Research on key Technologies of 5G Mobile Communication
D2D

Jin Jin\textsuperscript{1,2}, Lipeng Zhao\textsuperscript{1*}, Guoquan Zhang\textsuperscript{3}, Shenguo Zhang\textsuperscript{1} and Kun Jiang\textsuperscript{1}

\textsuperscript{1}School of Electrical Engineering, Northwest Minzu University, Lanzhou, Gansu, 730030, China
\textsuperscript{2} Key Laboratory of China's Ethnic Languages and Information Technology of Ministry of Education, Northwest Minzu University, Lanzhou, Gansu, 730030, China
\textsuperscript{3} School of Mathematics and Computer Science, Northwest Minzu University, Lanzhou, Gansu, 730030, China

\*Corresponding author’s e-mail: Y200130485@stu.xbmu.edu.cn

Abstract. As one of the main technologies of 5G, device-to-device (D2D) technology directly transmits data between mobile terminals in the adjacent area, and there is no need for base station relay equipment to transfer, so as to realize high data rate transmission, improve communication capacity, reduce transmission delay, and make full use of wireless spectrum resources. With the support of D2D technology, cellular wireless communication can be avoided between devices, so that wireless communication can be realized without occupying the bandwidth resources. In this paper, with the support of D2D technology, firstly, the transmission path optimization of D2D technology is realized by artificial swarm algorithm. Secondly, the simulation is carried out by MATLAB software. Finally, the path optimization of D2D communication is realized by simulation, and the test results are compared and analyzed.

1. Introduction
With the rapid development of intelligent terminals and people's demand for high speed when surfing the Internet, the development of 5G key technology has become the object of people's research. The fifth generation mobile communication (5G) system has become the focus of the new generation of communication\cite{1}. In the new 5G technology, device-to-device (D2D) communication realizes high data rate transmission, improves communication capacity, reduces transmission delay, and makes full use of wireless spectrum resources. Therefore, 5G mobile communication D2D technology has attracted extensive attention\cite{2}. D2D in mobile communication transmission technology is the intelligent device directly connected to data transmission of voice, don't have to rely on relay stations for transit, reduce the base pressure, improve the utilization of wireless spectrum, and then implement the direct communication between the devices and equipment, which reduces the cost of the construction of the communication equipment\cite{3}.

2. Research on artificial swarm algorithm of D2D communication system

2.1 Research on transmission path of multi-objective optimization problem.
When seeking the optimal solution of multi-objective optimization function, it can only optimize and find the average value between each objective function. When all the objective functions achieve the
optimal performance, the global optimal solution can be obtained. Therefore, the optimal solution of the multi-objective problem is determined. It is composed of a set, and each solution in the set is part of the optimal solution in the global search, which is defined as the pareto optimal solution set[4-5]. Taking minimizing N targets as an example, the mathematical model of multi-objective optimization problem is expressed as

\[
\min y = f(x) = [f_1(x), f_2(x), \cdots, f_N(x)]
\]

\[s.t. \quad g_i(x) \leq 0, 1, 2, \cdots, p \quad h(x) = 0, i = 1, 2, \cdots, q\]

Where, x is the decision variable, y is the target variable, gi(x) and hi(x) are inequality constraints and equality constraints, respectively.

2.2 In the process of multi-objective optimization, multiple targets need to be searched at the same time, and the whole swarm search direction is guided by the global information. The improved neighborhood search method is shown in formula (2).

\[X_i = X_i + W_1 \cdot \text{rand}(X_i - X_k)\]

(2)

Where, xk is the non-inferior solution randomly selected in the external file, w1 is the scaling factor, and rand() generates a random number between [0,1].

2.3 The flow of multi-objective artificial swarm algorithm is as follows. (1) initialization stage: parameters and population initialization are set in accordance with the pareto optimal solution set dominance principle. All non-inferior solutions are set in the initial population, and all these non-inferior solutions are included in the external file to form the external file set again and finally initialize the external file[4].

(2) bee collecting stage: according to equation (2), when bees are searching in the adjacent area, they are guided by the non-inferior solution in the external file. According to the dominance principle of pareto optimal solution set, the dominance relationship between the newly generated neighborhood solution and the original solution is compared, and the optimal solution is preserved[4].

(3) the corresponding follow-up probability of all solutions is calculated as formula

\[P(i) = \frac{\text{fit}(i)}{\text{FoodNumber}} \sum_{j=1}^{\text{fit}(j)}\]

(3)

(4) observation of bees: according to the following probability, one of the solutions is selected randomly, and equation (2) is used to search between neighborhoods.

(5) scout phase: discard the solution that reaches the Limit number of trials and then randomly generate a new solution.

(6) the external file update: the current population of the optimal solution in the pareto optimal solution set to join the external file collection, when reach maximum external file collection, need to external files for the database to update, the final output external file collection, all that is left in solution and the solution as the final optimization results.

3. Simulation parameter design
The parameters are set as follows: the population number is 30, the number of bees collected and
observed is NP/2, Limit=50, and maxCycle=1000. In the artificial swarm algorithm, each forager and observer corresponds to an optimal path. Find out the current minimum value and corresponding position, carry out algorithm iteration, and finally find out the optimal path that meets the condition, and ensure the shortest length of this path.

FIG. 1 and FIG. 3 are respectively the path graphs before and after optimization, while FIG. 2 is the path graph after optimization. Graphical curves can be seen that using artificial colony algorithm, the path is optimized, with the completion of the iteration, path length can quickly converge to the shortest path length, thus reduce the D2D to the frequency interference between, greatly saves the traditional mobile cellular wireless spectrum resources, reduces the communication time between mobile terminals.

![Figure 1. Path diagram before optimization](image1)

Figure 1 is a simulation diagram of D2D pair communication before optimization. Represents D2D users at different locations. Before optimization, the communication path between D2D users is very complex. In data transmission, D2D users interfere with each other, which greatly reduces the communication quality of D2D users.

![Figure 2. Optimization diagram](image2)

Figure 2 is the optimized graph. After 1000 iterations, D2D users realize path optimization and achieve the shortest communication distance, thus reducing the interference between users in communication. Improve the service quality of D2D users.
Figure 3. Optimized path

Figure 3 path diagram optimized by artificial bee colony algorithm. Compared with FIG. 1, the path is obviously optimized by applying artificial bee colony algorithm.

4. Conclusion
In this paper, the iterative function of artificial swarm algorithm is optimized to find the optimal shortest path under multiple target users. After system modeling, this paper compares artificial swarm algorithm with system-level simulation. The simulation results are evaluated from different transmission paths under the optimization of artificial bee colony algorithm. According to the simulation results, artificial bee colony algorithm has great potential in performance improvement. With the shortage of wireless spectrum resources, D2D technology has more obvious performance advantages and low transmission delay, greatly reducing the transmission time. However, the complexity of this algorithm in practical application is more complex than that of the original algorithm, and there are other uncertainties in the process of multi-objective optimization, so further research is needed to reduce the interference between users.

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