Research on the Internet of Things Based on Ant Colony Optimization Algorithm

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Abstract:

The purpose of this paper is to prove that the ant colony algorithm is an excellent mathematical modeling method and improve the production efficiency of the single drilling machine. The methods of mathematical induction and mathematical deduction and mathematical hypothesis are commonly used mathematical methods in scientific research. The ant colony algorithm to solve the TSP problem: algorithm design ideas: using the standard ant colony algorithm or its improved to achieve a traveling salesman problem TSP, find the shortest distance of the 51 City, the number of iterations is 1000 times, the final output of the optimal solution. Algorithm flow: (1) initialize ant colony: initialize ant colony parameter, set ant number, ant put in 51 vertices, initialize path pheromone. (2) Ant action: the ants leave their paths by the ants in front of the pheromone and their own judgments to complete a loop path. (3) Releasing pheromones: the path to releasing ants through a certain percentage of pheromones. (4) The evaluation of ants: the fitness is evaluated according to the objective function of each ant. (5) If the shortest path condition is satisfied, the optimal output is obtained. Otherwise, the algorithm continues. (6) Pheromones evaporate: pheromones continue to dissipate over time. The result of this paper is that the ant colony algorithm has high accuracy and efficiency; the TSP problem can be solved, to improve the production efficiency of the single drilling machine. The conclusion of this paper is that ant colony algorithm is an excellent algorithm, the TSP problem can be solved, for example, can improve the production efficiency of the single drilling machine.

Keywords:

Internet of Things, Colony Optimization Algorithm, TSP Problem, the Production Efficiency of the Single Drilling Machine

1. Introduction

The Internet of things is a kind of Internet, and all the problems in this article are studied under the Internet of things. The methods of mathematical induction and mathematical deduction and mathematical hypothesis are commonly used mathematical methods in scientific research. Artificial intelligence includes machine learning, and machine learning includes ant colony algorithm [1-10].

In reference [48], ant colony optimization (ACO) is pointed out as a naturally inspired swarm intelligence algorithm, which belongs to the category of meta heuristic algorithm. It is derived from the simulation of ant colony foraging behavior in nature. When ants are foraging, they secrete a chemical hormone pheromone on the path they pass through, and at the same time, judge the direction of progress according to the concentration of pheromone nearby. The individual behavior pattern in the ant colony is relatively simple, and its interaction is only through a single scalar letter. The concentration of the pheromone is carried out indirectly. But the independent and parallel behavior of multiple individuals shows the whole population. Complex, intelligent behavior. The ant colony system is naturally distributed, self-learning, self-organizing, robust, and simple. The single character makes the ant colony optimization algorithm more powerful than the traditional mathematical method in solving the optimization problem. The ability to solve the problem has been widely concerned and applied in all fields of production and life. The key of the ant colony optimization algorithm is a parameterized probability model, called the pheromone model. At each iteration, the system generates population based on pheromone model, and then reflects the generated population information in the pheromone model to affect the next generation population. That is to say, the upper and lower generations of the population communicate indirectly through the pheromone model. The pheromone model is not only a priori knowledge to guide the evolutionary direction of the population, but also a posteriori knowledge of preserving the information of the historical population. Therefore, the selection of the pheromone model directly determines the performance of the whole ant colony optimization algorithm. Reference [49] points out that the theoretical research of ant colony optimization algorithm is helpful to better understand the principle of the algorithm and to guide the application of the algorithm. The convergence analysis, time complexity analysis and approximate performance analysis of the ant colony optimization algorithm are reviewed. The object of theoretical research is transformed from a simple pseudo Boolean function to a combinatorial optimization problem and its practical application. The theoretical research of ant colony algorithm is reviewed from 2 aspects: the theoretical analysis method of ant colony algorithm and the type of research problem. The basic mathematical analysis tools such as adaptive value division and drift analysis are introduced, and some important problems, such as time complexity and approximate performance, are discussed. The performance of an ant colony algorithm for solving all kinds of problems is summarized and compared, and it is pointed out that these studies can be more in-depth understanding of the operating mechanism of the ant colony algorithm. Finally, we discuss the problems to be solved in the theoretical research of the ant colony algorithm. It is pointed out that the introduction of new analytical tools and the research of more complex algorithm models are the directions and contents worthy of further research. Reference [50] points out that with the rapid development of network technology, the demand for multimedia services has increased dramatically. Multicast as a basic technology of point to multipoint, can support multimedia business well, so it has attracted wide attention. The traditional "Store-and-Forward" method is used for data forwarding in traditional sister sowing, which cannot guarantee the maximum multicast rate in theory. In 2000, network coding was proposed. The technology retransmitted data according to the "code forwarding (Coding-and-Forward)" mode, which made up for the shortcomings of traditional technology, and enabled multicast to better support multimedia services with increasing bandwidth demand. In the early research of network coding and multicast, most of them assume that all nodes with coding function carry out coding operation. However, encoding operation requires additional computation and storage resources, which brings extra computation cost and time delay. Therefore, the problem of network coding resource optimization is proposed, which is to ensure the maximum rate of multicast and reduce the coding operation as much as possible. Ant colony optimization algorithm has been successfully applied to many combinatorial optimization problems, but it has not been applied to this problem. This paper studies the ant colony optimization algorithm to solve the optimization problem of network coding resources. The reference [51] points out that continuous ant colony optimization algorithm is an important research direction of ant colony optimization algorithm, ant colony optimization algorithm for continuous domain (ACOR) longer computing time and easy to fall into the local optimum problem, put forward a kind of continuous ant colony optimization algorithm based on artificial bee colony (ABCACOR). First of all, the introduction of an alternative mechanism to guide the selection of solutions, to replace the original selection method based on sorting, to save calculation time and diversity as much as possible to keep the search; secondly, combined with the artificial bee colony algorithm search strategy to improve the global search capability of the algorithm, further reduce the computation time and improve the accuracy of the solution. Simulation experiments on a large number of test functions show that the ABC ACOR algorithm has better performance than the existing ant colony algorithm in continuous domains. Reference [52] pointed out that the ant colony algorithm itself has slow convergence speed and easy to fall into the local optimal solution, and proposes some improved ant colony optimization algorithm for this defect. Mainly discusses the convergence of ant colony optimization algorithm theory and application, the performance of ant system and the max min ant system is better than the performance of ant system and the max min ant system, ant system and the max min ant system is a special kind of convergence. It is crucial to find the problems to be solved according to the current research situation at home and abroad. The research status at home and abroad has been written a lot and a lot of work has been done. Research basis is the basis of research, literature research, practical research, experiments, and so on. In the process of finding problems, the research foundation, the research basis and the research status at home and abroad have been written a lot. There are two cases of propositional paper and non propositional paper. Is there a difference between the application value and the specific application? The data should be obtained in the first part of the experiment, the regression of the law and the revaluation of the law, then the experiment, and the regression of the rules and then the revaluation. The price of a sensor in the Zhichun Road electronic city is about 90-200 yuan. The method of mathematical modeling and the method of writing code are an important research method.

1.1. The Ant Colony Algorithm to Solve TSP Problem

The ant colony algorithm to solve the TSP problem: algorithm design ideas: using the standard ant colony algorithm or its improved to achieve a traveling salesman problem TSP, find the shortest distance of the 51 City, the number of iterations is 1000 times, the final output of the optimal solution. Algorithm flow: (1) initialize ant colony: initialize ant colony parameter, set ant number, ant put in 51 vertices, initialize path pheromone. (2) Ant action: the ants leave their paths by the ants in front of the pheromone and their own judgments to complete a loop path. (3) Releasing pheromones: the path to releasing ants through a certain percentage of pheromones. (4)

The evaluation of ants: the fitness is evaluated according to the objective function of each ant. (5) If the shortest path condition is satisfied, the optimal output is obtained. Otherwise, the algorithm continues. (6) Pheromones evaporate: pheromones continue to dissipate over time. Basic design idea: (L) pre initialization of pheromone intensity and ant tabu list. Ants follow the rules in the tabu list of certain probabilities and arrive at the nodes at the next choice until a legitimate path is formed. (2) Calculate the length of the path generated by each ant, and the path length is the sum of the length of each path. (3) Update the pheromone on each side. Each side of the first pheromone volatile operation, and then, according to the path length generated by ants, to get the release of acne by pheromones. (4) when all the ants have completed the pheromone update operation, record the current shortest paths, and the tabu list and the pheromone value added in the △ (t， t ＋ l) is initialized, and go to step 2. And so on, until the end of the algorithm is satisficannoth as the solution can not be further improved or reached the predetermined number of cycles. First, set up an ant class, and then set up a TSP class, call the ants in TSP class variables and methods, and then define the main function, in the main function calls the TSP class variables and methods [1-10].

1.2. The Artificial Ant Colony Algorithm for TSP Problem

In the artificial ant colony algorithm of TSP problem, it is assumed that the M, ant moves between the adjacent nodes of the graph, thus the solution of the problem can be obtained asynchronously and asynchronously. The probability of a step shift for each ant is determined by the two parameter on each edge of the graph: (1) Pheromone values are also called pheromone traces. (2) Visibility, that is, a priori value. There are 2 kinds of information update in a way, is volatile, which is all the information on the path for a certain ratio of reduction, process simulation of natural pheromone volatile over time; the two are to enhance the value, to "good" (ants through side) increase pheromone. The downward movement of a target is realized by a random principle, is the use of the storage node information, the next step is to calculate the probability of a node, and according to the probability of achieving a step by the reciprocating movement, more and more close to the optimal solution. Ants in the search process, or find a solution, will evaluate the optimization of the solution or part of the solution, and the evaluation information stored in the relevant connection pheromone. Ant colony algorithms are used to find the shortest distance between 51 cities [11-20]. The flowchart of the ant colony algorithm is shown in figure 1.

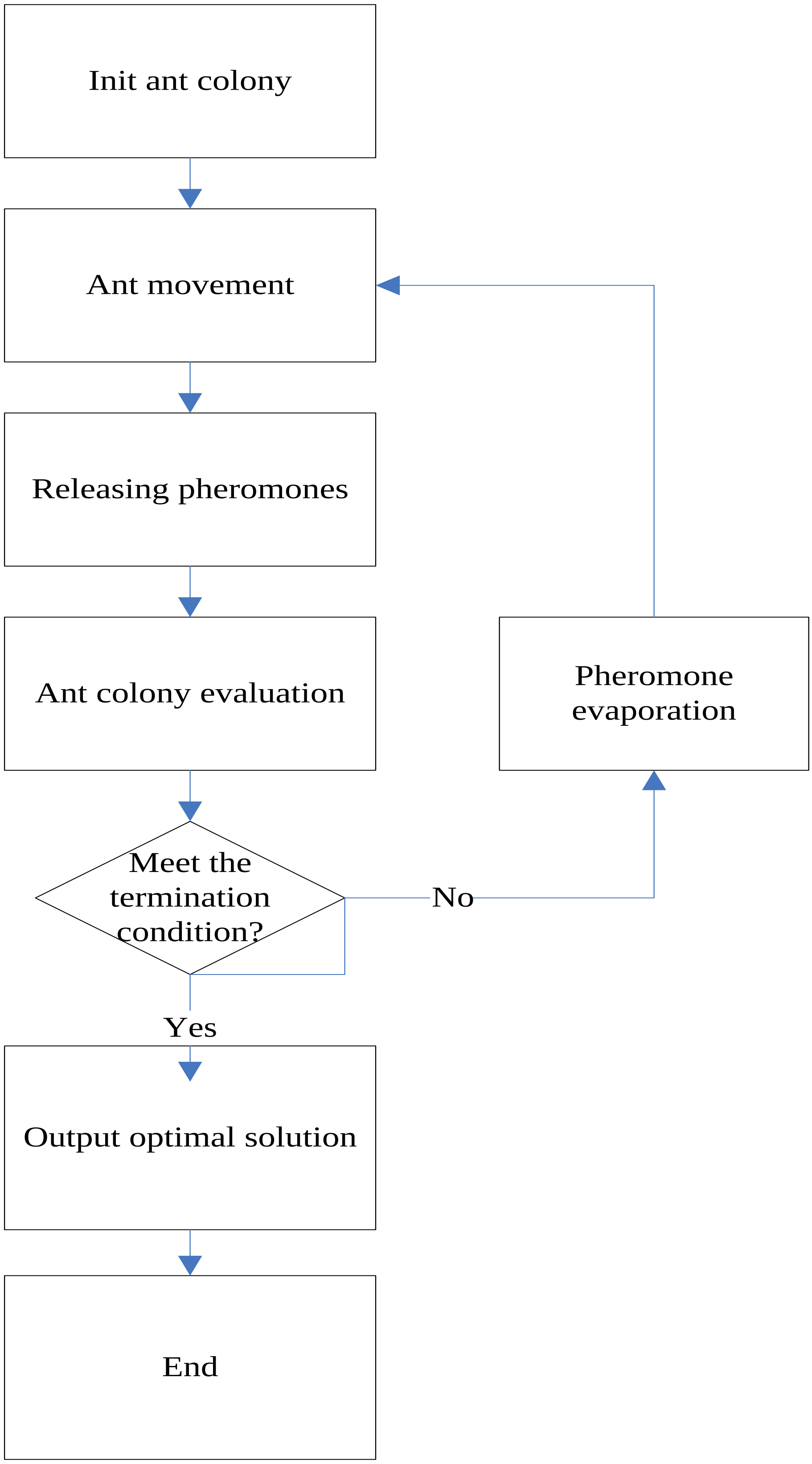

Figure 1. *Flow chart of ant colony algorithm.*

1.3. The Idea of Algorithm Design

Using the standard ant colony algorithm or its improved traveling salesman problem TSP, find the shortest distance between 51 cities, the number of iterations 1000 times, and finally output the optimal solution. The basic flow of the algorithm is: in the artificial ant colony algorithm for the TSP problem, it is assumed that the M, ant moves between the adjacent nodes of the graph, thus the solution of the problem can be obtained asynchronously and asynchronously. One step of each ant's transition probability is determined by two parameters on each edge of the graph: (1), pheromone values are also called pheromone traces. (2) visibility, that is, a priori value. There are 2 kinds of information update in a way, is volatile, which is all the information on the path for a certain ratio of reduction, process simulation of natural pheromone volatile over time; the two are to enhance the value, to "good" (ants through side) increase pheromone. The downward movement of a target is realized by a random principle, is the use of the storage node information, the next step is to calculate the probability of a node, and according to the probability of achieving a step by the reciprocating movement, more and more close to the optimal solution. Ants in the search process, or find a solution, will evaluate the optimization of the solution or part of the solution, and the evaluation information stored in the relevant connection pheromone [21-30].

1.4. Algorithm Flow

Algorithm flow: (1) Initializing ants: initializing ant colony parameters, setting ants quantity, placing ants on 51 vertices, initializing path pheromone. (2) Ant movement: the ant chooses the path according to the pheromone left by the ant in front and its own judgment, and completes a cycle. (3) Release pheromone: release the pheromone in a certain proportion to the path of the ants. (4) Evaluate the ant colony: evaluate the fitness of each ant, according to the objective function. (5) If the condition of the shortest path is satisfied, the output optimal solution is obtained. Otherwise, the algorithm continues. (6) The pheromone pheromone volatilization: as time continues to dissipate.

1.5. Ant Colony Optimization Algorithm

Ant colony optimization algorithm: (1) A group of ants starts randomly from the starting point, meets food, holds food, and returns along the road. (2) Ants on the way back and forth, leaving pheromone signs on the road. (3) The pheromone will gradually evaporate over time (usually available as a negative exponential function or released at a certain rate). (4) From the nest of ants, the path selection and the probability of each path pheromone concentration is proportional to the. Note: the same principle can be used to describe the foraging situation of multiple food sources by ant colonies. The framework of general ant colony algorithm has three components: A: the activity of ant colony; B: the volatilization of pheromone; C: the enhancement of pheromone; the transition probability formula and the pheromone update formula are mainly reflected in the previous algorithm [31-40].

1.6. Basic Design Idea

Basic design idea:

$q_i(t)$: t times the number of ants in the city of i;

m: The total number of ants in an ant colony, m=$\sum_{i=1}^{n} q_i(t)$;

τ_{ij}: Pheromone intensity on edges (i, j);

n_{ij}: Visibility on sides (i, j);

d_{ij}: The distance between city i and city j;

P_{ij}^{k}: The probability of the transfer of ant k from urban i to urban j.

Pre initialization pheromone intensity on each side, and tabu list of ants. In accordance with certain rules of probability, the ants select the next node to be reached under the restriction of the tabu list, and eventually form a legitimate path. (2) Pre initialization pheromone intensity on each side, and tabu list of ants. In accordance with certain rules of probability, the ants select the next node to be reached under the restriction of the tabu list, and eventually form a legitimate path. (3) Update the pheromone on each side. Each side first carries out pheromone volatilization operation, and then obtains the pheromone released by ants according to the path length generated by each ant. (4) When all ants have completed the pheromone update operation, the current shortest path is recorded, and the tabu table and pheromone values are added (t， t＋l) proceed to initialization and go to step (2). And so on, until the end of the algorithm is satisfied, such as the solution cannot be further improved or reached the predetermined number of cycles. First, set up an ant class, and then set up a TSP class, call the ants in TSP class variables and methods, and then define the main function, in the main function calls the TSP class variables and methods.

2. Methods

A hole is a printed circuit board (also known as printed circuit board) one of the important components of the processing cost holes usually accounted for 30% to 40% of the cost of the system board, punching machine is mainly used in the drilling process in the manufacture of printed circuit board, the problem is to improve the production efficiency of a certain kind of punch.

The production efficiency of drilling depends mainly on the following two aspects: (1) the drilling time of the through hole, which is determined by the manufacturing process, assumes that the operation time for each hole is the same.(2) punch in the processing operation, bit travel time (or walk), assuming the drill only horizontal and vertical motion. A company shall produce a batch of printed circuit boards of large quantity and of the same specifications, and the data for the through-hole coordinates are as follows: please design an optimum through-hole plan for the company.

Data figure as shown below in figure 2, (x, y) represents the center coordinate data of the hole; the Center coordinates data of printed circuit board as shown in table 1.

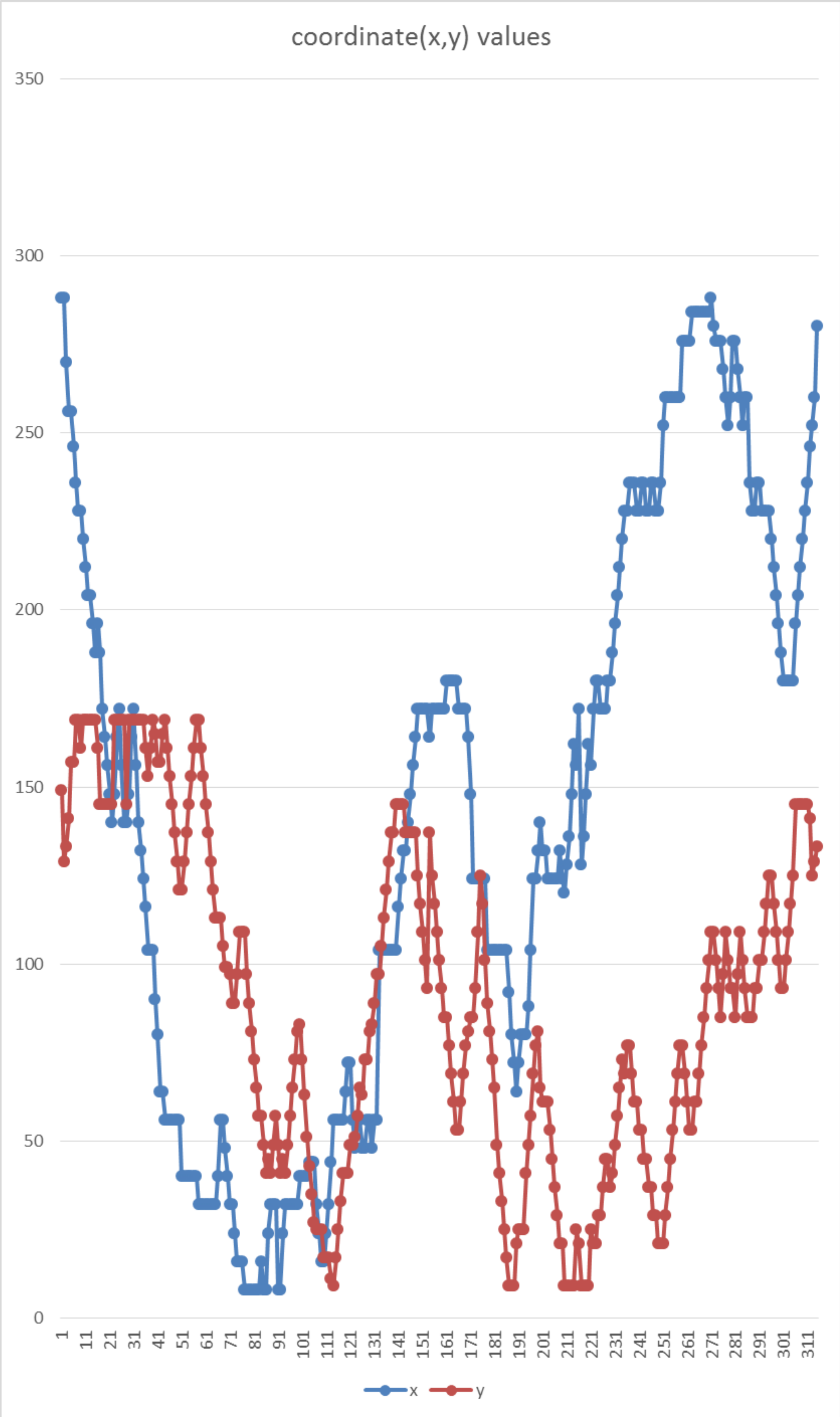

Figure 2. *Data figure.*

Table 1. *Center coordinates data on printed circuit board.*

x	y	x	y	x	y	x	y	x	y
288	149	32	121	48	73	64	21	260	37
288	129	32	113	56	73	72	25	260	45
270	133	40	113	56	81	80	25	260	53
256	141	56	113	48	83	80	25	260	61
256	157	56	105	56	89	80	41	260	69
246	157	48	99	56	97	88	49	260	77
236	169	40	99	104	97	104	57	276	77
228	169	32	97	104	105	124	69	276	69
228	161	32	89	104	113	124	77	276	61
220	169	24	89	104	121	132	81	276	53
212	169	16	97	104	129	140	65	284	53
204	169	16	109	104	137	132	61	284	61
204	169	16	109	104	137	132	61	284	61
196	169	8	109	104	145	124	61	284	69
188	169	8	97	116	145	124	53	284	77
196	161	8	89	124	145	124	45	284	85
188	145	8	81	132	145	124	37	284	93
172	145	8	73	132	137	124	29	284	101
164	145	8	65	140	137	132	21	288	109
156	145	8	57	148	137	124	21	280	109
148	145	16	57	156	137	120	9	276	101
140	145	8	49	164	137	128	9	276	93
148	169	8	41	172	125	136	9	276	85
164	169	24	45	172	117	148	9	268	97
172	169	32	41	172	109	162	9	260	109
156	169	32	49	172	101	156	25	252	101
140	169	32	57	172	93	172	21	260	93
140	145	8	49	164	137	128	9	276	93
148	169	8	41	172	125	136	9	276	85
164	169	24	45	172	117	148	9	268	97
172	169	32	41	172	109	162	9	260	109
156	169	32	49	172	101	156	25	252	101
140	169	32	57	172	93	172	21	260	93
132	169	32	65	172	85	180	21	260	85
124	169	32	73	180	85	180	29	236	85
116	161	32	81	180	77	172	29	228	85
104	153	40	83	180	69	172	37	228	93
104	161	40	73	180	61	172	45	236	93
104	169	40	63	180	53	180	45	236	101
90	165	40	51	172	53	180	37	228	101
80	157	44	43	172	61	188	41	228	109
64	157	44	35	172	69	196	49	228	117
64	165	44	27	172	77	204	57	228	125
56	169	32	25	164	81	212	65	220	125
56	161	24	25	148	85	220	73	212	117
56	153	16	25	124	85	228	69	204	109
56	145	16	17	124	93	228	77	196	101
56	137	24	17	124	109	236	77	188	93
56	129	32	17	124	125	236	69	180	93
56	121	44	11	124	117	236	61	180	101
40	121	56	9	124	101	228	61	180	109
40	129	56	17	104	89	228	53	180	117

40	137	56	25	104	81	236	53	180	125
40	145	56	33	104	73	236	45	196	145
40	153	56	41	104	65	228	45	204	145
40	161	64	41	104	49	228	37	212	145
40	169	72	41	104	41	236	37	220	145
32	169	72	49	104	33	236	29	228	145
32	161	56	49	104	25	228	29	236	145
32	153	48	51	104	17	228	21	246	141
32	145	56	57	92	9	236	21	252	125
32	137	56	65	80	9	252	21	260	129
32	129	48	63	72	9	260	29	280	133

2.1. Problem Analysis

Problem analysis: This will improve the production efficiency of the machine and make an analysis, the production efficiency refers to the unit of time production capacity, processing efficiency. So in order to improve the production efficiency of drilling, we can make the travel time and the total drill tool change time as short as possible, the production efficiency will be higher.

For a single drill, we first draw the distribution of all points to determine that the diagonal of the circuit is approximately, and that the speed of travel is rough and that the time of travel is not long. Considering the moving speed and the conversion time of the tool, it is found that the conversion time of the tool is much longer than the travel time, so we want to achieve the shortest time when the tool's conversion time is the best. Therefore, we use an ant colony algorithm to compute the shortest distance between the shortest distance and the least number of tool conversions, and compare the two, and get the optimal results.

2.2. Model Hypothesis

Model hypothesis:

(1) The drilling time of a single through the hole is determined by the manufacturing process. In order to simplify the problem, it is assumed that the drilling time for the same pass is the same.

(2) In order to calculate the travel expenses, need to calculate the travel time, in order to simplify the problem, assuming the punch travel is uniform motion.

(3) It is assumed that the change over time of the tool is the same for different pass processing operations;

(4) Between the two hole distance calculation, to simplify the problem, the drill bit is a particle hypothesis punch.

(5) In order to avoid the touch and interference between the drills, it is assumed that the distance between the two drills is not less than 3cm.

2.3. Model Establishment

Model establishment: A single bit model: for a given size of the hole, adjust the corresponding tool, from the point of the tool knife along the shortest distance path, moving from one hole to another hole, the hole until all objects is processed, processing the other hole then the next size conversion tool, such an arrangement. Describe the problem as the following optimization model:

(1) Variable design. A collection with n holes $V_1V_2V_3......V_n$, set up i, j Represents any two holes in a collection, d_{ij} Represents the distance between i, j two holes in a collection,M is the total distance traveled.

(2) Objective function. You need to find a non repeating whole arrangement in the hole collection

$T = \{T_1T_2 \cdots T_n\}$, order $M = \sum_{i,j>0\&i\neq j}^{n-1} d(T_i, T_j)$, find the minimum value of M.

(3) Constraints: the machining path starts from one hole, processes only one hole at each hole, traverses each hole, and finally goes back to the starting point, including tool switching.

(4) Optimization algorithm: ant colony algorithm.

3. Results

Results analysis of single drill bit: For the single bit mode of production, way of using a drilling tool for drilling holes corresponding to all a tool of the corresponding hole drilling in conversion tool, the line of work by using ant colony algorithm, data processing by MATLAB. (In order of order Cutting tool: d→e→f→g→h→a→b→c→f, Pass: DG→DI→J→FG→HF→AC→B→CEIJ→EG）.

The following table shows the stroke of each tool (unit: 104mil), the stroke of each tool as shown in table 2.

Table 2. *The stroke of each tool.*

tool	**d**	**e**	**f**	**g**	**h**	**a**	**b**	**c**	**f**
Trip	5.9257	5.9527	4.6661	3.2375	3.0941	12.586	11.573	11.123	4.8309
time/s	8.361821	8.399921	6.584386	4.568472	4.366119	17.76024	16.33079	15.69579	6.816937

According to the above table, under the optimal line condition of single drill operation, the total length of various tool operations can be as follows: 62.989e+004 mil. The following is the point of view we have set for each tool (1/100mil), the point of view we have set for each tool as shown in table 3.

Table 3. *The point of view we have set for each tool.*

	d	**e**	**f**	**g**	**h**	**a**	**b**	**c**	**f**
x	-267400	-257400	-222047	-301300	-311300	-202800	-197600	-202800	199800
y	184518	184518	100000	84300	74300	190200	180800	190200	203200

4. Discussion

The distance from the previous table and the distance traveled for the selection of 1.2471e+004mil, plus the distance of advance, shows that the total distance of the route is Shortest_Length= 64.2361e+ 004 (mil) = 16315.97 (mm). The speed of movement of all bits is the same, and the drilling time of all bits of the drill is

12*18=216 (s). Timing: job travel time = shortest distance / bit travel speed =90.64427 (s),

Total operating time = drill travel time + drill conversion time =306.64 (s),

Cost: travel cost = travel time * travel cost =978.9594 (yuan),

Job conversion cost = conversion times * conversion cost =25.2 (yuan),

Total operating cost = travel cost + job transfer cost =1004.159 (yuan),

That is to say, this method will cost 306.64 (s) and cost 1004.159 (yuan) when needed [43-47].

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