Research on algorithm of information transmission path planning in big data environment

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Abstract: The information transmission path planning is conducive to the improvement of efficiency of information transmission, which matches requests of development of era. However, most of the information transmission path plans select transmission paths based on ID format. Although this algorithm can make nodes in big data environment reach the optimal path of sink node, it has high computational complexity. Therefore, an information transmission path planning algorithm based on an ingress-priority under big data environment is proposed. Based on this algorithm, a method for evaluating the information transmission path planning is obtained. Then analysis model of the information transmission path planning is constructed. Based on these, dynamic information transmission path planning is implemented by utilising priority multi-actuators. Experiments show that our proposed method can effectively improve the efficiency of information transmission path planning, ensure the accuracy of information after transmission and improve the quality of information transmission. Therefore, our proposed method is significant in application.

Keywords: big data; information transmission; path planning; internet manufacturing; internet services.

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1 Introduction

With the development of internet technology, data memory capacity is increasing (Yan and Shi, 2016). In big data environment, the accuracy and effectiveness of information transmission is receiving more and more attentions (Cao et al., 2015). Path planning is an important part of network optimisation problems (Liu et al., 2013b; GAO et al., 2014; Hu et al., 2015), which is widely used in the field of logistics and transport, communication engineering, traffic navigation (Pan and Li, 2016; CAI et al., 2016). Due to the complexity of network, the complexity of information transmission is also increased with it (Levchenko and Nemenman, 2014). The traditional information transmission path planning is the information transmission path planning algorithm combining multiple transmission path algorithm (Liu et al., 2013a; Jonsson, et al., 2015; Mancini et al., 2016). This method for information transmission path planning can not guarantee the accuracy of information transmission, and the quality and efficiency of information transmission need to be improved (Kim et al., 2014; Jia et al., 2014). However, this method caused widespread concern of experts and scholars, which has become the focus of the industry research topic (Makki et al., 2016; Le et al., 2015).

Luo et al. (2014) proposed the information transmission path planning algorithm based on service quality. Zou et al. (2014) proposed the information transmission path planning algorithm facing to the communication data. Kwon and Hedman (2015) proposed the information transmission path planning algorithm based on genetic algorithm.

For above problems, this paper proposed an information transmission path planning algorithm based on service quality in big data environment, realising the information transmission path planning in big data environment. First, a multi-transmission path generation based on node potential was proposed. Based on the analysis of existing multi-next-hop transmission algorithms, a multi-transmission-path generation algorithm framework NPMA based on node potentials was proposed (Liu et al., 2015). Combining the shortest transmission path standard with the minimum cost idea, a multi-path generation algorithm under the framework of the algorithm was proposed. Then the assessment of the information transmission path planning method under the data environment was analysed, and the factors that affected the path planning efficiency in the big data environment were analysed, and the analysis model of the information transmission path planning problem was established. After that, the multi-actuators with in-degree priority were used for dynamic information transmission path planning. The establishment of the shortest path tree was done in consideration of energy consumption based on the energy and information sources of the transmission nodes. Considering the maximum delay of the network in the big data environment as a constraint, the heuristic search rule was used as the ingress of the information node to determine the convergence point of the information. Update information convergence points by periodically adjusting the shortest path tree. By solving the shortest travelling salesman problem at the meeting point, a single multiple access transmission path was determined. According to the energy loss characteristic of the information node, the network was divided into load balancing sub-regions to realise the information transmission path planning in the big data environment.

2 Research on information transmission path planning algorithm in big data environment

With the development of computer technology, the way of information transmission is various.

2.1 Algorithm for generating multiple transmission path based on nodal potential

There is a one-to-one relationship between the hard disk and the bus for general computer host, a hard disk is usually connected to a bus. However, there is a many-to-many relationship between hard disks and buses in Big Data environment because hosts and storage are connected through fibre switches or multiple network cards and IP. Therefore, there are multiple path selections from host to storage. If multiple paths are used at the same time or one of the paths is broken, the multiple pathing process is required.

Multi-path generation is the basis and prerequisite for multi-path processing in big data environment analysing existing multi-hop transmission algorithm, multi-transmission path generation algorithm framework NPMA based on node potential is proposed. The algorithm framework indicates that multipath generation is equivalent to converting network graphs to directed acyclic graphs. Besides, the conversion of directed acyclic graphs can be implemented by assigning different potential values to network nodes. Through the combination of the shortest transmission path criterion and the minimum cost, the multipath generation algorithm under algorithm framework is proposed.

2.1.1 Common multi-next-hop transmission generation algorithm

In the multi-next-hop transmission generation algorithm based on acyclic inequality condition, the condition of acyclic inequality can be expressed as equation (1).

$$\begin{cases} FD_j^i(t) \le D_{ji}^k(t) \\ S_j^i(t) = \left\{ k \,\middle|\, D_{ji}^k(t) < FD_j^i(t) \right\} \end{cases} \tag{1}$$

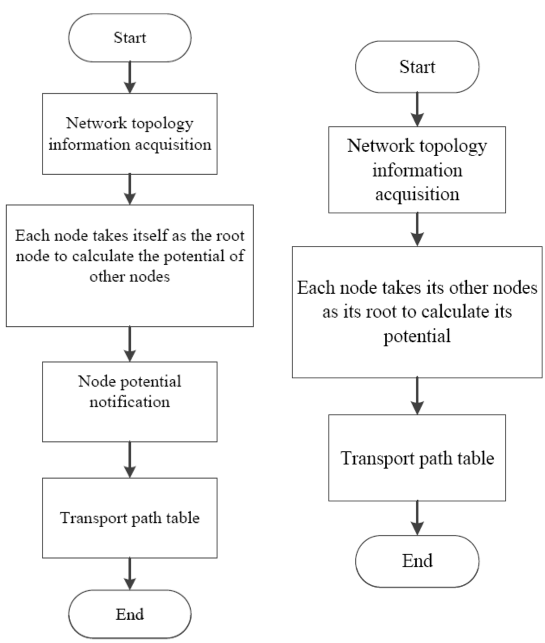
In equation (1), $FD_j^i(t)$ represents the feasible distance from node *i* to node *j*. In the steady state of the network, $FD_j^i(t) = D_j^i$, S_j^i represents the selectable descendant node set of node *i*, D_{ji}^k represents the optimal distance from node *i* to destination node *j*, which is noticed by *k*. *t* represents the time function. From equation (1), we can obtain that node j represents the destination node, and the optimal distance from node i to destination node j which is notified by descendant node k is less than the distance from its adjacent node to the destination node, which notified by node i. So node i selects descendant node k for information transmission. That is to say, for all adjacent nodes of node i, as long as the distance to the destination node is closer to the node i, it can be used as the feasible next-hop of node i, thus forming many feasible paths.

The algorithm of multi-next-hop transmission generation based on acyclic inequality is the multi-next-hop generation algorithm widely used at present. But this method has the high cost in the information transmission path planning, which influences the information transmission path planning. Therefore, this paper uses the multi-next-hop information transmission algorithm based on node potential. The frequently-used multi-next-hop information transmission algorithms based on node potential can be divided into the node potential multi-next-hop information transmission algorithm based on the shortest path expansion and the node potential multi-next-hop information transmission algorithm based on the minimum cost sum. Two algorithms are compared in this paper, so as to complete the information transmission path generation algorithm.

2.1.2 Algorithm for generating multiple transmission paths based on node potential

In the idea of algorithm based on node potential, the implementation process of node potential multi-next-hop transmission algorithm based on shortest-path Expansion is shown in Figure 1.

Figure 1 Implementation process of node potential multi-next-hop transmission algorithm based on shortest-path expansion, (a) centralised implementation of algorithm (b) distributed implementation of algorithm



(a) (b)

As can be seen from Figure 1, in the implementation process of a specific algorithm, a centralised multi-hop transmission algorithm based on the shortest path extension can be adopted. Distributed multi-hop transmission algorithms based on shortest path extensions can also be implemented. The minimum cost and the algorithm is corresponding to the network diagram $G = (V, E)$, firstly we set up an empty set S, and s represents any node in network diagram. $\sum_{s \in S} \cos t(v, s)$ represents the sum of cost of all paths between all nodes in set S and node v, gradually put node v which is not in set S and minimises $\sum_{s \in S} \cos t(v, s)$ into set S. When all the nodes belong to set S, the sequence that the nodes join set S is the demand. We set the destination node is node s which is firstly added to set S, and its potential value is 0, and the sequence that other nodes are added into set S is the potential value of nodes relative to s.

The minimum cost and algorithm have the following properties.

When the set of points satisfies the relational expression $A \subseteq B$, we can obtain equation (2).

$$\sum_{x \in A} \cos t(v, x) \leq \sum_{x \in B} \cos t(v, x) \tag{2}$$

Setting $i = k + 1, k + 2, \ldots, n$, thus equation (3) is obtained.

$$\sum_{x \in V_k} \cos t(v, x) \leq \sum_{x \in V_k} \cos t(v, x) \tag{3}$$

Because v_i is earlier to be selected into the set than v_i, the inequality must holds according to the minimum cost and in the sequence that nodes join the set in algorithm.

2.2 Evaluation of information transmission path planning method in big data environment

In order to improve the efficiency of information transmission path planning in big data environment, several problems need to be researched.

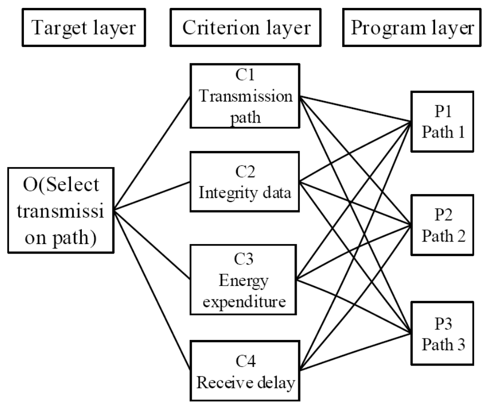
1 The efficiency of the core algorithm. It determines the efficiency of information transmission path planning, which is one of the key factors for realising the efficient path planning.

2 The problem of concurrent computation in multipath transmission. In big data environment, the information transmission path planning is simultaneously received by multiple user requests, and the method of processing requests will definitely influence the efficiency of the information transmission path planning.

3 The problem of information transmission. In big data environment, data sources are multi-directional.

Aiming at the above problems, in order to achieve the transmission path planning information in big data environment, we use the efficient and improved Highway Hierarchical algorithm, and use the distributed processing technology to solve the problem of multi-information transmission in big data environment, and build the distributed system, and use hierarchy analysis method to complete the information transmission path planning. Through the hierarchical analysis of transmission problems of information transmission path, according to the nature of path planning problem and the general objective to be achieved, the problem is decomposed into multiple different component factors. We use relationship among factors to gather and combine factors according to different levels, forming a structure model with multi-level analysis. Finally the path planning problem is divided into the target layer *O*, criterion layer *C* and the program layer *P*, the relationship among elements at each layer is connected by a straight line, and the analysis model of information transmission path planning problem is shown in Figure 2, so as to complete the analysis.

Figure 2 Information transmission path planning problem analysis model



According to Figure 2, for the realisation of information transmission path planning, we use criteria layer path length *C*1, the data integrity *C*2, energy consumption *C*3 and receiving time delay *C*4 to set up relative important judgment factors, by pairwise comparing the importance between elements, we determine the weight value of criterion for target.

For the comparison factor, 1:1 represents the equal importance. 9:1 represents the strong importance, comparing the importance among elements, the values are filled and arranged to form a judgment matrix *A*. Matrix *A* is presented in equation (4).

$$A = \begin{Bmatrix} 1 & 1/2 & 4 & 3 \\ 2 & 1 & 7 & 5 \\ 1/4 & 1/7 & 1 & 1/2 \\ 1/3 & 1/5 & 2 & 1 \end{Bmatrix} \tag{4}$$

We use the ratio of actual data measured by different paths in schematic layer to build so as to complete the analysis of the information transmission path planning under the big data environment.

2.3 Dynamic information transmission path planning of multiple actuators based on in-degree preference

Because the multipath access in information transmission path planning for the use of node energy is unbalanced, this paper proposes a dynamic information transmission path planning strategy based on in-degree preference, so as to optimise the energy utilisation in information transmission.

Multi-information transmission path planning problems mainly include energy optimal path planning for single information transmission and multiple information transmission load balancing. Due to the given information node set and delay constraint, the total energy consumed for information transmission is reduced by finding information transmission paths that do not exceed a specified length and connecting sub-trees of all information nodes. Aiming at the problem of load balancing of information transmission, the energy consumption of each area is load balanced by searching for a strategy for dividing each information transmission network.

In the process of derivation of information transmission node energy model, we use First Order radio model, and set the energy from the transmission *mbit* packet to the distance d as $E_{tx}(m, d)$, $E_{rx}(m)$ represents the energy consumption receiving *mbit* packets, $E_{tx}(m, d)$ and $E_{rx}(m, d)$ can be expressed as equations (5)–(6).

$$E_{tx}(m, d) = \alpha m + \beta m d^{n} \tag{5}$$

$$E_{rx}(m) = \lambda m \tag{6}$$

In equations (5)–(6), α and λ represent the constant of transmitting and receiving electrical equipment, β represents the energy consumption of transmission gain. The energy consumption in this paper represents the energy consumption of information transmission nodes, in other words, it is the total energy $C_{ij}(m)$ consumed by the transport *mbit* packet of node i to node j, the expression of $C_{ij}(m)$ can be obtained by equation (7).

$$C_{ij}(m) = \begin{cases} \alpha m + \beta m_{ij}^{n} & \text{if } j \text{ is multiple path} \\ (\alpha + \lambda)m + \beta m d_{ij}^{n} & \text{others} \end{cases} \tag{7}$$

Assuming the energy for information transmission is enough, without considering the energy consumption in receiving, the information transmission carries on the multi hop forwarding and the data fusion through receiving the data of sub information node, and completes the information transmission. We set the total energy consumed in this process as $i(\omega_i(m))$, among them $\omega_i(m) = \delta_i^{+} \lambda m + \alpha m + \beta m d_{ij}^{n}$, δ_i^{+} indicates the in-degree of node i. From the above discussion, it can be concluded that in order to reduce information loss during information transmission. It is imperative to find suitable confluence points and transmission paths from nodes to confluence points. By reducing the ingress of nodes and the distance of information transmission, the consumption of information transmission energy is reduced.

We set a given set V of information transmission nodes as well as the information transmission path set $K = (1,\dots, k)$, and look for k moving path U, taking the points on U as the root to establish a geometric tree $\{u \in K | \mathrm{T}_i^{u}(V_i^{u}, E_i^{u})\}$, $\bigcup_i V_i^{u} \supseteq V$, make sure the following two points are true.

1 the total energy consumption $f_1 = \sum_{(u,v) \in E_i^{u}} |C_{uv}|$ of information transmission is minimal.

2 make $\sum_{(p,q) \in E_i^{1}} C_{pq} = \sum_{(p,q) \in E_i^{2}} C_{pq} = \cdots = \sum_{(p,q) \in E_i^{k}} C_{pq}$.

For above two objectives, object 1 and object 2 can be expressed as equations (8)–(9).

$$Minimise \quad \sum_{i,j,u \in V} x_{iju} C_{ij} \tag{8}$$

$$\sum_{i,j,u \in V} x_{iju} C_{ij} Z_{u1} = \sum_{p,q,u \in V} x_{pqu} C_{pq} z_{u2} = \cdots = \sum_{m,n,u \in V} x_{mnu} C_{imn} z_{uk} \tag{9}$$

Object 1 can be divided into three sub-problems: convergence point selection, information transmission path problem, and the shortest path selection problem of information transmission when satisfying the constraints. In this paper, the problem is transformed into a certificate optimisation problem, and the specific constraint process is described by equations (10)–(12).

$$\sum_{u \in V} y_{iu} = 1 \quad \forall i \in V \tag{10}$$

$$\sum_{u \in V} y_{iu} \geq I_u \quad \forall u \in V \tag{11}$$

$$y_{iu} \leq I_u \quad \forall i, u \in V \tag{12}$$

Above formulas correspond to sub targets selected by confluence points. Equation (10) shows that any information transmission is only attached to one confluence point. In other words, the information data cannot be transmitted to the two confluence points at the same time. Equation (11) shows that a confluence point can receive multiple information transfer tasks. Equation (12) shows that the root of sub aggregation tree must be composed of confluence points.

$$x_{iju} \leq I_u \quad \forall i, j, u \in V \tag{13}$$

$$x_{iju} \leq 0.5\left(y_{iu} + y_{ju}\right) n_{ij} \quad \forall i, j, u \in V \tag{14}$$

$$\sum_{i,j \in V, i \neq j} x_{iju} = \sum_{i \in V, i \neq u} y_{iu} \quad \forall u \in V \tag{15}$$

Above formulas correspond to sub targets of information transmission path. Equation (13) shows that the information node can only transmit data to an aggregation tree taking rendezvous point as the root. Equation (14) shows that the neighbour nodes in aggregation tree belong to a rendezvous point. Equation (15) shows an equal number and the number of aggregation tree the number of sub nodes attached to the rendezvous point.

$$\sum_{k \in K} z_{uk} \leq I_u \quad \forall u \in V \tag{16}$$

$$\sum_{p \in V} e_{pqk} = z_{qk} \quad \forall q \in V, \forall k \in K \tag{17}$$

$$\sum_{p \in V} e_{pqk} = z_{pk} \quad \forall p \in V, \forall k \in K \tag{18}$$

Above formulas are corresponding to the selection problem of information transmission shortest path, equation (16) shows that each confluence point can only be accessed by a multipath; equations (17)–(18) show that the information transmission passes through a confluence point.

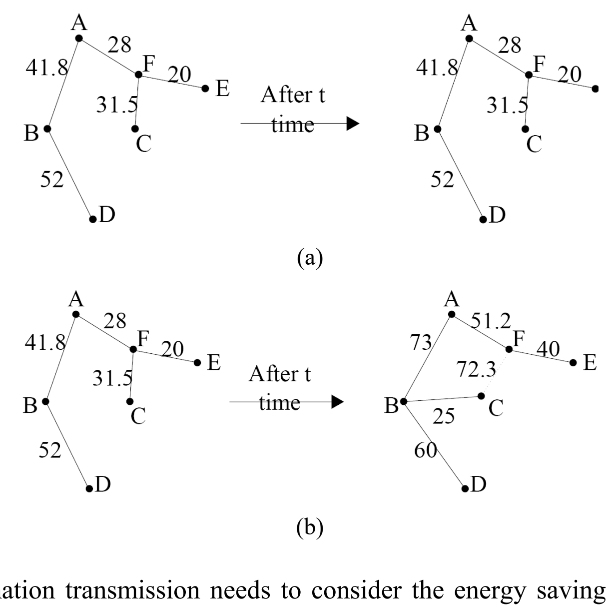
$$\sum_{p,q \in V} l_{pq} e_{pqk} \le c\Delta_{delay} \quad \forall k \in K \tag{19}$$

$$\sum_{i,j,u \in V} x_{iju} C_{ij} \le VE_{\max} \tag{20}$$

Equation (19) shows that the information transmission distance can not exceed the maximum information transmission distance under given time delay. Equation (20) shows that the energy of information transmission node can not exceed the initial value of energy in network.

In each of above constraints, $\{0, 1\} \forall u \in V$ when node u is the convergence point, thus $I_u = 1$, otherwise $I_u = 0$; $y_{iu} = \{0, 1\}\ \forall i, u \in V$ if node i is in that subtree taking u as the root, then $y_{iu} = 1$, otherwise $y_{iu} = 0$, in $n_{ij} = \{0, 1\}\ \forall i, j \in V$, when i and j are adjacent nodes, thus $n_{ij} = 1$, otherwise $n_{ij} = 0$, in $x_{iju} = \{0, 1\}\ \forall i, j, u \in V$, if the data of i passes j and meets at u, then $x_{iju} = 1$, otherwise it is 0. In $e_{pqk} = \{0, 1\}\ \forall p, q \in V, \forall k \in K$, if the (p, q) edge are accessed by sin k k, thus it is 1, otherwise 0; in $z_{uk} = \{0, 1\}\ \forall u \in V, \forall k \in K$, when node u is accessed by sin k k, it is 1, otherwise 0; $l_{pq}\ \forall p, q \in V$ represents the length of (p, q) edge, $C_{ij}\ \forall i, j \in V$ represents the periodic line (i, j) of energy consumption.

Figure 3 Shortest-path tree based on distance and energy-aware, (a) static tree (b) dynamic tree



Because information transmission needs to consider the energy saving and the shortest path, in order to balance these two goals, we need to consider three aspects, including network topology, node routing, and information transmission path. Since the information transmission node is fixed, no packet scheduling factor is considered for any node in the network. Passing a data energy needs to consume the minimum path as the shortest distance between the source node and the information transmission node. In view of the above discussion, this paper proposes an information transmission mobile acquisition scheme based on the dynamic shortest path tree, and dynamically selects information convergence points and information transmission paths. Under the precondition of satisfying the constraint, it is the information transmission load balancing. The shortest-path tree model is shown in Figure 3.

In this paper, the dynamic shortest-path tree is used to build the data gathering tree of network.

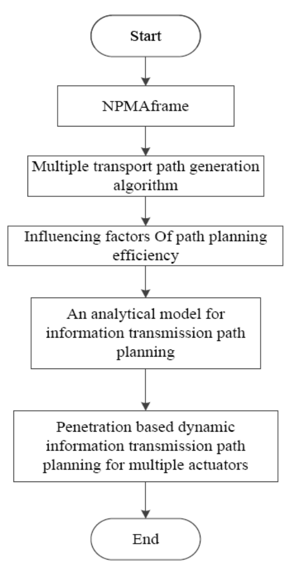
$$C_{ij}^{*} = C_{ij} \big/ \left(r_i \times r_j \right) \tag{21}$$

In equation (21), C_{ij}^{*} represents the dynamic weight of information transmission periodic line (i, j), r_i and r_j represent the ratio of residual energy and initial energy of node i and node j respectively. Form the shortest-path tree built by above formula, we synthetically consider the distance between originating node and destination node and the energy of originating node and destination node, according to static shortest-path tree and dynamic energy sensitive path tree from Figure 3, Figure 3(a) after the establishment of static tree, root nodes will consume more energy, after the death of nodes, other nodes will die in turn; from Figure 3(b), because C_{ij}^{*} will dynamically change according to the residual energy of nodes. After a period of time, the node will rebuild the minimum spanning tree, which balances the network energy load to each node.

As mentioned above, the energy consumption of node is related to the in-degree of node and the distance between the node and its father node. The greater the in-degree of node is, the longer the distance from the father node is, the more likely to die. Therefore, reducing the in-degree and the information transmission distance can decrease the energy consumption of the information transmission node and complete the information transmission path planning.

In conclusion, concrete steps of information transmission path planning algorithm in large data environment proposed in this paper are shown in Figure 4.

Figure 4 Steps of information transmission path planning algorithm proposed in this paper

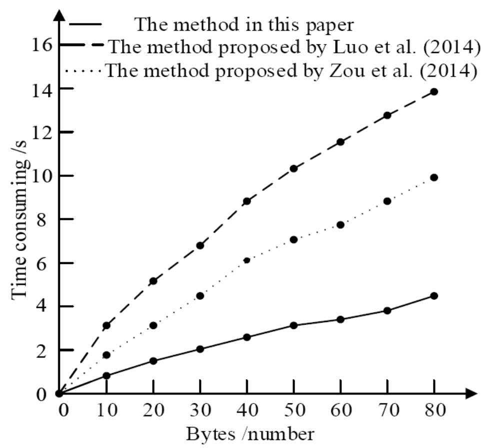


3 Experimental results and analysis

In order to prove the validity and feasibility of information transmission path planning algorithm in big data environment based on in-degree preference proposed in this paper, we need a simulation experiment, which is carried out in Windows 7 Ultimate operating system. CPU is Intel Core I3 with 3.2 Ghz. The operation platform is Microsoft Visual Studio.NET 2010. Besides, information transmission path planning algorithm that our proposed is compared with those algorithms proposed by Luo et al. (2014) and Zou et al. (2014).

With the change of the transmission information in big data environment, the transmission information size is expressed by the number of bytes, the unit is the piece, and comparison of time consumption of three information transmission path planning algorithms are obtained. The comparison results are shown in Figure 5.

Figure 5 Comparison of time consumption of three information transmission path planning algorithms



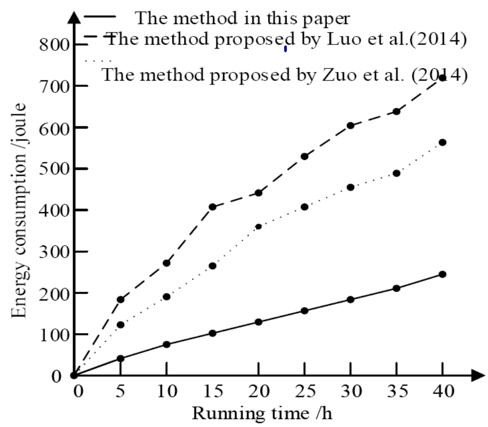
As shown in Figure 5, with the increase of the number of bytes, the information that requires transfer is gradually increasing. With the time consuming of 4 seconds, 80 bytes are transported using our proposed method. While 15 and 20 seconds are transported using the method proposed by Luo et al. (2014) and Zou et al. (2014), respectively. Compared with the information transmission path planning algorithm proposed by Luo et al. (2014) and Zou et al. (2014), the method proposed by us has a less time-consuming increase with the increase of transmission information. Therefore, the method proposed in this paper takes less time for information transmission path planning.

Using information transmission path planning algorithm that our proposed and proposed by Luo et al. (2014) and Zou et al. (2014), the information transmission path in big data is planned. Then, energy consumption (joule) of three path planning algorithms is calculated by equation (22).

$$Q = I^2 Rt \tag{22}$$

In above formula, Q represents the energy consumption (joule) of information transmission path planning algorithm. I represents the electric current of information transmission path planning, and the unit is the ampere; R represents the resistance of conductor, and the unit is ohm; t represents the running time, and the unit is the hour (h). Through this calculation, the comparison of energy consumption of three information transmission path planning algorithms is obtained, and the comparison results are shown in Figure 6.

Figure 6 Comparison of energy consumption of three information transmission path planning algorithms



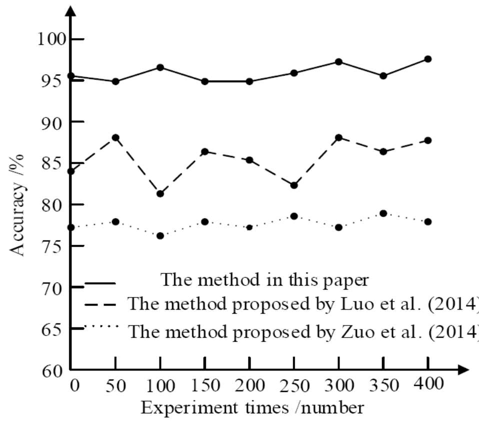
As shown in Figure 6, using our proposed information transmission path planning algorithm, energy consumption is 240 joules in 40h, while energy consumption exceeds 240 joules in 10 h and 15 h using the method proposed by Luo et al. (2014) and Zou et al. (2014), respectively. Besides, energy consumption fold line obtained by our proposed method approximates a straight line, while energy consumption fold line obtained by the method proposed by Luo et al. (2014) and Zou et al. (2014) has a larger range of fluctuations. Therefore, the information transmission path planning algorithm proposed in this paper can effectively reduce the energy consumption of the path planning, and the energy consumption is relatively stable.

Finally, the accuracy of the three information transmission path planning algorithms is compared, and the accuracy (%) is defined to indicate the coherence between the information and the original information after transmission. The calculation method is as follows.

$$\varphi = \frac{\rho}{\theta} \times 100\% \tag{23}$$

In equation (23), φ represents accuracy, ρ represents correctly transmitted information and θ represents the total amount of information transmitted. Accuracy of three information transmission path planning algorithms is calculated, accuracy of the three algorithms is compared. The comparison results are shown in Figure 7.

Figure 7 Comparison of accuracy of three information transmission path planning algorithms



As shown in Figure 7, compared with the information transmission accuracy obtained by the method proposed by Luo et al. (2014) and Zou et al. (2014), accuracy of information transmission obtained by our proposed method is high and accuracy fluctuation is small. Accuracy fluctuation keeps more than 95%. However, accuracy obtained by Luo et al. (2014) is between 80% and 90% and has a larger fluctuation. Accuracy obtained by proposed by Zou et al. (2014) is between 75% and 80% and has a smaller fluctuation while accuracy is low. Which indicates that accuracy of information transmission obtained by our proposed method is relatively stable.

In summary, the information transmission path planning algorithm proposed in this paper can effectively reduce the time and energy consumption of information transmission, improve the accuracy of information transmission, and the quasi-determinacy of information transmission.

4 Conclusions

The information transmission path planning in big data environment is the key problem of network optimisation, which is receiving more and more attention with the development of era. This paper proposes an information transmission path planning algorithm in big data environment based on in-degree preference. Experiments show that the proposed method can effectively improve the efficiency of information transmission path planning, and ensures the accuracy of information after the transmission, and improves the quality of information transmission, which has highly practical value.

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References

Cai, L., Zeng, W. and Wu, H. (2016) 'Design of path planning system based on SAT', *Electronic Design Engineering*, Vol. 24, No. 7, pp.11–12.

Cao, Y., Deng, B. and Zhan, Y. (2015) 'Study on local path planning of RoboCup soccer robot based on fuzzy neural network', *Electronic Design Engineering*, Vol. 23 No. 23, pp.141–144.

Gao, M., Wang, J. and Chen, S. (2014) 'Study on large-scale network topology detection and path performance measurement', *Computer Measurement and Control*, Vol. 22, No. 2, pp.336–338.

Hu, L., Yang, J-f. and Guo, C-c. (2015) 'Study on dual-path concurrent performance in multi-channel wireless Mesh control networks', *Science Technology and Engineering*, Vol. 15, No. 4, pp.150–154.

Jia, B., Liu, S. and Yang, Y. (2014) 'Fractal cross-layer service with integration and interaction in internet of things', *International Journal of Distributed Sensor Networks*, Vol. 10, No. 3, p.760248.

Jonsson, R.H., Martínmartínez, E. and Kempf, A. (2015) 'Information transmission without energy exchange', *Physical Review Letters*, Vol. 114, No. 11, p.110505.

Kim, Y.S., Kim, J.H. and Kim, S.H. (2014) 'A secure information transmission scheme with a secret key based on polar coding', *IEEE Communications Letters*, Vol. 18, No. 6, pp.937–940.

Kwon, J. and Hedman, K.W. (2015) 'Transmission expansion planning model considering conductor thermal dynamics and high temperature low sag conductors', *IET Generation Transmission & Distribution*, Vol. 9, No. 15, pp.2311–2318.

Le, TA., Nguyen, H.X. and Vien, Q.T. (2015) 'Secure information transmission and power transfer in cellular networks', *IEEE Communications Letters*, Vol. 19, No. 9, pp.1532–1535.

Levchenko, A. and Nemenman, I. (2014) 'Cellular noise and information transmission', *Current Opinion in Biotechnology*, Vol. 28, No. 8, pp.156–164.

Liu, M., Liu, S. and Fu, W. (2015) 'Distributional escape time algorithm based on generalized fractal sets in cloud environment', *Chinese Journal of Electronics*, Vol. 24, No. 1, pp.124–127.

Liu, S., Fu, W. and Deng, H. (2013a) 'Distributional fractal creating algorithm in parallel environment', *International Journal of Distributed Sensor Networks*, Vol. 9, No. 9, p.281707.

Liu, S., Fu, W. and Zhao, W. (2013b) 'A novel fusion method by static and moving facial capture', *Mathematical Problems in Engineering*, No. 5, pp.497–504.

Luo, C., Mcclean, S.I. and Parr, G. (2014) 'A communication model to decouple the path planning and connectivity optimization and support cooperative sensing', *IEEE Transactions on Vehicular Technology*, Vol. 63, No. 8, pp.3985–3997.

Makki, B., Svensson, T. and Zorzi, M. (2016) 'Wireless energy and information transmission using feedback: infinite and finite block-length analysis', *IEEE Transactions on Communications*, Vol. 64, No. 12, pp.5304–5318.

Mancini, F., Marsili, M. and Walczak, A.M. (2016) 'Trade-offs in delayed information transmission in biochemical networks', *Journal of Statistical Physics*, Vol. 162, No. 5, pp.1088–1129.

Pan, X. and Li, B. (2016) 'Application of ant colony algorithm optimization and path planning problem', *Bulletin of Science and Technology*, Vol. 32, No. 6, pp.99–103.

Yan, W. and Shi, H-w. (2016) 'Study on multi-channel transmission path planning method for network data', *Computer Simulation*, Vol. 33, No. 8, pp.284–287.

Zou, Q., Zhang, J. and Deng, B. (2014) 'ISO-level tool path planning for free-form surfaces', *Computer-Aided Design*, Vol. 53, No. 5, pp.117–125.