

The Ad Hoc Network Routing Protocol Research Based on High Stability of the Quantum Algorithm Based on Improved Grover

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Abstract: The traditional GROVER quantum algorithm exists when the target state more than half the total agreement fails, when the number of target state more than a quarter of a large amount of calculation, stability, rapid deterioration. For when the number of target state more than a quarter of the algorithm is not stability problem are analyzed, and puts forward a improved algorithm by combining the DSR routing protocol is proposed. Through simulation found that the number of new GROVER quantum algorithm in the target state more than a quarter, when the amount of calculation and no more than a quarter compared with an increase of just 5 %, while the probability of successful search can reach more than 95 %, the agreement overall stability compared with the traditional GROVER quantum algorithm nearly 50 %. Copyright © 2014 IFSA Publishing, S. L.

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1. Introduction

Quantum theory has been put forward as early as last century, it has the characteristics of high security, and apply it to the algorithm is technology has always been the pursuit of the goal. Now computer is generally operations using binary code, subject to the amount of data carried by binary code. As discussion of fundamental particles in quantum mechanics behavior when uncertainty principle exists, so there will be two or more quantum unit of a superposition state, so it carries information could be far greater than the binary code. And a certain instruction set based on quantum superposition principle [1], far more than the same degree of complex instruction set of binary code. This can be called quantum algorithm. In the application of

quantum algorithms is very primary, the year before launch: quantum cryptography, as a result of the superposition is much higher than the binary complex. So the quantum cryptography is almost unbreakable. For example: a standard 128 year password (similar to the U.S. department of defense password) by exhaustive method to crack need to one thousand years, but the same quantum cryptography requires beyond the age of the universe is almost time to go to crack on defense and confidentiality has important significance [2-3]. There is a way to use two separate distance of quantum entanglement with each other to try to superluminal instantaneous communication we call it a "distance". His role is a call to the sun, the earth, even if the signal is the speed of light transmission, there are eight minutes of delay. A distance function

is almost instantaneous. In the future between human interstellar communications has a great effect. But it is a pity now only complete a single atomic quantum entanglement, quantum entanglement and temporarily unable to use to pass any information.

Due to the quantum theory have the characteristics of such high confidentiality; application in the field of wireless ad-hoc network nature is valued. Mobile ad-hoc network (Mobile Ad Hoc Net Work, MANET), is the product of the development of wireless communication technology. Because the network does not need infrastructure support, and allow the free mobile nodes, the nodes form a self-organization network communication, has a strong resistance to damage [4]. The network is no designated special nodes forward as intermediate nodes, so the network is also known as no infrastructure network. Mobile ad-hoc network (Mobile Ad Hoc Net Work, MANET) routing technology at the core of Mobile ad-hoc network technology has been paid close attention to by scholars both at home and abroad. The research field of mobile ad-hoc network routing technology mainly includes: multiple hops routing protocols, broadcast and multicast protocol, a new type of MAC protocol, network security. For mobile ad-hoc network, scholars put forward different routing algorithm. But the current mobile self-organizing network routing algorithm generally has the following disadvantages: poor convergence of computing nodes, network delay, routing algorithm of computation and storage. So the suitable for mobile ad-hoc network routing algorithm has been a hot research field of Ad Hoc network. Aiming at the defects of Grover algorithm is an improved quantum search algorithm. According to mobile ad-hoc network routing problem, after studying the existing network of Ad Hoc routing algorithm and Grover quantum search algorithm, on the basis of new quantum routing algorithm is proposed. The advantage of the algorithm is using the quantum parallel computing, and overcome the failure problems of Grover search algorithm is more suitable for Ad Hoc network in the network environment.

2. Traditional GROVER Quantum Algorithm

In quantum physics, for the description of the problem can be described using quantum state. For quantum states is Hilbert space. Each of the images of the quantum state can be described as the space of a vector. The Hilbert space, also known as the state vector space, the state vector space by Eigen state is known as the basic quantum state. Any quantum states in the space, can be composed of the basic state of linear superposition. Generally for quantum computing and quantum information

processing, we only need to consider the finite dimensional Hilbert space. How to describe the quantum state and action on the quantum state of transformation is another problem for the application of quantum science, described above each quantum state can be expressed as a vector, a Hilbert space is usually the matrix form of the vector is used to describe the quantum state. In order to more succinctly describe quantum state, introduced is the Dirac notation to describe. Right arrow (Ket) x said column vector, left arrow (Bra) x is right vector x conjugate transpose, is a row vector. For not finishing the database of data search, the complexity of the classical search algorithm is $O(n)$, when the scale huge database, data search is a search for a needle in a haystack. The superiority of using the quantum parallel computing, in the 90 s, scientists in the United States Grover puts forward a new type of quantum search algorithm based on quantum parallel computing feature, the algorithm of size N can be the database data traversal of the complexity of the problem down to $O(\sqrt{N})$. Compared with the classical search algorithm, this algorithm has a square root times faster. Since the beginning of the quantum Grover search algorithm, which has been attracting the attention of scholars both at home and abroad and research, aiming at the shortcomings of quantum Grover algorithm, are asked various improved algorithms, make Grover algorithm to develop a system to meet the demand of different search algorithm.

Nodes in Ad Hoc networks is irregular movement, which makes the unceasing change of network topology, had certain influence on the operation of the MAC protocol. When a pair of nodes is communication, because of the other nodes move into the receiving such intrusion node (the node), may send data or is sending data caused by the conflict; Or are in the communication of two due to the mobile node is beyond the scope of their respective communication. But because the time period relative to the node mobile communication rate is very short, in the process of a transfer theory can usually consider node is relatively static, so as a result of the movement of nodes corresponding problems caused by the often ignored in the theoretical analysis. Single channel access protocol is only a Shared channel, all the control packets and data packets sent and received on the same channel. By hidden terminal, exposed terminal and mobile nodes and time delay, the influence of the network is likely to produce conflict between message, affect the utilization of network resources. Because the data message much longer than the control, the conflict probability of data packet is higher, greater influence on channel utilization. So single channel access protocol's main goal is to minimize or eliminate data packet conflict.

The DSR protocol is put forward for the first time to use the control packet RTS - CTS mechanism to solve the hidden terminal and exposed terminal problems. Listen it draw lessons

from the carrier collision detection (CSMA/CA) mechanism, the main ideas of the protocol is sending node and the receiving node before sending and receiving data packets, to control the message first handshake to notify the receiving node and other nodes within the scope of the sending node, receiving ready to corresponding. Protocol specific process is sending node before sending data packet to send control packets RTS. The receiving node right after receiving the RTS packet responding confirmation message CTS; The sending node right after receiving the CTS control packet to send data packets; Received the RTS and CTS message node can't send any messages into retreat wait state so that the sending node and the receiving node to successful communication. CTS message successfully received node is hidden terminal nodes, will be delayed to send information, but don't have the right to receive the CTS packet node will not delay to send, this part solves the hidden terminal problem. The DSR protocol is mechanisms for conflict resolution in the Binary index retreat (BEB, Binary an Exponential Backoff) algorithm.

Control channel and data channel, so as not to appear the conflict between control packets and data message. Protocol: a typical dual channel BAPU agreement is in the single channel DSRW modified on the basis of channel access protocol. It is RTS - CTS message interaction order - DS - DATA - an ACK. The control messages the RTS and CTS and DS in the control channel transmission. The DATA in the DATA transmission is channel and an ACK. Of course, there is no this agreement can thoroughly solve the problem of hidden terminal and exposed terminal. DBTMA agreement busy mechanism is introduced. In this agreement in addition to the control channel and data channel also added two out-of-bands busy: busy sending and receiving a busy signal. Message interaction is RTS - CTS - DATA sequence. The RTS and CTS on the control channel transmission, DATA transmission on the DATA channel. When nodes to send data at the same time send continuous send busy tone (BTr); when the node is in a state of receiving and sending continue receiving busy tone (BTr). When a node to send data, the first to check whether there is receiving channel busy, if you have that is hidden terminal nodes, delay to send; If not send the RTS listening at the same time on the node in the control channel are busy, if there is a busy signal detected in the meantime, also want to delay sending. When the receiving node received sent to own the RTS, monitoring presence of sending or receiving busy first, if you have that is exposed terminal or hidden terminal nodes, cannot send data; If no busy, reply the CTS and began to send and receive busy tone, received a sending node sending CTS busy tone and sends the data packet on the data channel. DBTMA protocol solves the hidden terminal and exposed terminal problems, but also increase the cost of two busy tone and paid the extra hardware support. Considered as a contains N elements of the database

structure to search the data. For the sake of simplicity, assume that $N = 2$, search problem happens to have M a solution. Each element index can be stored in n bits ($1 < M < n$). For convenience, we can convert search problem to the function of domain of 0 to $N - 1$, for this function, if the input data is the target state, the function value of $f(x) = 1$; If the input data is not to search the target state, the function value is 0.

3. Improved High Stable GROVER Quantum Algorithm

This paper mainly discusses the improved routing protocol algorithm is combined with the DSR algorithm. When to search the database size is large, the number of target state rarely Grover algorithm can very good play to the advantages of its quantum parallel computing, able to quickly search to the target state. But Grover operator is not a perfect algorithm, in some special cases, Grover algorithm will fail, and iterative iteration and direct measurement results are not the same. Grover algorithm has the following defects, including set N is the number of data to search the database, m is the number of the target database solution. According to the relationship between P and j, as you can see, when $m = N/2$, no matter how many times after Grover operation, the final measurement of target state probability is $P = 1/2$, and without iteration, the probability of obtaining the target state directly measuring the same. Grover algorithm fails at this time. When in the $m > N/4$, this time the number of times to higher probability search to the target state, we will continue to increase iteration steps. This will obviously increase the complexity of the algorithm. When the number of iterations is 1, you can find out at this point the probability of successful search with the search failure probability is as follows:

$$P_v = \sin[3 \arcsin \frac{\sqrt{m}}{n}], \quad (1)$$

$$P_f = \cos[3 \arcsin \frac{\sqrt{m}}{n}], \quad (2)$$

The simulation results are shown in Fig. 1, the inverse of m/N , the vertical axis is measured to obtain the probability of search target state.

At present most of the improved algorithm are given Grover algorithm in the success probability of $m/N = 0.5$ search fell rapidly, puts forward the improved algorithm.

At present most of the improved algorithm are given Grover algorithm in the success probability of $m/N = 0.5$ search fell rapidly, puts forward the improved algorithm. The basic idea of the improved algorithm is mostly by changing the initial Grover iterative phase of mobile operator, to construct the

new iteration algorithm to improve search probability of success. Grover algorithm is a kind of a kind of algorithm for large-scale database search.

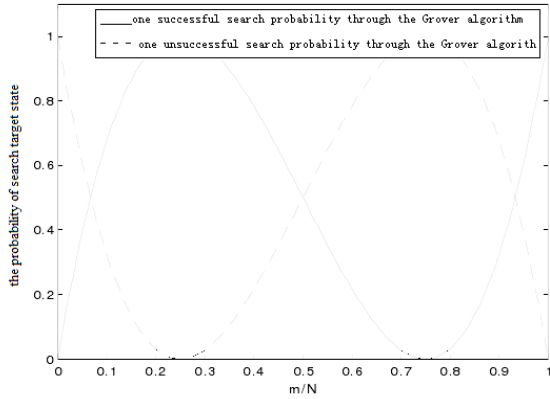


Fig. 1. The probability of Grover search iteration after a change.

Figure 1 shows the variation curve of the traditional algorithm and the new algorithm in the iterative speed on the different. When the database size is large, Grover algorithm calculation also is very considerable. How to further reduce the complexity of the algorithm. This paper proposes a modified algorithm; the algorithm can search success probability in guarantee more than 95 %, the amount of calculation reduced to 1/3 of the original algorithm. Improvement is discussed in this paper are as follows:

Step 1: apply same Walsh Hadamard transform function in 00... 0, state initialization, the system state is divided into two parts of the target state and target state, after defining the normalized state as follows.

$$H(x) = \frac{1}{\sqrt{2}} \sum_{i=0}^{\infty} (xi), \quad (3)$$

Step 2: remember to use (including Grover operator transformation after the transformation of the mode.

$$\langle \phi \rangle = G \langle \alpha \rangle, \quad (4)$$

Step 3: to construct a quantum operator

$$U_s = 2 \langle \phi \rangle - I, \quad (5)$$

Step 4: repeat operator, O U, a total of repetitions for:

$$R = C[\arcsin \frac{\sqrt{m}}{n}] / 6\mu, \quad (6)$$

Step 5 measurements: after the iteration, the probability of target state of maximum, when

measuring the most likely to search the target state. When u in O image of one iteration can be expressed in below figure 2.

When the “m” is less than 0.001, the “R” will bigger than “0.05”.

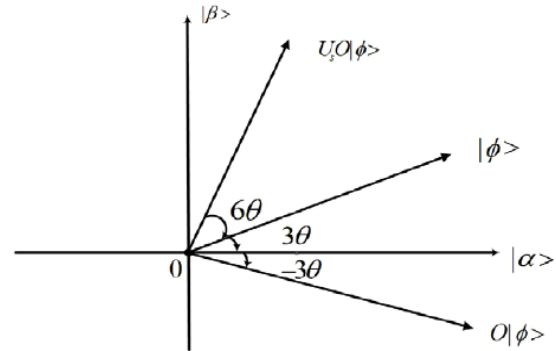


Fig. 2. The improved algorithm of iterative instance.

4. Simulation and Analysis of Routing Protocols

In order to verify the performance of the proposed algorithm in this section, the use of Matlab simulation platform to build network simulation analysis was carried out on the performance of the algorithm. The scope of the network of 25 m - 250 m, 50 random distribution of the nodes, the network of specific performance parameters is as follows: the highest speed per unit time mobile node 2 m, random movement node, the node of the velocity and direction are evenly distributed, the biggest communication distance between nodes is set to 50 m, the initial energy of nodes are equal. Grover algorithm of minimum number of iterations is 32. An improved algorithm based on the application of variable rotation axis, at this time to guarantee the success probability of algorithm on the basis of more than 93 % of the algorithm's calculating amount will decrease the offer for a third of Grover algorithm. The lowest probability is success when Grover algorithm is about 95 %. The modified algorithm and Grover algorithm search success probability is shown in figure 4.

Mobile ad-hoc network routing algorithm based on Grover algorithm is one of the biggest advantage is: through the Grover algorithm can choose good link as a forward link, rather than the forward routing discovery message every link, thereby reducing the amount of forward network node, due to Grover search algorithm made full use of the characteristics of quantum parallel computing, can make the routing algorithm convergence rapidly.

According to different node selection probability, set up network routing computation also each are not identical. For each node selection probability, under the same simulation environment, 1225 route search process, the simulation results are shown in Fig.3-5.

From Fig.3-5 we can see that when the node selection probability of 50 %, this section puts forward the algorithm of calculation only dynamic source routing protocol (Dynamic Source Route) of the half, therefore in this section, the algorithm has higher performance than the DS.

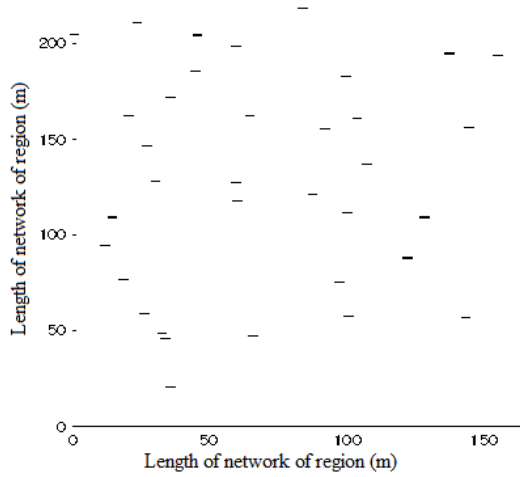


Fig. 3. The node location distribution map

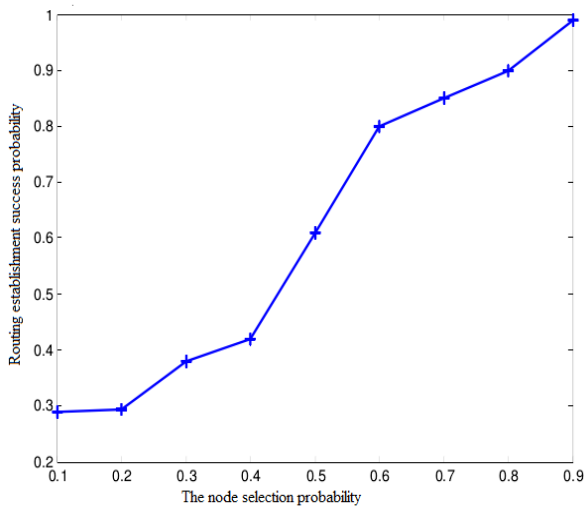


Fig. 4. Two algorithms in different node selection probability calculation ratio.

Comprehensive the above analysis: as the node selection probability increased, the more intermediate node routing forwarding, namely, the greater the amount of calculation of the algorithm, but the route setup success probability also increases. Therefore, a high performance routing algorithm should not only have high routing also should have a lower success rate, amount of calculation is established. In order to investigate the best point of improving the performance of algorithm, we consider the effect of different node selection probability on the network

performance. The simulation results as shown. From the diagram can be found: when the forward rate is set to 40 % of each node algorithm can get the best performance, as shown in the figure 5 below.

The improved algorithm and Grover algorithm presented in this paper has carried on the simulation (database size is 142-8192) shows that the proposed algorithm can significantly reduce the amount of calculation.

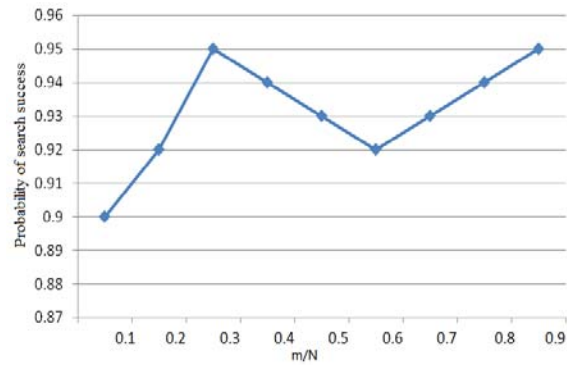


Fig. 5. The new algorithm iteration with the increase of the node to the exhibit.

With the development of multimedia technology, the requirements of mobile ad-hoc network service quality is higher and higher, the research can satisfy the QoS requirements of routing algorithm is very meaningful. This chapter firstly introduces the existing Ad Hoc network QoS routing algorithm, then Grover quantum search algorithm is applied to the Ad Hoc network routing search, and has carried on the simulation analysis to the algorithm, finally discussed the Grover will improved search algorithm is applied to the QoS routing in Ad Hoc network. By the improved algorithm and QoS routing algorithm based on Grover algorithm simulation analysis show that the improved algorithm can than QoS routing algorithm based on Grover algorithm has higher performance.

5. Conclusions

The quantum Grover algorithm has grown into a system to meet the requirements of different search algorithm. This article in to Grover algorithm on the basis of in-depth study put forward an improved Grover search algorithm. Show that this algorithm has better search performance. Mobile ad-hoc network as a product of the development of wireless communication technology, since its birth in the military, industrial and so on various aspects obtained the widespread application. Mobile ad-hoc network because there is no infrastructure, such as the topology of the network variable characteristics, making traditional routing protocols of the Internet will not be able to apply to the mobile ad-hoc

network. Along with the rapid development of quantum information processing technology, many scholars of quantum information processing technology is introduced into the mobile ad-hoc network routing, put forward a lot of routing algorithm based on quantum algorithms such as routing algorithm based on quantum genetic algorithm, based on quantum particle swarm optimization (pso) algorithm, etc. This paper proposes an algorithm based on improved Grover mobile ad-hoc network routing algorithm, with the development of Internet technology, mobile ad-hoc network will get more extensive application, mobile ad-hoc network routing technology will get more extensive attention and in-depth development.

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