评委一评分，签名及备注	队号： 50104	评委三评分，签名及备注
评委二评分，签名及备注	选题： A	评委四评分，签名及备注
题目：**无人机飞行轨迹规划**		

Abstract:

This paper make the optimal design for the trajectories of the unmanned aerial vehicle (uav) and monitoring area,which is based on uav monitors yangpu district's three planning requirements.The scheme sets up the uav optimal path model which is based on genetic algorithm and the uav monitoring regional planning model and simulated annealing algorithm.and then combined two models, analyze and solve.

To plan a, this paper analyzed the specific parameters of the uav photogrammetry system firstly, and then got the uav monitoring area is 0.6849 km2. At the same time,through processing image,the problem is simplified to meet the constraints uav monitoring flight path node and path problem. According to the plan a, it is found that this problem belongs to the global optimal search problem.As a result, this paper introduces and uses genetic algorithm to solve the problem. Based on genetic algorithm,this paper established a model of the unmanned aerial vehicles (uavs)'s optimal path. And then with the aid of MATLAB ,this article calculated the shortest flight path length of unmanned aerial vehicle (uav) is 209.0776 km. By physics kinematics formula the article converts that the number of unmanned aerial vehicle (uav) will need at least nine which contents the condition that yangpu district everywhere is under the condition of not more than 15 minutes from monitoring state.

This paper extracted 2012 yangpu district population density that can reflected the streets traffic statistical yearbook data to analyze kmeans clustering. According to the clustering results, streets and population density,this paper is divided into large population density, medium population density and small population density of three level area. Next for each level design targeted area uav monitoring solution.At the same time,the paper analyses the problem belongs to the local optimal search.As a result,the paper choose a kind of heuristic random search algorithm, simulated annealing algorithm. And established the model of unmanned aerial vehicle (uav) to monitor regional planning,which is based on simulated annealing algorithm.Finally,the article calculated that each level area needs unmanned aerial vehicle (uav) is six, four and 1 respectively, which can draw a conclusion that in the population capacity as the constraint condition , monitoring yangpu district all areas need the unmanned aerial vehicle (uav) are.11 in all.

According to plan c, the problem's solution is based on the core of the plan a,b after analyzing the question.Firstly, according to the plan a's required number of unmanned aerial vehicle (uav),this paper caculate plan c that there are only 6 drone operations. Using unmanned aerial vehicle (uav)'s optimal path model which is based on genetic algorithm to

calculate the unmanned aerial vehicle (uav) within 15 minutes of the largest monitoring area is 28.66 km2,which is based on the maximum range of monitoring area. Initialize the six rules which is based on the basic shapes of the map of yangpu district ‘s actual shape . Then use the uav monitoring regional planning model basing on simulated annealing algorithm,and got the result that 6 drone monitoring area location graphic and corresponding total monitoring scope biggest area account for 66.94% of the total area of the yangpu district.

Keyword： the unmanned aerial vehicle (uav) optimal path, the constraint, the unmanned aerial vehicle (uav) to monitor regional planning model based on simulated annealing algorithm,the optimal path model of unmanned aerial vehicles (uavs) based on genetic algorithm, MATLAB

1 Introduction

1.1 The research background and meaning

On September 25, 1999 by the group of eight finance ministers in Washington, dc, announced the formation of the group of 20 (G20) summit, the typical international economic cooperation BBS, wide coverage of the members of the group of 20 nations, the group's GDP accounted for 90% of the global economy trade accounted for 80%, has replaced the G8 as the main national economic cooperation BBS. The g20 leaders announced that the ninth summit 2016 G20 summit will be hosted by the Chinese.

On November 16, 2014 in Australia's G20 leaders encountered security scare, the ninth summit at 40 points 7 am on Australian military scrambled two f-18s fighter investigation, lifted the panic. Meanwhile, U.S. President barack Obama Brisbane marriott hotel 15, there is a suspicious man, the police took him into custody and searched his two suitcases, party rule out the suspicious of the man. World leaders gathered for the G20 summit in Brisbane, security forces on high alert all the time, some 6000 police are patrolling the streets in Brisbane, more military personnel and volunteers for their support.

Ensure the security of the leaders at the G20 meeting as host of the G20 summit in 2016 China must pay attention to the problem. Based on the above situation, according to the assumption, in this paper, the host of the 11th at the G20 summit of the Shanghai yangpu district for unmanned aerial vehicle (uav), the optimal monitoring scheme research, to ensure the smooth operation of the summit held a deep going analysis research.

1.2Repeat problem

The Group of Twenty (also known as the G-20 or G20) is an international forum for the governments and central bank governors from 20 major economies. The 11 th G20 meeting will be held in China two years later. We assume that the final conference center locates in the Yangpu District of Shanghai. The host city need invest plenty of manpower the stability of the order of the city. As the development of unmanned aerial vehicle (UAV), it has been used in the field of the security. Now the government hires you to design a surveillance plan for the entire borough of Yangpu by the UAVs. The current UAVs are relatively robust to complicated external environment, can fly up to 4 hours without need to refuel, and require no human being to monitor each of them – instead, a sophisticated computerized controller can be programmed to follow any patrol strategy of your choice. The government requires your team to accomplish the following different plans:

Requirement 1: All geographic point of Yangpu District should remain observed from the air for at least 1 5 minutes in a row. How many UAVs will you need to achieve this goal?
Requirement 2: Some parts of the district are more important, e.g. the neighborhood of Fudan University and the Wanda Plaza. Such areas should be observed at least once in each 5 minutes interval. On the other hand, some roads has lower density of people, and there is no need to observe it more than once in 20 minutes. How many UAVs will you need to provide the requested variable level of coverage?
Requirement 3: Assuming that all areas are equal important and should remain regularly observed, but some UAVs are not reliable and 30% of them become unusable. What kind of surveillance coverage will your plan provide?

2 Breaking Down the Problem

This paper based on universal uav monitoring YangPu district of Shanghai the 11th at the G20 summit set three scenarios, combining with the universal uav photogrammetry system coefficient and YangPu district area, boundary, such as the actual situation, the preliminary analysis of the number of aircraft and unmanned aerial vehicle (uav) fully monitor the yangpu district need each aircraft flight time, probably need for further in-depth research and analysis of the various plans provide logical basis.

2.1The basic idea

(1) Relationship between vision camera focal length and area
There is a certain relationship between Vision camera focal length and Angle of view. Traditional size of 35 mm film camera, 35 mm is the width of the film (including perforation part), 35 mm film of the photosensitive area of 36 x 24 mm, conversion to the digital camera, the closer the diagonal length is 43.2 mm, surface, the greater the CCD/CMOS ruler in digital SLR camera, many of them are closed to 35 mm film sensitive CCD/CMOS size. Vision camera focal length and area as shown in figure 2-1(the relationship between the focal length and the area)

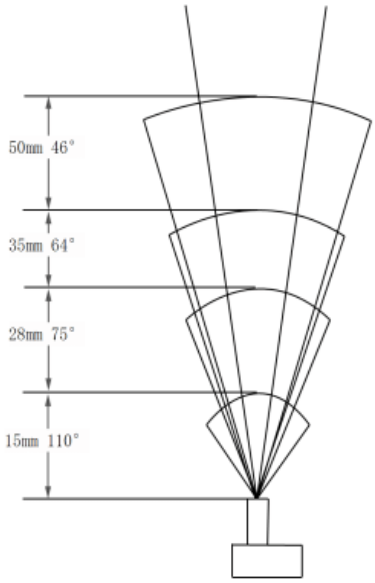


Figure 2-1 the relationship between camera focal length and area

(2) Determination the hight of aerial photography

Show the relationship between camera focal length and area, the aerial photography to determine the flying height of ground resolution aerial photography (GSD) depends on the flying height, the formula is:

$$\frac{a}{GSD} = \frac{f}{h} \Rightarrow h = \frac{f * GSL}{a}$$

In the formula: - flying height; - the lens focal length (50 mm); Size - phase (9 microns); GSD - ground resolution.

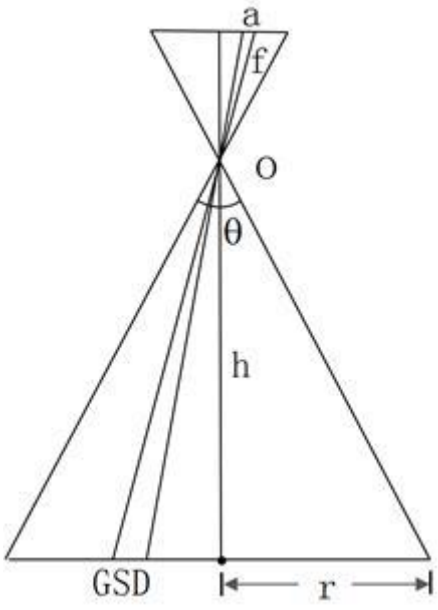


Figure 2-2 aerial photography course high figure

(3) This thesis select camera lens in the photogrammetric system for unmanned aerial vehicle (uav) of 50 mm, because the photography unmanned aerial vehicle (uav) photography image to get used to make into a map scale of 1:2000 scale digital products (DEM, DOM, DLG),

ground resolution aerial images (GSD) should be 20 cm, combining the above theory, the numerical calculation to obtain corresponding GSD flight height is 1100 m. Unmanned aerial vehicle (uav) monitoring scope radius:

$r = h \cdot \tan(\theta / 2) = 0.4669 km$

Monitoring scope: $s_{圆} = \pi r^2 = 0.6849 km^2$

2.1.1The analysis method of plan 1

Based on material information, the current drones on the complicated external environment also lasted four hours flight, because of the above of the photogrammetric system of unmanned aerial vehicle (uav) in selected parameters, analysis and calculation, the monitoring process will monitor access to images into digital products, is the lens focal length for the unmanned aerial vehicle (uav) of 50 mm in practical monitoring in flight altitude h = 1100 m, the monitoring area of 0.6849 km^2, known in Shanghai YangPu district region covers an area of 60.61 square kilometers, slightly to estimate a drone flying at the beginning of the time required to complete a YangPu district for 1h 37. 614 min, a preliminary estimate the required number of unmanned aerial vehicle (uav) for eight or nine. Further analysis of the question, where all meet the YangPu district under the premise of not from monitoring status for more than 15 minutes, with at least a unmanned aerial vehicle (uav) to ensure the smooth convening of the 11th session of the group of 20 summit, this paper converts the problem to optimize each uav flight path, in the same way in local optimum global optimal principle, namely, calculated by using genetic algorithm (ga) draw a drone to monitor the entire YangPu district all the region of the shortest path, through the path length and the kinematics formula principle of conversion between unmanned aerial vehicle (uav) flight speed, it is concluded that the number of unmanned aerial vehicle (uav) will need at least

2.1.2he analysis method of plan 2

According to the overall characteristics of uneven distribution of population, the 11th during the G20, YangPu district of points around the traffic changes over the site location and environment, the location of the stream of the existing safety problems more sparsely populated place, must be more to the place where the stream of security monitoring. On the 11th of the G20 summit in safety monitoring plan 2 requests for traffic is relatively large area at least once every 5 minutes be monitored, and traffic was relatively small area of more than 20 minutes can be monitored at a time, targeted to strengthen regional security monitoring can effectively guarantee the smooth convening of the 11th at the G20 summit. Scheme 2 is different from 1, joined the traffic was a variable

constraint conditions of path planning for uav monitoring with regional population in general population density can response traffic situation, this article first to various streets of the YangPu district population density clustering analysis, the YangPu district area according to the population density is divided into three levels, the largest population density control of unmanned aerial vehicle (uav) at least once every 5 minutes to monitor, population density of the larger regional control of unmanned aerial vehicle (uav) is not 15 minutes from the monitoring status, while the population density of the smaller regional control of unmanned aerial vehicle (uav) monitoring can be more than 20 minutes at a time; based on the first plan of the proceeds of the unmanned aerial vehicle (uav) optimal control path trajectory, made up of the two dimensional plane figure as the initialization of graphics, analysis, study and using the core idea of simulated annealing algorithm, to meet different segments of the population flow level under the premise of monitoring time interval, to initialize graphics to fill each flow level area, it is concluded that the traffic density area the required number of unmanned aerial vehicle (uav), finally will add up the number of each area, namely get number of unmanned aerial vehicle (uav) needed to plan at least

2.1.3The analysis method of plan 3

To identify all areas as the same important, all areas that are not more than 15 minutes from monitoring status, the problem of dealing with plan 1's handling of the same, the difference is due to the failure, lead to 30% of the unmanned aerial vehicle (uav) have been unable to use, is based on the required number of unmanned aerial vehicle (uav) plan 1 calculation shows that only provide 6 drone to monitor yangpu district; 6 drone how to make the monitoring area of the largest, processing logic is similar to plan 2, based on the unmanned aerial vehicle (uav) for 15 minutes can monitor the biggest area, on the basis of YangPu district map shape, initialize the 6 shapes, the basis of the optimal still using simulated annealing algorithm, the overlap between the six basic graphics area as small as possible and position to YangPu district center, finally calculated the six basic shapes cover the size of the total area of the YangPu district is only 70% of the unmanned aerial vehicle (uav) monitoring can provide the largest range of monitoring.

3 Assumptions

(1)Assume that regardless of yangpu poor population of district distributi on throughout every street, that every street population density as the sam e everywhere

(2) The unmanned aerial vehicle (uav) flight trajectory of two-dimensional infinite plane figure area close to the person flow level

the actual required scope of monitoring area;
(3) Every moment uav monitoring scope of regional gap between the negligible.4 symbols instructions

4 Nomenclatures

Nomenclatures	symbolic
GSD	GSD ground resolution aerial
$S_{基}$	images
θ	Basic graphics movement direction and the x axis Angle
f	Penalty function
$T = 0.999$	Lower temperature slowly
N	flight pathpath
(xx, yy)	flight pathpath
L	The shortest flight pathpath

5The optimal path model of unmanned aerial vehicles (uavs) based on genetic algorithm

5.1The representation of a uav flight path

Unmanned aerial vehicle (uav) flight trajectory can be expressed as a series of trajectory planning space, connected by straight line between adjacent track points, any path is actually a composition of nodes sequence

$\{S, P_1, P_2, \ldots, P_{n-1}, G\}$

S as the begin point

G as the end point

$P_1, P_2, \ldots, P_{n-1}$ as the middle path node

Figure 5-4 shows a flight path planning area.

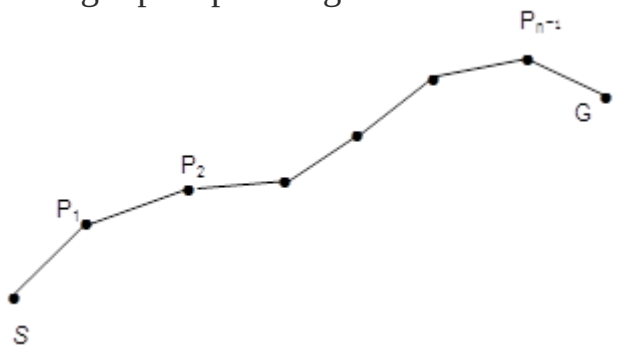


Figure 5-4 flight trajectory

The flight trajectory which is expressed as a series of nodes connection will flight trajectories nodes are as follows: the purpose of the first can be

achieved by adjusting the node number of the flying track any expected accuracy; And the original programming problem is decomposed into a series of smaller sub-problems, in each subproblem, what the paper study is only the coordinates of a point. Examine whether the flight path satisfy the constraint conditions into consideration a point or a line whether meet the constraint condition; Finally, the path planning problem is confined to a series of flight path points, is advantageous for the realization of parallel and distributed computing[1].

Yangpu district is located in the northeast of Shanghai central city, located in huangpu river downstream northwest, and the pudong new area, hongkou district in the west, north and baoshan border. On the scale of 1:2000 baidu map display as shown in figure 5-1, part of the actual area shown in the figure is $S = 201km^2$

Figure 5-1 yangpu district map

To preprocessingly deal with figure 5-1 by MATLAB, steps are as follows:

(1) First,put it in the 450 x 300 2d coordinate system, radius of uav monitoring scope.Conversion to the coordinate system of 10.3068 cm, use matlab to fitting the figure 5-1 in yangpu district boundary, namely the function of the red line;
(2) Defined within the scope of the Curve fitting functions, randomly generated Randomly generated. The circle Is allowed within a certain scope of radius;
(3)It will be generated in the first of a circle circle coordinates into the Cu rve fitting functions formula, is invisible to the size, judge whether the cir cle in the Curve fitting functions scope, if within the scope of the Curve fi tting functions, the center of the circle is fixed, if ever, to that point to con tinue moving;
(4) After moving point is defined as the first circle, if the distance between the circle‘s center and the circle’s within the scope of , the

centre point is fixed, otherwise the centre point moving; (5) In this loop, fixed the centre point till they are equal to the total, stop t he circulation and preprocessing steps over, finally get the radius of a circ le covered the yangpu district map, as shown in figure 5-2 ;
(6) To further deal with FIG. 5-2, remove the circle, marks the centre point of all circles in the figure, it is concluded that the unmanned aerial vehicle (uav) to monitor the entire yangpu district series of flight path node graph, as shown in figure 5-3:

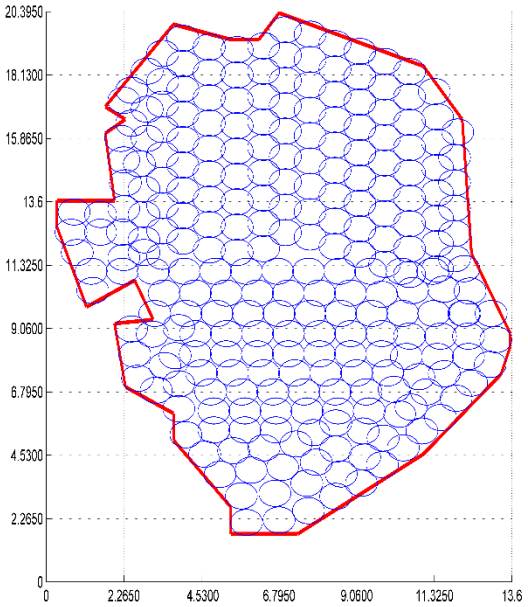


Figure 5-2 after the pretreatment of graphic

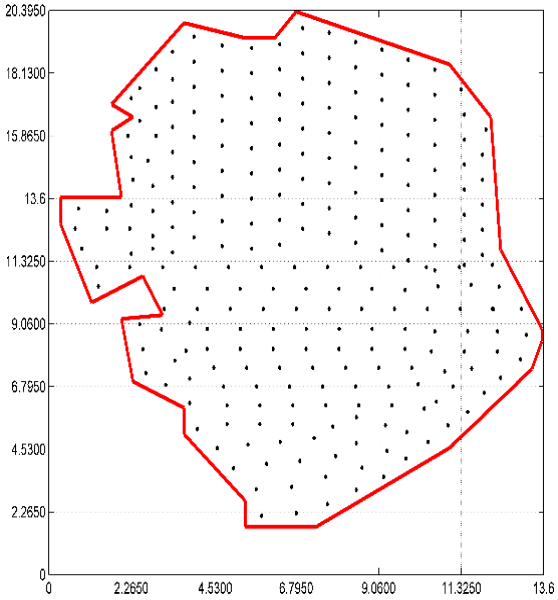


Figure 5-3 monitoring flight path node

At this point, through the graphics, the problem of unmanned aerial vehicle (uav) monitoring flight paths satisfy all place not from monitoring state constraint conditions, more than 15 minutes into consideration uav monitoring flight path node, flight path whether meet the constraint condition; Finally, unmanned aerial vehicle (uav) flight path planning problem is confined to a flight path node, to facilitate the use of genetic algorithm on the analysis of unmanned aerial vehicle (uav), the optimal flight path planning.

5.2The basic principle of genetic algorithm

Genetic Algorithm (based Algorithm) is a kind of reference to the evolution rule of biology (survival of the fittest, superior bad discard Genetic mechanisms) evolved random search method. Tt is first proposed by the Professor of United States J.Holland in 1975, its main characteristic is directly on the object structure, there is no continuity of derivative and function limit; Has intrinsic implicit parallelism and global optimization ability; Using probability optimization method, which can automatically acquire and to guide the optimization of search space,

adaptively adjust the search direction, do not need to make sure the rules. The properties of genetic algorithm, has been widely used in combinatorial optimization, machine learning, signal processing, adaptive control and artificial life, etc. It is a modern one of the key technologies of intelligent computing.

Operation process of genetic algorithm including coding, generating initial population, fitness value evaluation testing, selection, crossover and mutation of six parts, the following respectively do a brief introduction:

(1) Code: skill according to the solution space, as a form of phenotype of genetic algorithm. From phenotype to genotype map, called encoding. Genetic algorithm in searching the solution space before skill, according to genetic said into space of genotype data string structure, the different combinations of these string structure data into different points.
(2)The generation of initial population:randomly generated a series of data structure, each string of data structure known as an individual, an individual constitute a group. Genetic algorithm (ga) with this string structure as the initial point iteration. Set the evolution algebra counter; Set the maximum evolution algebra; Randomly generated individuals as the initial group;
(3) The fitness value evaluation tests[2]: pros and cons of fitness function indicates that an individual or a solution. To the problem of different fitness function defined in a different way. According to the specific question, calculating the fitness of the individuals in groups.
(4) Choice: will select operator acting on the group, according to the size of the fitness function value, high fitness individuals selected for the next step of operation.
(5) The cross: the crossover operator acting on the group, crossover operation to crossover probability random group of individuals to cross in the position of the randomly generated.
(6) Variation: to mutation operator role in groups, mutation in mutation probability of randomly selected individuals based on a variation, get new individual.

5.3 Unmanned aerial vehicles (uavs) based on genetic algorithm the optimal path

Operation process, based on genetic algorithm for uav monitoring shortest path model is as follows:

(1) Establish the flight space model
Unmanned aerial vehicle (uav) flight refers to the physical space, from its starting point to its maximum range to reach the area. Path planning space is actually a preset area, this area is the task of the unmanned aerial

vehicle (uav) monitoring area. Path planning in this paper is based on the area twice in monitoring time, the route planning for unmanned aerial vehicle, in order to meet the regional monitoring time interval conditions, make track for the best, the required number of unmanned aerial vehicle (uav) at least;

(2) Select the initial points

By the method of Brute force in unmanned aerial vehicle (uav) flight space model select the unmanned aerial vehicle (uav) flight starting point S (the end point as well)from a series of flight path node, $P_1, P_2, \ldots, P_{n-1}$ as the middle path node;

(3)Arrange all of the middle path nod

N toconcluded that all possible trajectories monitoring area;

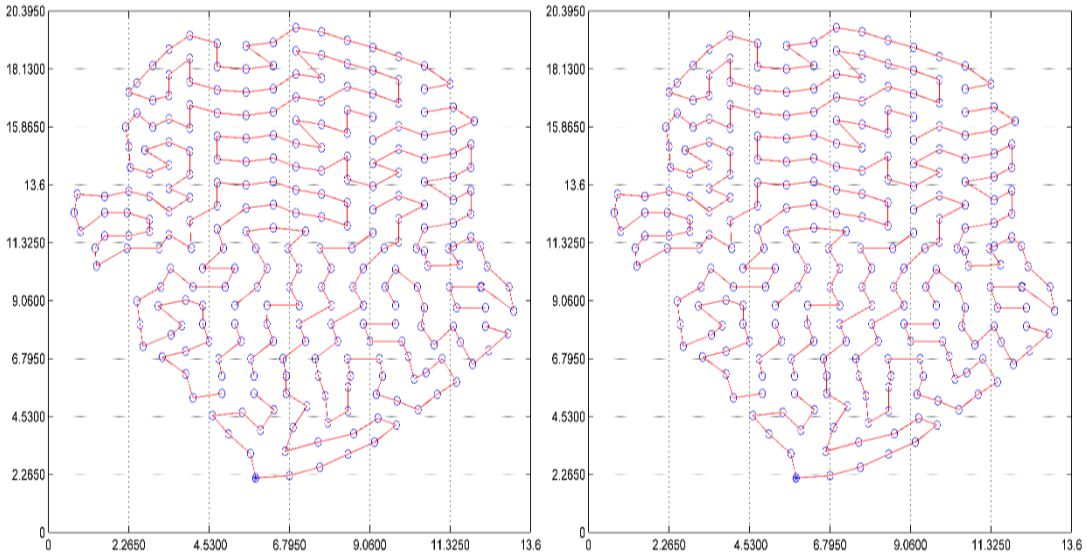


Figure 5-4 part of the flight path path chart

(4)Getting the coordinates

(x_0, y_0) of the starting point of the optimal flightpath L

by comparing size thelength of all the optimal flight path N .

Use the MATLAB editing genetic algorithm, itis concluded that the short est flight path is:,

L=209. 0776km flight path trajectory as shown in figure 5-5

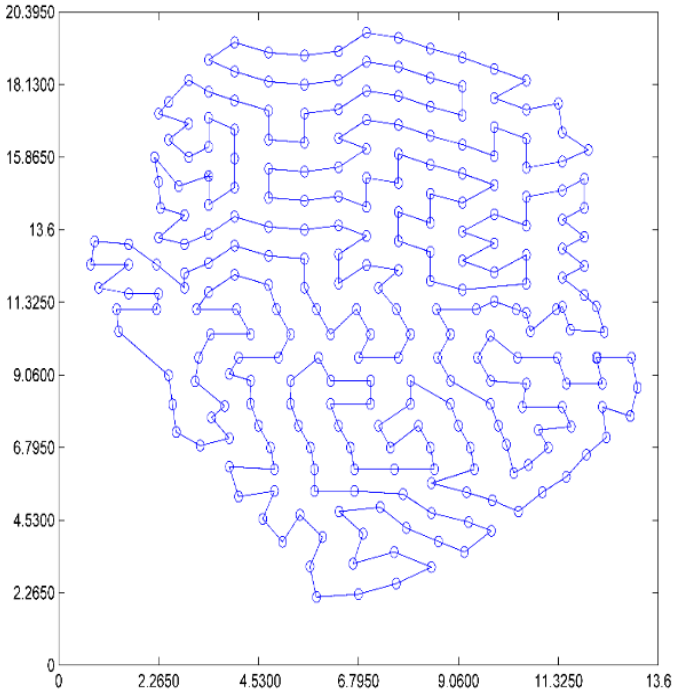


figure 5-5 The optimal flight path trajectory

5.4The optimal path of aircraft based on unmanned aerial vehicle (uav) is calculated

Relevant data shows drone aircraft speed range in general in 0 km/h to 10 0 km/h, through physics kinematics formula:

$$\begin{cases} t = \dfrac{L}{v} \\ number = \dfrac{t}{15min} \end{cases}$$

The optimal path trajectory calculation length L=209. 0776km on the plug type, get the least need number of drones: $number$=8. 3132, namely all areas in YangPu district under the condition of not more than 15 minutes from monitoring state, the number of unmanned aerial vehicle (uav) will need at least nine.

6The unmanned aerial vehicle (uav) to monitor regional planning mo del based on simulated annealing algorithm

6.1Based on the yangpu district zoning street traffic data

Port of huangpu river tributaries poplar distributes throughout the area in the north and south, YangPu that evolution of the name. The huangpu river coastline of 15.5 kilometers (including Renaissance island), dalian road, YangPu bridge and xiang Yin road, war industry road (under construction) 3 roas tunnel and six river ferry lines connected to the pudong new area.

Log in YangPu district bureau of statistics, because usually, the population density can response distribution of visitors, so the analysis of the selected data shown in the table below:

Table 6-1 the population density of YangPu's district or streets in 2011,2012

Population density / Street,town	2011year	2012year
Dinghai street road	12827	12894
Bridge street	28263	28494
Pingliang street road	31075	30876
Jiangpu street road	31454	31454
Siping street road	35614	35720
Kongjiang street road	34848	34897
Changbaixinchun street	20758	20743
Yanjixinchun street	37517	36981
Yinxing street road	19416	19302
Wuyangchang street	15573	15537
Wuyangchang town	11019	11105
Xinjiangwang street	1074	1187

Horizontal analysis table, 2011-2012 statistical yearbook of YangPu district population density of the data in the streets, that every year the streets population density were similar, so one year selected numerical as population density, street analysis to estimate the traffic around the YangPu district and hierarchy of data on the basis of a certain scientific.

Extract YangPu district administrative division table data in statistical yearbook 2012 is as follows:

Table 6-2 YangPu district statistical yearbook 2012 administrative division

Street,town	Land area (km^2)	population	population density	residents committee
total	**60.61**	**1092280**	**18021**	**307**
Dinghai street road	7.02	90516	12894	19
Bridge street	4.36	124236	28494	28
Pingliang street road	3.44	106212	30876	29
Jiangpu street road	2.39	75175	31454	24
Siping street road	2.71	96801	35720	22
Kongjiang street road	2.39	83403	34897	25
Changbaixinchun street	3.05	63240	20734	16
Yanjixinchun street	2.05	75812	36981	17
Yinxing street road	7.40	142837	19302	49
Wuyangchang street	7.61	118234	15537	31
Wuyangchang town	9.50	105497	11105	42
Xinjiangwang street	8.69	10317	1187	5

（Note: the land area provided by the planning bureau of surveying and mapping data, the population of data by the public security bureau.）

Kmeans clustering method is based on partitioning, is one of the top ten classic data mining algorithm. Kmeans algorithm the basic idea is: through a user specified cluster number k, random selection of k objects as the initial clustering center, object classification of closest to them. Through iterative method, successive update value of each cluster

center until standard measurement function began to convergence[3].

With the help of MATLAB, the streets in table 6-2 population density of kmeans clustering analysis, the results shown in figure such as 6-3:

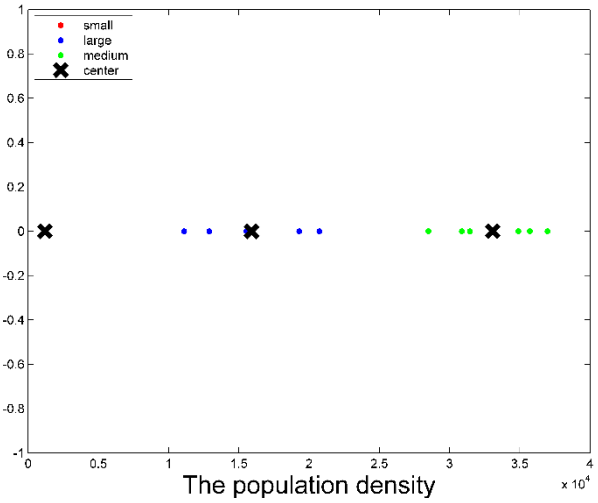


Figure 6-3 streets population density clustering analysis diagram

Figure 6-3 in YangPu district the streets according to the population density is divided into bigger population density, population density and population density of small three categories, and mark out all kinds of center; Classification based on the streets, map as shown in 6-4:

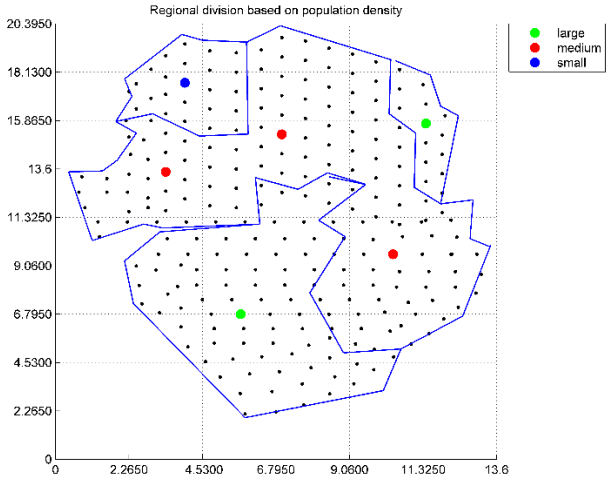


Figure 6-4 street zoning map

Area because of the large population density during the 11th at the G20 s ummit, the greater the visitors so targeted to the population density of the large regional regulations once every 5 minutes by unmanned aerial vehic le (uav) monitoring; large Population density of area is not out of monitor ing the status for more than 15 minutes; Small population density area ca n be monitored more than 20 minutes at a time.

Based on the results of YangPu district traffic hierarchy, this paper will re search direction to how to plan the regional internal unmanned aerial vehi

cle (uav) to monitor the optimal trajectory, to minimize the number of un manned aerial vehicle (uav) needed for monitoring work.

6.2The basic principle of simulated annealing algorithm

Method in the optimization algorithm, because of its different, so it can be divided into two kinds, one kind is to use the function of the first or second order derivative, known as the analytical method, another kind is only using the information of function value itself, called the direct method, simulated annealing algorithm (SA) belong to the optimization algorithm of the second category. It is presented in recent years, as a kind of suitable for solving large-scale combinatorial optimization problem of general effective approximate algorithm, is an extension of the local search algorithm. In theory, it is a global optimal algorithm is proposed. Simulated annealing algorithm (SA) is the result of the study of solid annealing process, the algorithm of thought is put forward by Metropolis in 1953; Kirkpatrick, in 1982 successfully applied in combinatorial optimization problem. The physical properties of solid annealing process is the physical background of simulated annealing algorithm, Metropolis accept standards make jumping out of local optimal algorithm "trap"[4].

Simulated annealing algorithm is a basic description:

(1) The initialization: initial temperature T, the initial solution state S (is the starting point of iteration algorithm), every T value iteration times L;
(2) For $k = 1$ to L, L time to do the first step (3) to (6)
(3) Produce the new solution S'
(4) Calculatethe incremental $\triangle t' = C(S') - C(S)$, C(S) as the evaluation function;
(5) If $\triangle t' > 0$, S' is accepted as a new current solution, or otherwise accepted S' with probability $\exp(-\triangle t / T)$ as a new current solution;
(6) If meet the termination conditions, the output current solution as the optimal solution, the end of the program. Termination conditions off for several consecutive data processing usually is not accept termination algorithm;
(7) T reduce gradually, and $T > 0$, then go to step 2.

Flow chart of 6-1:

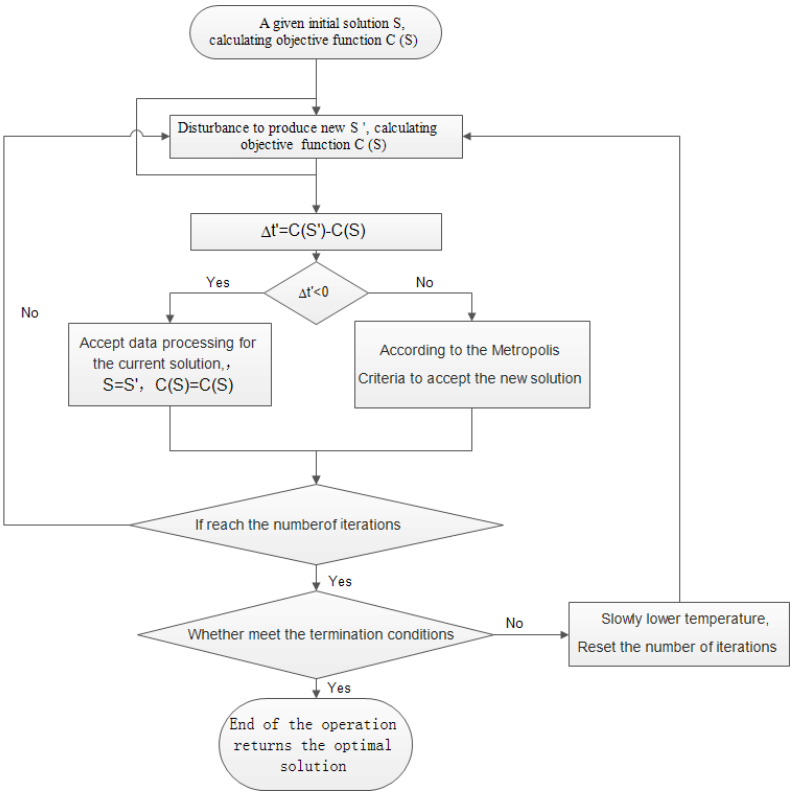


Figure 6-1 flow chart of simulated annealing algorithm

The third step is to determine whether the new is accepted, the basis of judgment is an accepted principle, the most common accepted rule is rule of Metropolis: if $\Delta t' > 0$, S' is accepted as a new current solution S ,else and S' is accept as the new current solution S with the probability $\exp(-\Delta t'/T)$.

The fourth step is when the new is sure to accept and use new to replace the current solution, this just put the current solution corresponding to produce transformation in the new parts have to be addressed, fixed objective function value at the same time. At this point, the current solution implements an iteration. Can begin to the next round of experiments based on this. While when data processing was judged to be abandoned, on the basis of the current solution is to continue to the next round of testing[5].

6.3Capacity constraints analysis model

Capacity constraints, monitoring area required for uav monitoring number problem can be described as: with the time needed for regional monitoring meet each traffic class conditions, with a minimum number of unmanned aerial vehicle (uav) to monitor person flow level area, each level is an area of a certain size, unmanned aerial vehicle (uav), the optimal path of two-dimensional plane figure.

YangPu district were calculated based on simulated annealing algorithm, all the places not from monitoring status for more than 15 minutes at least the number of unmanned aerial vehicle (uav) steps are as follows:

On the basis of the research level of traffic zone area of graphics, artificial initialization uav optimal monitoring path constitute the basis of graphics, in a traffic rank area a random initialization m points, as the center of the basic shapes of (xx, yy).

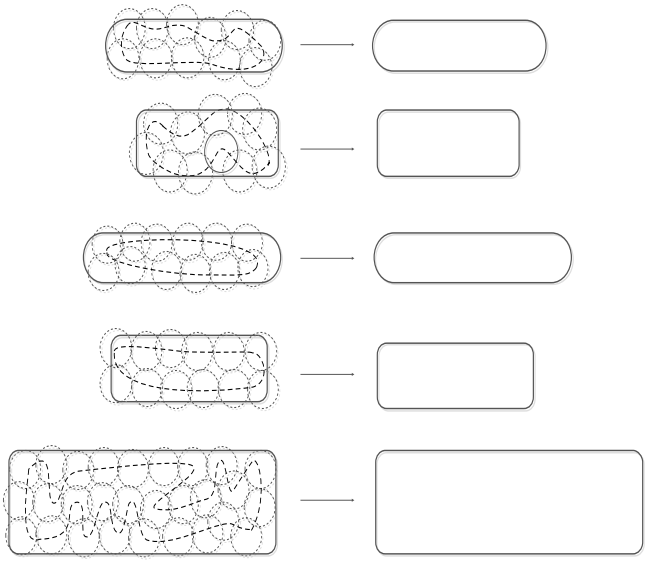


Figure 6-2 unmanned aerial vehicle (uav) constitute the basis of the optimal monitoring path graph combination

(1) The level of the traffic area all initialized to point coordinates of 1 each element matrix T_1, have been a center of the graphic calculation equation of the midline $y = x \cdot tan(\theta) + \beta(:, 2) - \beta(:, 1) \cdot tan(\theta)$, initialize the movement in each level traffic area of 25 size is 100 * 100 square, define the square center movement in the range of [1, 1], and the direction of the next movement with the x axis Angle θ, θ change in the range of $[-\text{pi}/2, \text{pi}/2]$;

(2) The graphic matrix T_1 after a movement, whether central point in traffic area within the scope of the grade, if not, then continue to point at which a mobile, if yes, then a fixed point, record the position of the center point coordinates and graphics within the area covered by the coordinates, of all points that graphic matrix T_2;

(3) Such as graphics overlap between matrix, the corresponding graphics overlap matrix elements within one to one correspondence together;

(4) Recording and person flow level area overlap the area of the corresponding graph matrix addition, it is concluded that the numerical as punishment function ;

(5) Person flow level area all center after the transformation, calculated by the same token transformation after the penalty function value ;

(6) To determine relationship between and the size of this , it is used as the next transformation center coordinates and the comparison of the penalty function value, determine whether the number of iterations , if reached, the output current value ;

(7) For all level of traffic areas to step (1) ~ (7), it is concluded that all value, the value it is concluded that the overlap area of total;

(8) Compare all overlap area combined with the person flow level, 4% of the total area size if is greater than the person flow level is 4% of the total area, is the center of the fixed as a drone monitoring work area;

(9) To other regions do step (1) ~ (10), it is concluded that the level of traffic area the required number of unmanned aerial vehicle (uav), can be concluded that traffic as the constraint conditions of unmanned aerial vehicle (uav) total number needed to monitor the YangPu district.

(10) The above steps can be converted to flow chart shown in figure 6-2

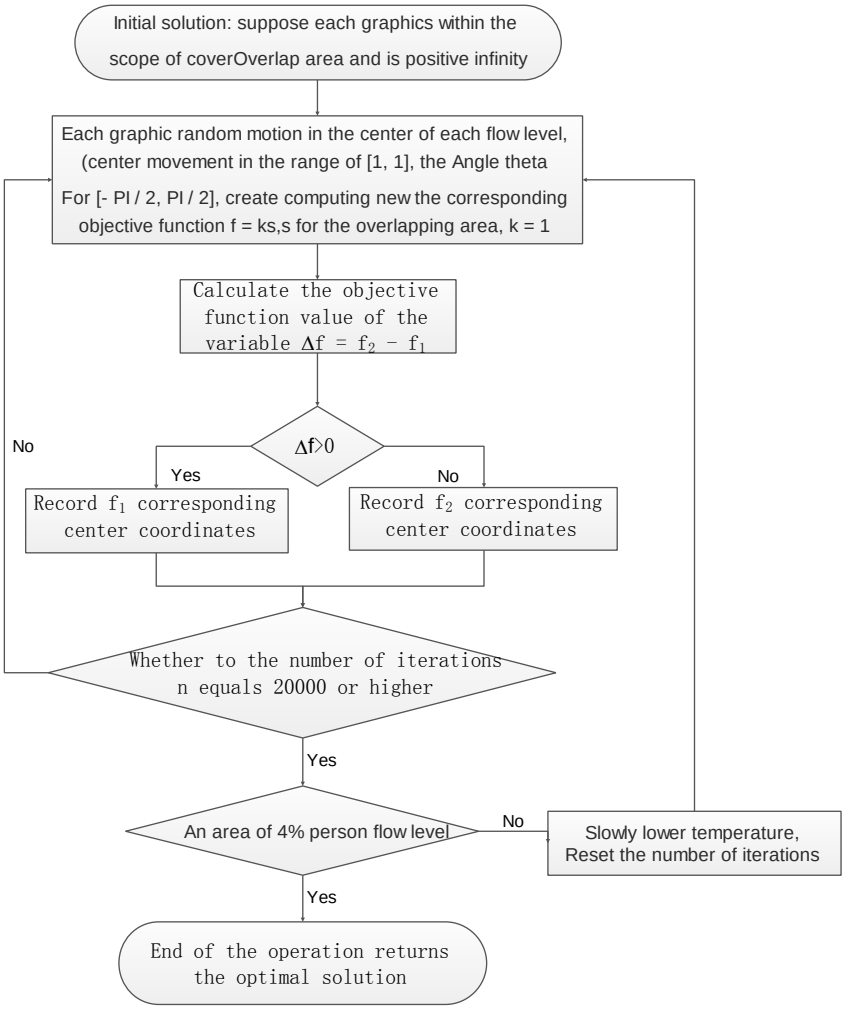


Figure 6-3 population capacity constraint problem analysis flow chart

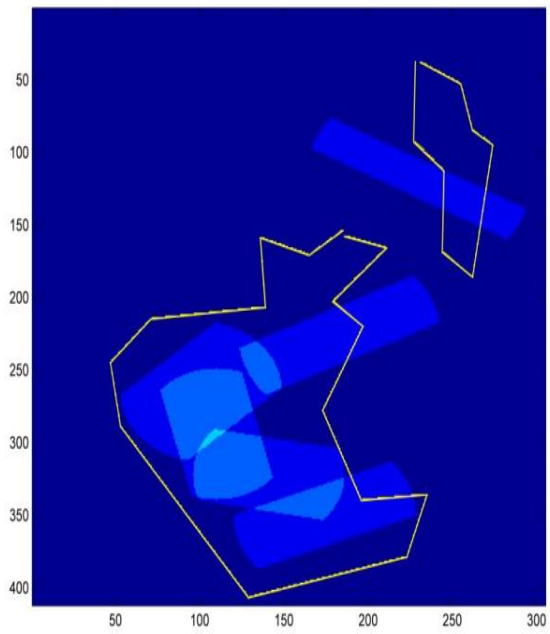


Figure 6-4 large Population density area planning process

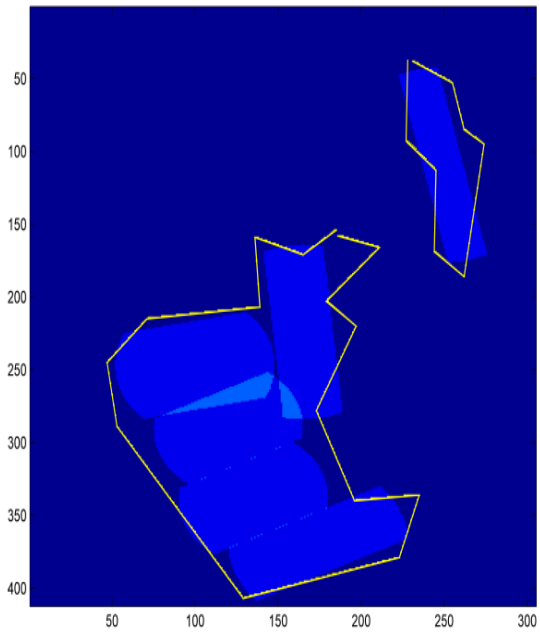


Figure 6-5 large Population density area planning result

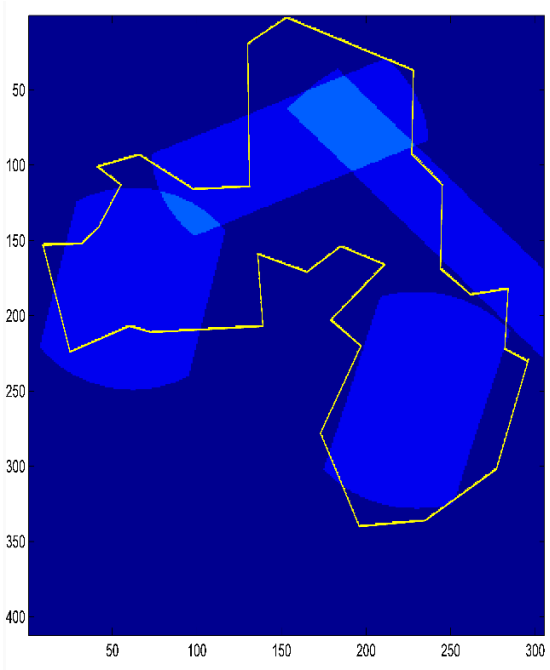


Figure 6-6 medium Population density area planning process

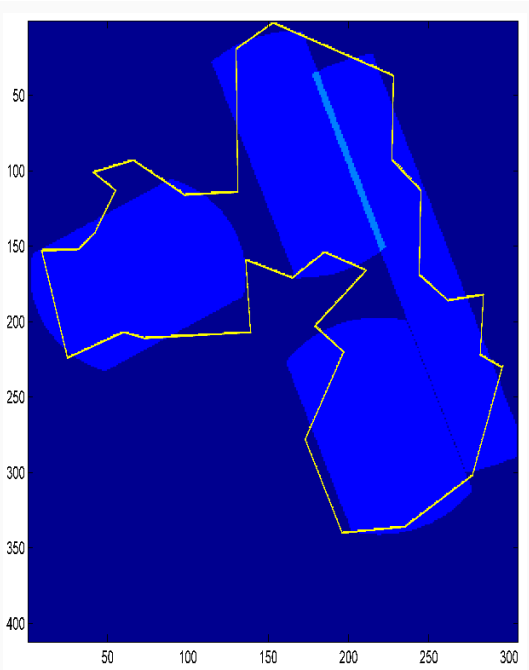


Figure 6-7 medium Population density area planning result

Analysis program results figure 6-5, figure 6-7, shows that using the simulated annealing algorithm to calculate the area of stream of the required number of unmanned aerial vehicle (uav) for six, the required number of unmanned aerial vehicle (uav) for four foot traffic area, observation program results figure 6-4, 6 regional scale are used in the stream of uav monitoring blind area, namely the error area, foot traffic level regional program results figure 6 - existing error area, handling of error area is classified with the region traffic was smaller level area, due

to the discrete distribution area of the area, and area of small, only a drone to monitor traffic was smaller level parts at the same time both the error area of the monitoring work.
Therefore, based on the simulated annealing algorithm, traffic as a constr aint condition monitoring of unmanned aerial vehicle (uav) a total numbe r of YangPu district all areas need is 11

7 The third model and solving

7.1 Solution framework

Missing 30% of unmanned aerial vehicle (uav), need to meet all area can't out to monitor the condition of the premise of the more than 15 minutes, provide in the state monitoring program can provide the biggest monitoring scope. , based on the results of the plan 1 in unmanned aerial vehicle (uav) no damage conditions, monitoring the whole YangPu district needs a minimum number of unmanned aerial vehicle (uav) is nine, and after missing 30%, only 6 drone of YangPu district monitoring work.
Plan 3 ‘s difference to 2 is without considering the traffic impact on the regional monitoring work, the principle and the solution of the two plans are consistent. The analysis method of based on the scheme 2, 3 as shown in figure 7-1:

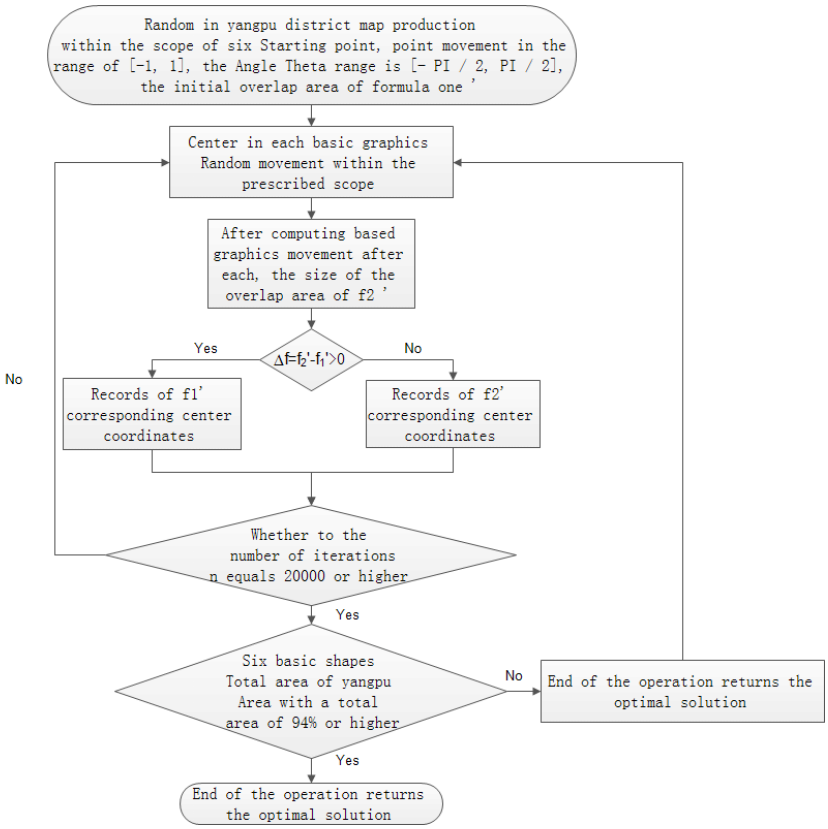


Figure 7-1 plan 3 solution

7.2 Concrete steps to solve

(1) On the basis of YangPu district map geometry, artificial initialization 6 unmanned aerial vehicle (uav), the optimal monitoring path constitute the basis of graphics, in YangPu area within the scope of random initialization 6 moving point, as the center of the basic shapes, set point of the movement range of [-1, 1], and the direction of the next movement with the x axis Angle θ, θ changes in the range of $[-pi/2, pi/2]$, initialize the area of overlap between the basic shapes for f1 ';

(2) Each basic random motion graphics center within the prescribed scope, calculation of each basic shapes overlap each other after motion area of the size of the f2 ';

(3) Determine the Df = f2 '- f1' value plus or minus, if Df > 0, record the f1 'corresponding to the center coordinates, otherwise, the record f2' corresponding center coordinates;

(4) Determine whether the number of iterations $n \geq 20000$, $T = 0.999$, if reached, the output current value $f_{1\max}$;

(5) Determine six basic graphic detection area of value is greater than or equal to 94% of total YangPu district area, and if so, the end of the operation and output 6 drone monitoring area location at this time.

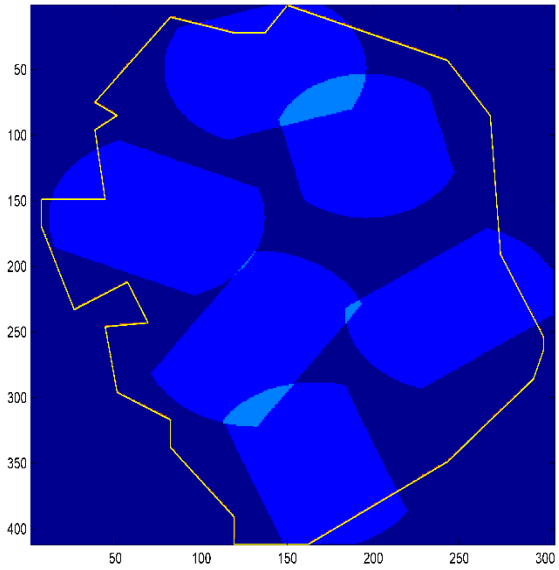


Figure 7-3 of the final plan

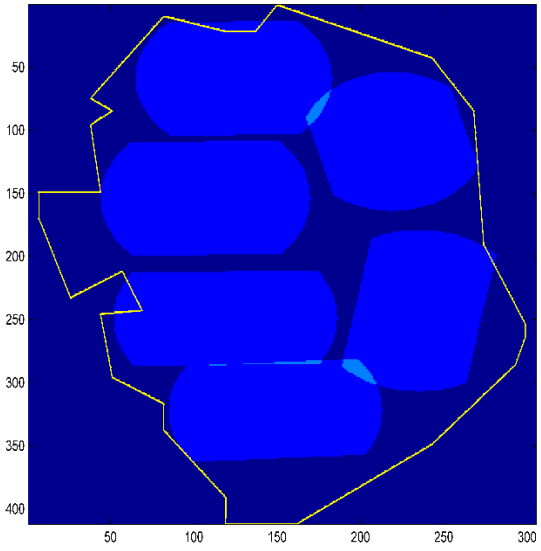
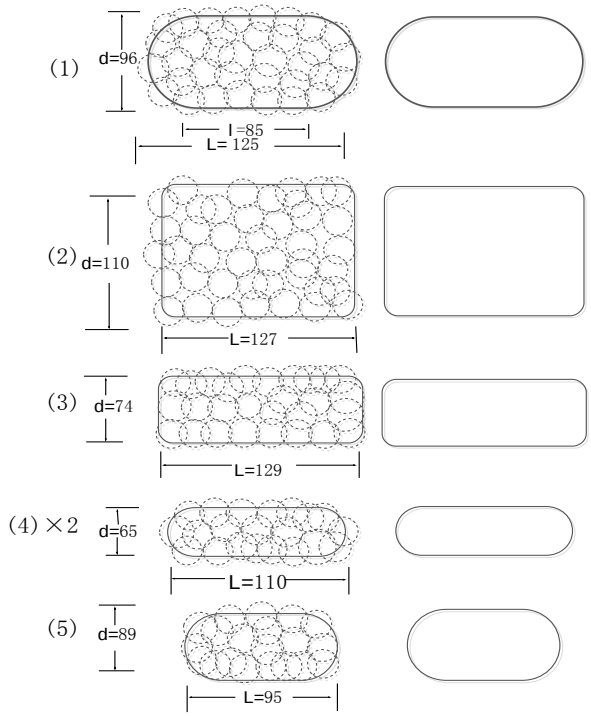


Figure 7-3 of the final plan

7.3 Monitor the area calculation

7-3 combined numerical minus the overlap area, is the plan 3 can provide the greatest monitoring scope.

The basic shapes of vector diagram as shown in figure 7-4 :



picture7-4 basic shapes of vector

Figure 7-4 based graphics vector diagram analysis the geometric relationships in 7-4, according to the formula:

$S_{基}=(L-l)/2\cdot(d/2)\cdot\pi+L\cdot d$ Calculate the area of each basic shapes through calculation formula :

$M=(S_{基1}+S_{基2}+S_{基3}+2S_{基4}+S_{基5})\times 45.3^2/1000000/283/0.6849=0.6694$ draw a plan 3 can provide the largest scope of monitoring area account for 66.94% of the total area of the YangPu district. In all areas, therefore, under the condition of not more than 15 minutes from monitoring, only provide 6 drone to monitor YangPu district, monitoring program can provide most surveillance area account for 66.94% of the total area of the YangPu district.

References

[1]LI Zhengbing, LUO Bin, ZHAI Sulan, et al. Kmeans algorithm based on partition of correlational graph. Computer Engi-
neering and Applications, 2013, 49（21）：141-144.

[2]Using Ant Colony Algorithm and Simulated Annealing Parallel Algorithm to Solve Traveling Salesman Problem
XU Zhi-hong，SONG Bo，GUO Yan-yan

[3]李正兵, 罗斌, 翟素兰, 涂铮铮. 基于关联图划分的 Kmeans 算法[J]. 计算机工程与应用, 2013, 21:141-144+151.

[4]冯玉蓉. 模拟退火算法的研究及其应用[D]. 昆明理工大学, 2005.

［5］wujinbo Study of the immune algorithm and simulated anneali algorithm for TSP problem Wuhan University of Technology 2007.4