area or key areas under public security control. When combining sensitive time data, weather data and other impacts on patrol routes, we can achieve prediction of the high incidence of preventable cases [6,7]. Also, we plan to remodel a new generation of accurate patrol and inventory mechanism to further improve the social security prevention and control system. Combining our existing police data sources and the actual situation, we try to use K-means clustering algorithm and heuristic genetic algorithm to achieve our goal of automatic patrol route plan, and use the online map api interface provided by the National Platform for Common Geospatial Information Services to display. As shown in Figure 1.

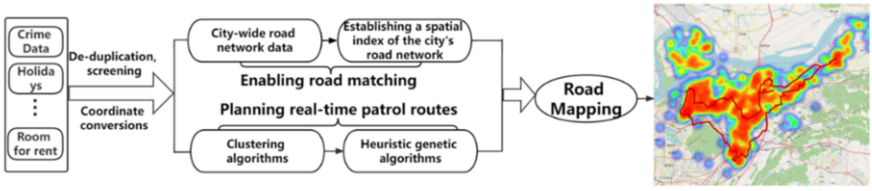

Fig. 1. Technical route

2.1. Data source

The source of data for this practice is the police data of a branch of Nanjing Public Security Bureau, with a total of 26,409 entries. Each police data contains a large amount of effective data information, such as "identity information, cell phone number, license plate, related person, account number, network communication tool, identity mark, address, etc[8]. After conversion, it can be obtained that only one branch of Nanjing

Public Security Bureau dynamically collects millions of pieces of fresh data and information every year by receiving and handling police affairs, which realizes "data is being collected every second". And these data have obvious advantages: the largest amount of Public Security data volume, the highest speed of updating, the widest source, the richest content, and the most vivid information. However, due to the confidentiality of data, the data used in this practice are desensitized data.

2.2. Clustering algorithm

After obtaining the population density, weather conditions and other related information, due to the wide distribution, the map has a larger area and may contain more locations, which is not conducive to the public security patrol work. The purpose of K-means algorithm is to solve the problem of scattered patrol locations and multiple locations. After the calculation and clustering of K-means algorithm, it can better fit the more aggregated points as the key areas of patrol, and its algorithm ensures the distance from the clustered points to other hot spots, which can ensure that more areas are taken into account when patrolling. It improves the efficiency of police handling and guarantees the effective implementation of public security work.

2.2.1 Data pre-processing

- Data deduplication

  In the alarm situation, there are some cases that are duplicate, and the table shows that it is a duplicate alarm list. And these duplicate alarms are invalid for our analysis, so some duplicate alarms in the table are deduplicated.

- Information filtering

  There is a part of the data that is incomplete, which is not meaningful for analysis. Also, there is a part of the data that has an unclear or non-existent address on the map, which also needs to be manually eliminated. After eliminating these data, the data that can be used is left.

- Coordinate conversion

  Most of the data we get are Chinese addresses, which cannot be used directly. We need to convert the Chinese addresses into latitude and longitude coordinate points under the WGS84 coordinate system, and we use arcg is geocoding to decode the Chinese addresses to get a relatively accurate latitude and longitude data.

2.2.2 Application in the project

After processing the data into standard latitude and longitude coordinates, you can use the K-means algorithm to process them. Firstly, import the latitude and longitude coordinates. Secondly, convert them into the numpy array format that can be used in the algorithm to facilitate the import function for calculation. Thirdly, adjust the number of clustering points that need to be output and specify the location of the clustering points as points on the road in order to facilitate the map generation at a later stage and ensure the routes can be accurately mapped to the road surface. Then, we can ensure the accuracy of the patrol route. Then use the function in sklearn to get the labels of the clusters, get the clustering centers obtained by K-means algorithm, combine them with

the labels, write them to the csv file together, and finally save them to the csv file according to the vehicle id.

K-means clustering selects multiple locations as objects after calculation. Then compare the distances to all valid data points. According to the distance, it can be determined to be classified as which kind of position. Then we use machine to learn the algorithm. After many iterations, the calculation will be more and more appropriate, until the completion of clustering analysis.

2.3. Optimal route implementation based on heuristic genetic algorithm

After determining the patrol points in the area, the next step is to plan the optimal patrol routes. According to previous studies, police car patrols and foot patrols have a positive impact on the social control of security problems. By using foot patrols or police car patrols, a better quality route can be selected for a specific area to ensure a further reduction in crime incidents based on resource conservation. Both types of patrols have their own advantages in terms of patrolling methods, with foot patrols being able to effectively view all blind angles and police car patrols being able to patrol a wide area as long as they are carried out. In order to further use advanced technologies such as communication and information to take targeted initiatives to combat and prevent and control areas with a high incidence of incidents, this study focuses on how to develop a quality route in the police car patrol mode.

2.3.1 Application process

Step 1: Genetic encoding and initialization of the population. We use 1~n integers to encode the input n addresses one by one. An address is a gene, and a chromosome contains all the genes, which is a patrol route. The length of the chromosome is the number of addresses. The initialization of the population is also performed, and our program uses the method of randomly disrupting the genome arrangement to generate different chromosomes each time to initialize the population.

Step 2: Fitness function. Since populations need to evolve iteratively, we need to define a rule to evaluate which populations can survive in the current environment by scoring which routes require the shortest distance. Those with too long a distance will be eliminated, and we will call this rule the fitness function. We can design the fitness function for this project as: use the reciprocal of the total distance walked on a patrol route, to achieve the conversion between the maximum and minimum values. The smaller the value of the objective function, the greater the value of the fitness function. The stronger the adaptation, the better the individual, and vice versa the worse the individual.

Step 3: Selection of elite populations. After the previous step, we get the fitness function of each route, and we need to save the route with short distance, as is to say, let the elite population survive as long as possible. The probability that the population is selected to be defined as an elite population is proportional to its fitness, i.e., the higher the fitness of a patrol route, the higher the probability that the route will be selected as an elite chromosome. For the probabilistic approach to selecting elite populations, we use the optimal individual preservation strategy and the roulette wheel selection.

Step 4: Crossover, mutation and reversal of chromosomes. In genetic algorithms, the crossover operation involves swapping two random chromosomes for certain genes to produce two new combinations of genes, resulting in two new individuals. The pairing is based on the crossover probability, except for the first directly copied optimal chromosome. Two points were randomly selected to swap between the two calculated

patrol routes, that is the two patrol routes underwent crossover operations. However, we find that after swapping the route segments, the patrol points of the patrol routes are duplicated. For this reason, we need to solve this route conflict problem. And our method is to swap the punch points of the two patrol routes one by one, which can resolve the conflict to produce a new pair of chromosomes. And the new chromosome is a new patrol route. The above operation provides a new possibility to find the global optimal solution.

Variation of chromosomes. A mutation operation is a random selection of individuals in the population at mutated positions, where some individuals in that gene string are changed and one part of the chromosome changes accordingly, and the other part changes accordingly to ensure diversity and algorithmic convergence in the population. Our mutation operation occurs at two patrol points along a patrol route. The mutation of chromosomes makes the genes of chromosomes more stochastic, offering the possibility of jumping out of the local optimum solution.

Chromosome reversal operations. Reversal operations occur on a segment of a gene from a single chromosome. Two random sections of a patrol route are reversed and the fitness scores of the old and new patrol routes are compared. If the fitness score of the new route after reversal is greater than that of the old route, the reversal makes sense. If the new route has a smaller fitness score than the old route, then the reversal is not meaningful. After chromosome reversal, the reversed chromosome becomes superior and accelerates the quality of population evolution.

Step 5: Output the best patrol route.

2.4. Road matching and map visualization

This project realizes the mapping of genetic algorithm on roads by using python third-party tool library and relevant principles of gis to obtain the rasterized road network data of the desired area us. And this project uses the global common coordinate system WGS84, with an error of less than one meter. This is achieved so that our public security system can patrol using existing police cars, which cost little, and is fast and convenient.

We've got an approximate patrol route in the above process. We split the existing road network data according to the traffic intersection (road intersection) split. After that, we store each road's fold coordinate string according to the path ID, and use linear equations to calculate the diagonal intersection of these four points. Based on the intersection point split road network vector line, we record the intersection point connected to the road id in the point set. Then we can get the subdivided road data. Finally, the spatial index is established, realizing road matching. As shown in Figure2.

After implementing road matching, we use the folium open source library to add the base map and combine it with the rest of the data visualization to generate an interactive HTML file.

We use multidimensional data to construct three-dimensional patrol routes, and different patrol routes are planned for different time periods, as shown in Figure 3.

Our project can change different base maps for presenting data according to the actual work, as shown in Figure 4.

Fig. 2. Roadmap

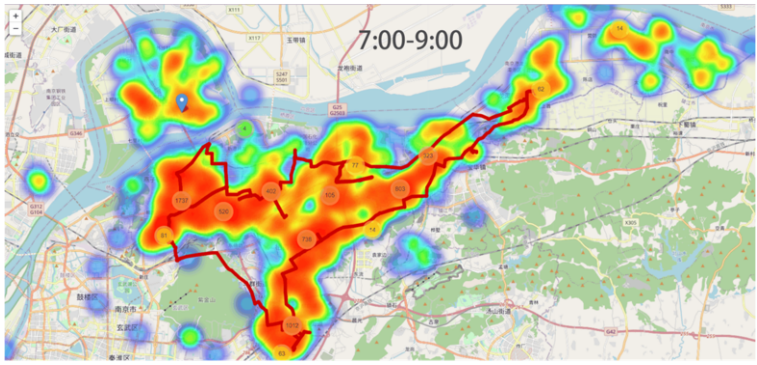

Fig. 3. Time dynamic chart

Fig. 4 Image marker map, topographic map, satellite

For a medium-large sized city, diversified patrol methods are essential. Therefore, we can choose three patrol methods in route generation, including foot patrol, vehicle patrol and riding patrol, which correspond to the most common public security patrol methods at present, making the public security patrol mechanism more perfect and scientific. As shown in Figure 5.

Fig.(a) Fig.(b)

Fig. 5. Car patrol route and step patrol route design

The project all uses open source database, including map data, road data and so on. And the use of .csv files within the program to facilitate the police departments will be data access. Open source database can further reduce costs and save money. At the same time, when used in multiple police stations, you can string data to make patrol road routes to achieve full coverage and further accelerate the road of science and technology for the police.

2.5. Future prospects

Our model has advanced algorithmic ideas. With the in-depth promotion of "Internet+" action plan, the model follows the development trend of the times and responds to the call of General Secretary Xi Jinping "to take big data as a big engine to promote the innovation and development of public security work and to cultivate new growth points for combat force generation". And in response to the advancement of the social wave, developers have improved and optimized it by using data analysis and genetic algorithm, which has become a successful application recognized by the professional field in terms of big data technology being close to police combat. Our model design is close to a real application. The purpose of the model is to deepen the application of "data policing" in actual combat, to give full play to the subjective initiative of street patrol police, to make the information "move" and to make the data "live", and to strengthen the insight of public security organs. It strengthens the ability of public security organs to see and grasp the development of social security, and increases the efforts to combat illegal crimes. Our model is a social service application. Through the application of the intelligent patrol model, we can reduce the loss of human and material resources in the process of public security patrol and defense. The model realizes the reform of patrol mechanism through big data analysis. It reshapes the patrol system with clear responsibilities, smooth operation, integration of combat and defense, and high efficiency in combat. What's more, it improves the mode of "supervising and patrolling docking, police street, and moving preparation", further weaving the social security prevention and control system.

3. Concluding remarks

This paper designs a system that can be used to intelligently plan the optimal route for patrolling, based on Python basic data analysis, genetic algorithms and other technologies. It responds to the new requirements of economic and social development

for public security patrol work and effectively solves the traditional crude model of simply increasing the police force. Furthermore, it weaves an all-time, all-coverage "prevention and control network", helping to improve dynamic patrol capacity, instantly grasp the crime scene. It is also conducive to improving the dynamic patrol capability, grasping first-hand information on crime scenes, and taking immediate and effective targeted measures when encountering unexpected situations. Also, it is of benefit to comprehensively sort out and rectify urban patrol points, realize the technology of the police force, enhance the combat effectiveness and overall efficiency of the public security department, and achieve the goal of promoting the police with technology. It is more likely to gain more public recognition. Intelligent patrol routes are in line with the new requirements of economic society for public security work, but this work is still in the exploration stage. As long as we continue to improve and develop this new police patrol mechanism, we will be able to achieve the goal of promoting the police with technology.

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