Anycast Routing Algorithm With The chaotic Disturbance

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Abstract. There is a problem of partial convergence in anycast routing based on genetic algorithm, therefore an improved anycast routing algorithm is proposed in this paper. The chaotic disturbance operator is adopted in the improved algorithm. The simulation results show that the proposed algorithm has a faster convergence rate, better ability of global search, and a set of low-cost paths with band constraints. The problem of partial convergence based on genetic algorithm is better solved. By comparing the simulation data, the success rate for finding the optimal solutions is improved, its advantage is more obvious for the larger networks.

Introduction

Anycast is a standard communication model in IPv6. With this model, a host can communicate with the nearest destination host which have the same anycast address and provide the same service. There is a broad prospect for improving load balance and improving network quality of service in the network of this communication model, also it can meet the various requirements for many emerging businesses, such as bandwidth, delay, cost, etc[1-2].

Premature convergence of genetic algorithms is a common difficult problem in practice, also there is a problem of easy-to-converge to part (premature phenomenon) for the anycast routing algorithm based on genetic algorithm. In recent years, the researchers got some research results in view of the problem of premature convergence[3-4].

This article presents an anycast routing algorithm based on chaotic genetic algorithm, which adopt the theory of chaos to make population diversity, and the idea of dissimilarity to judge whether the premature is occurrence, in case of premature, to disturbance populations with chaotic operator, so as to restrain the premature convergence. The simulation results show that the proposed algorithm has a faster convergence rate and better ability of global search. The problem of partial convergence based on genetic algorithm is better solved.

Judge on Premature Convergence

Premature convergence, which exists in practical application of genetic algorithm, is a difficult problem. One of the reasons, resulting in premature convergence, is premature reduction in the diversity of population, leading to genetic algorithms search space extremely limited, which mainly manifests as the fitness of the best individual in population cannot increase, after several iterations the population still cannot find the optimal individual. It was found that when the genetic algorithm is applied to anycast routing algorithm, the individual in the group is easily similar to each other and there is not a mechanism to determine the mediation, so the algorithm stagnation into a local optimal solution, unable to move on, unable to converge to the global minimum point, which in the evolutionary process.

For these reasons, the article adopts the method of dissimilarity, uses the different rate of population as the standard to judge whether the premature is occurrence. The formula for different rate of population is:

$$d_t = \frac{\sum_{i=0}^{N}\sum_{k=0}^{M} f(a_i, b_k)}{(N-1)(M-1)l}$$

Where, ai and bk respectively represent the i-bit gene of a-chain gene and k-bit gene of b-chain gene; f (ai, bk) represent the dissimilarity of two individuals, the function uses XOR; N and M represent the length of chain gene; l represents the total number of individuals in population. The formula indicates, the greater the different rate of population, the better of the diversity of population, when different rate becoming small, the diversity of population decreases.

Chaotic Disturbance

Chaos is a ubiquitous nonlinear phenomenon, which has unique features, such as randomcity, ergodicity, regularity, sensitivity. Chaos seems chaotic, but has a delicate internal structure; seems complex and similar to random, but with inherent regularity.

This paper proposes an anycast routing algorithm with chaotic disturbance, which can effectively solve the premature convergence problem in the group anycast routing. The flow chart of algorithm was shown in figure 1, the algorithm thoughts were described as follows:

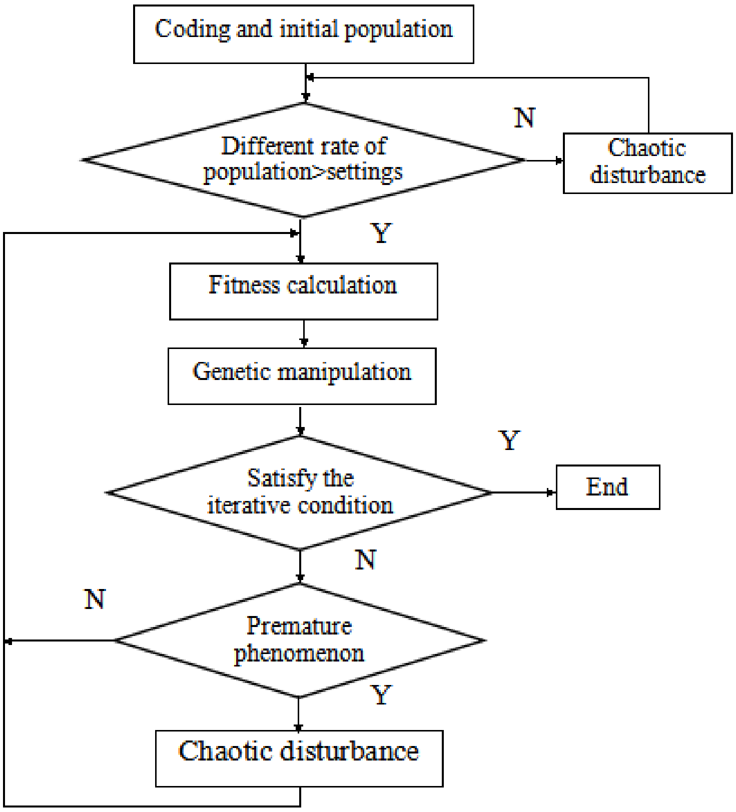

Fig.1. anycast routing algorithm with the chaotic disturbance

(1) Coding mechanism and the initial population

According to the features of anycast routing and the coding principle of genetic algorithm, this paper adopts variable length of the node sequence encoding mechanism, a chromosome represent a path between the source node and the destination node, chromosome codes is made of a set of natural number sequence which represent the nodes in the path.

(2) Improved chaotic disturbance operator

Chaotic disturbance has ergodicity, randomcity, and a wealth of space-time dynamics, so it can be used as an optimization mechanism to avoid falling into local minimum in the search process. Therefore, the introduction of chaotic disturbance operator can increase the population diversity and avoid the lack of genetic diversity. The method used in this paper is as follows:

Let $\delta'_k = (\varepsilon - \alpha)\delta^* + \alpha\delta_k$ Where, δ is a vector which is formed after the current optimal solution (x1*, ..., xr*) mapped to the interval of [0,1] , and called the optimal chaotic vector; δ_k is a chaotic vector after k times iteration; δ'_k is the corresponding chaotic vector of (x1, ..., xr) which adds random disturbance; 0<α<1, α is selected adaptively.

$\alpha = \varepsilon - [\frac{k-\varepsilon}{k}]^m$ Where, m is an integer, determined in accordance with the objective function, k is the genetic population. ε changes gradually with the increase of network nodes. Choose the ε produce disturbance dynamic range can generate chaos perturbation is relatively uniform.

In genetic algorithm, chaotic disturbance operator is perturbed in two cases. First, if the result of the different rate of initial population is greater than the settings, the calculation continues, if it is less than the settings, the chaotic disturbance is carried on; Second, in the evolutionary process, the different rate of new population is calculated, if there is prematurity, the chaotic disturbance is carried on.

(3) The establishment of the fitness function

The fitness function is defined as:

$$fit(path) = e^{f(path)/T} / \sum_{i=1}^{n} e^{f(path)/T} (T = T_0 * (0.99^{g-1}))$$

Where, T represents the g generation's temperature value, $f(path) = \lambda / \cos t(path)$, chromosome fitness value is inversely proportional to the cost of the path, also asked to meet the delay constraint, it has the following settings:

$$\lambda = \begin{cases} 1 & when\ delay(path) < \alpha \\ \tau & when\ delay(path) \geq \alpha \end{cases}$$, τ is between 0 and 1.

When using the roulette method in selection operator the entire population prone to flooding with good individuals which lead to "prematurity" phenomenon.

(4) Genetic Operator

This improved algorithm introduces the concept of the dissimilarity to the cross operator and mutation operator, the specific improvement ideas are as follows: pc (0<pm<1) is the probability to cross; after determining the two parental individuals, find the same nodes of individual first, if there are more than one same nodes, calculates the dissimilarity of the two new chromosome which is crossed from each cross point, and selects the node whose dissimilarity is the largest as final across point.

The mutation probability is pm (0<pm<1), after determining the mutation of chromosomes, randomly selects a gene locus (non-source node) as mutation point, to keep the path between the source node and the mutation node unchanged, the mutation point to the destination node is replaced with a new path. The method to find a new path is: searches several paths randomly start from the mutation points to the destination node, after mutation calculates the dissimilarity of the new chromosome and the original chromosome, selects the largest dissimilarity chromosome as the final new chromosome. The improved mutation operator can increase the diversity of chromosomes, to avoid premature phenomenon.

Simulation Results

Request success rate of the algorithm is defined as the experiment number of finding the optimal solution as a percent of the total number of experiments.

The relevant experimental parameters are: Pc is 0.55; pm is 0.15; Limit is 30; τ is 0.1; Alpha is 0.32; Beta is 0.45. ε is between 1 to 1.6. The request of anycast routing is R=(S, G (A), limit, B), the source node S and the destination node G (A) are selected for random,

Waxman's method is used to generate three random networks G1, G2, G3 that include from 20 to 160 nodes. The parameter references the literature[5], and etc.

Respectively experiment the IARGA and the ARGA, experimental results by comparison of the two algorithms as shown in figure 2.

Analysis of experimental results: the experimental data in figure 2 shows that as the network scale is more and more big, the IARGA performance advantage is more and more obvious. When the network size is 20, the request success rate is 99.6% by using the IARGA which is 4% more than the ARGA. When the network size is 160, the request success rate is 60% by using the IARGA which is 26% more than the ARGA.

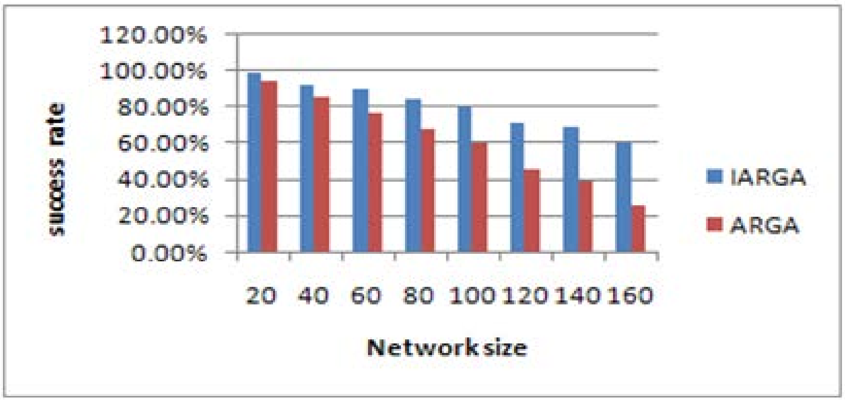

Fig.2 comparison of success rate

Conclusion

To overcome the easy-convergence to part for anycast routing algorithm, a new improved anycast routing algorithm is proposed by adopting the idea of dissimilarity and chaotic theory. Simulation results show that the improved anycast routing algorithm can find the optimal path to meet the delay and bandwidth constraint, and least costly, and has the higher success rate.

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