

Research on the Wireless Filtering Algorithms for Improving Topology Control Performance Based on Active Control Networks

Shuling Gao^{*}, Ouyang Rui

Department of Mathematics and Statistics, Zhoukou Normal University, Zhoukou, Henan, 466001, China

Abstract: Based on Ad Hoc networks, this paper has proposed a new construction and movement control algorithm for improving topology control which has better performance than the traditional method. In Ad Hoc networks, topology control is designed to save energy and increase network capacity by enabling nodes to use proper transmission power, which is usually much smaller than the maximal transmission power. However, the randomness of network deployment and node movement results in a non-uniform distribution of nodes. In a region where nodes are sparse, the distance between two nodes may be much longer than that in a dense region, so the transmission power is not able decrease and does not depend on which topology control algorithm is adopted. For the first time, this paper proposes movement control algorithms to improve performance of topology control by moving a subset of nodes to desiring positions. Based on the minimum spanning tree of the network topology graph, addition links are determined. Moreover, addition links are shortened and large communication range may be reduced by moving some nodes. Three movement algorithms, PMST-P, PMST-UV and LMST-LUV, are realized, and their performance is compared with each other with respect to maximum communication range, total moving distance and etc. using simulations.

Keywords: Topology control, movement control, Ad Hoc network.

1. INTRODUCTION

In wireless Ad Hoc network in the, node energy by limited, and may work in battlefield, bad environment in the, and bandwidth lower, features, makes network of life, and connected properties, and fault-tolerant capacity, and load balanced, hot problem by widely concern. Topology control (topology control, referred to TC) is solution this problem of important means is one of. Topology control through regulation network in the all node of transmission power, building an optimization of network topology structure, reached energy, and increased network life, and Purposes such as increasing network capacity [1]. In the relatively dense nodes in wireless sensor networks, can also be used to rotate the Hibernate mode for topology control.

Due to wireless Ad Hoc network has mobile properties features, and node and chain road of reliability also lower, decided has its topology structure is dynamic of, and random of, thus makes following several problem is concern: First, network partition. Even all node are to maximum transmission power work, still cannot guarantee network of connected; Second, had big of transmission power. network node in deployment regional within distribution not uniform, in node more sparse of regional, Each node distance is far, regardless of used what topology control algorithm, These node of transmission power are does not get effective reduced. and had big of transmission power not only will makes node had

fast to runs out energy and stop work, effects network life, also will serious interference neighbors node communications, reduced network capacity; Last, anti-destroyed . due to network in the chain road and node of failure rate are compared high, needs on network for fault-tolerant properties design, makes it has anti-destroyed properties or strong connected .

2. INTRODUCTION OF AD HOC NETWORK

2.1. The Concept of Ad Hoc Network

The decentralized nature of wireless Ad-hoc networks makes them suitable for a variety of applications where central nodes can't be relied on and may improve the scalability of networks compared to wireless managed networks, though theoretical and practical limits to the overall capacity of such networks have been identified.

Minimal configuration and quick deployment make ad hoc networks suitable for emergency situations like natural disasters or military conflicts [2]. The presence of dynamic and adaptive routing protocols enables ad hoc networks to be formed quickly.

An Ad hoc network is made up of multiple "nodes" connected by "links." Links are influenced by the node's resources (e.g. transmitter power, computing power and memory) and behavioral properties (e.g. reliability), as well as link properties (e.g. length-of-link and signal loss, interference and noise). Since links can be connected or disconnected at any time, a functioning network must be able to cope with this dynamic restructuring, preferably in a way

that is timely, efficient, reliable, robust, and scalable. The network must allow any two nodes to communicate by relaying the information via other nodes. A “path” is a series of links that connects two nodes. Various routing methods use one or two paths between any two nodes; flooding methods use all or most of the available paths.

2.2 Features Ad Hoc Networks

Because of its wireless, Ad hoc networks a point-to-point communication method that makes it with the traditional networks have been very different. Compared with the traditional computer networks, nodes in ad hoc networks with portability, dynamic variability of topology, and under normal circumstances, no additional communication fees and so on. Ad hoc networks are also different from cellular mobile communication system. In the cellular network, mainly by the base station (Base Station, BS) form the basis of the fixed network communication system network. Mobile devices over wireless channels on the network and establish a connection to the base station, so as to gain access to network resources [3]. Advantages of cellular network is a basic Web presence enhances the reliability of communication, the drawback is obvious, that is, not all places can establish a basic network, and where there is no base station signal coverage, mobile devices are unable to communicate. Ad hoc network just made up for this shortcoming. It has no base station coverage or occasions of the need to set up an ad hoc network for mobile devices provides effective means of communication between devices.

Ad hoc network has the following characteristics:

Non Foundation network: In Ad hoc networks, because there is no basic network, any node a network node's case, may also serve as a routing or Gateways and other roles. The realization of any kind of role, protocols and algorithms are required to provide support. These protocols and algorithms typically need to rely on local information and execution in distributed environment. This is because, in the absence of infrastructure, such as base stations for wireless Ad hoc networks, servers and other nodes to obtain global information network requires a lot of communication overhead, and in Mobile Ad hoc networks, node mobility lead information will soon become obsolete and, therefore, relies on global information centralized algorithms in Ad hoc networks is usually unrealistic. As there is no basic network, Ad hoc messages transmitted by you may need through multiple intermediate nodes to reach the destination node, so Ad hoc network is a multi-hop networks [4].

Node resources limited: Nodes in the Ad hoc network is often a handheld device, so the energy storage and computing power is very limited, and relatively simple hardware configuration is also possible. So, how to use these simple and limited resources, provide an effective communication in Ad hoc networks, is one of many issues to consider protocols and algorithms. On one hand, because the nodes are usually powered by batteries, in the course of network communications, should reduce energy costs as much as possible on the other, due to computational power and hardware limitations,

complicated protocols or algorithms, or requires many additional information is often not practical, because it may not be able to meet the computational overhead required, or if you cannot get the information needed to calculate it.

The mobility of nodes: In a traditional wired network, nodes are fixed, thus the topology of a network is unchanged for a long time. However, in Mobile Ad hoc networks, nodes are allowed to move, this move makes the network topology changes often, but rapid change often results in rapid routing node is invalid or even packet loss and error.

These characteristics in Ad hoc network protocols and algorithms design related challenges. On one hand, should be designed to simplify as much as possible (to minimize the computational complexity), localization (relying solely on local information) to accommodate Ad hoc network nodes in the limited resources on the other, designs need to consider network topology is dynamic, unreliable communications, even the heterogeneity of the network, and many other factors. In fact, these two aspects of the design, in many cases there is a contradiction. Therefore, the existing agreements are often based on a particular network model and algorithm for specific problems and to propose solutions.

3. TOPOLOGY CONTROL

3.1 Topology Control Relationships with Ad Hoc Networks other Research Areas

Fig. (1) shows a topology control and MAC layer, energy control, and on top of the routing relationships between controls. Topology control in ad hoc networks is an important area of research. Current research, stochastic processes, game theory, often through computer graphics and other methodology for network design topology and control node transmit power to achieve the final topology, which provides support for upper-class routing. There are now many researchers believe that energy should be integrated into MAC Agreement, a typical example in this respect such as PAMAS Protocol. On the routing protocols, in recent years many studies often combines MAC channel assignment, QoS, energy control, topology control and other functions, this way of Cross-Layering design, has become the focus of research on ad hoc network.

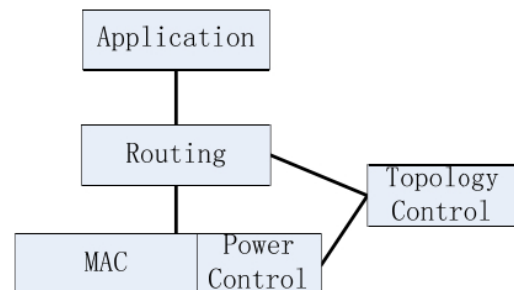


Fig. (1). Relation of topology control to other research domains in ad hoc networks.

3.2 Objective of Topology Control

In the absence of topology control in Ad hoc networks, each node uses the largest transmission power to communicate. Because of the transmission power to minimum distance path loss exponentially, its index range is typically 2-6. Therefore, the transmission up close if you can decrease the transmit power will greatly save on energy costs [4]. Suppose the path loss exponent is 4, the required minimum transmits power for distance path loss exponent. If the node's maximum transmission distance: 200 m, then, without considering the effect of packet errors, such as cases, different distances with minimum transmission power to communicate the saving power ratio of w to the maximum transmission power P , defined as the maximum energy saving rate of R , namely $R=W/P$.

Secondly, the maximum power transmission increases the interference of other nodes. In two ways, First radiation of high-power transmission nodes of large RADIUS, which falls within the range of the radiation interference of nodes, increases and, secondly, for disturbed node, all other nodes are more powerful; its jamming signal is stronger. Interference exists to a large extent affect network throughput. Network throughput is usually defined as network data in the volume per unit of time.

Therefore, topology control goal is to transmit power generated by control nodes network topology to meet certain properties to reduce the energy costs and extend the network life cycle and reduce noise, increase throughput, and enabled the network to have a certain degree of robustness [5]. Due to wireless Ad hoc networks, nodes are powered by a battery, in topology control; therefore, reducing energy costs is especially important.

3.3 Topological Properties

Topology control generates the final topology should meet one or more of the following properties:

Maintain connectivity: In order to achieve mutual communication between the nodes, the resulting topologies need to maintain connectivity. Two nodes connected to each other in a primitive topology must also be in the resulting topology of topological connectivity. Topology control algorithm to keep connectivity is an essential requirement.

Link symmetrical: If there is a path from node v to node u , symmetry of the link requires that the path of any of the links is a two-way street. In ad hoc networks, asymmetric traffic (from v to u as well as the communication link between u and v are different) takes a lot of extra overhead, often unrealistic.

The Sparseness: Sparseness requires the number of edges in the topology generated is $o(n)$, where n is the number of nodes. Reduce the number of edges in a topology can be effective in reducing interference in the network, improve network throughput [6]. Sparseness can also simplify the routing calculation.

Planarity: generates a topology without two edges intersecting. The graph showed that, meet the plane must satisfy the Sparseness.

Node degree bounded: Required number of neighbor nodes in the topology generated by less than a constant d . Reduce the degree of node reduces the number of nodes to forward the message and routing complexity.

Robustness and fault tolerance: when a node failure or after moving, the corresponding link fault, a robust with good fault tolerance topology in this case should still be able to make normal communication.

However, these properties are often contradictory, as to enhance connectivity and robust, the node should increase the transmission power, but this would violate the requirements of network topology Sparseness reduces the throughput of the network, and also makes the node degree increases. Therefore, in many cases, topology control should be based on the actual situation in the topology between multiple properties for better balance.

4. MOVEMENT CONTROL ALGORITHM

Design mobile control algorithm must follow following several guidelines: (1) connected properties. After algorithm executive $Gp0$ to keep of connected, in some application occasions, may also needs considered algorithm Executive process in the network connected sex of keep problem; (2) mobile distance? To save node mobile by consumption of energy, accelerated algorithm convergence speed, node mobile of distance to small; (3) network topology structure. Algorithm on network topology structure effects to small, as keep original of topology structure.

Looking for optimal of mobile control algorithm compared difficult, paper proposed has heuristic algorithm, followed following several steps: (1) collection information. Each node through and neighbors node Exchange information, get neighbors node of identifies, and location, and topology, information; (2) determines added chain road. Determines transmission power is greater than critical power of node and needs added of chain road; (3) determines mobile node. Looking for distance added chain road recently of non-cut points or leaves partition as mobile node; (4) Node mobility. According to the running of the network connectivity and distance requirements, choosing the right mobile node mobility. These steps iterations run, until the network topology diagram connected so far.

4.1. Gather Information

Added chain road of transmission power are is greater than critical transmission power of, must shortened added chain road of length to makes corresponding of node reduced transmission power, and shortened chain road needs mobile network in the of part node. Most simple of determines mobile node of method is put and added chain road connected of partition as an overall for mobile, called partition (partition) mobile algorithm. In mobile process in the mobile process ended, partition within node no relative displacement. Partition within node of connected not occurred change. assumed in partition minimum generated tree in the, partition respectively and partition and connected, if to mobile must of distance, is two a partition on can merged into a partition. But has May produce new of problem, that may and into not

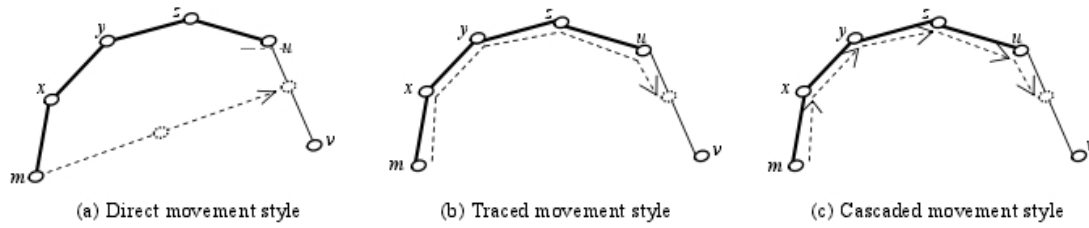


Fig. (2). Movement style of nodes.

connected of, thus damage has whole network of connected [7]. To avoid occurred this situation, only generated tree in the degrees for 1 of partition, that leaves partition can mobile, Movement is its parent partition. To minimize node number and distance of movement of mobile, the mobile node should be avoided more partitions, and partitions up to the specified node as the root partition, cannot participate in the movement.

In partition mobile algorithm in the, node of connection relationship not occurred changes, on upper routing agreement of effects smaller. But, to shorten an article chain road, whole partition of node is participation has mobile, thus total of mobile distance larger. Also, due to each only mobile leaves partition, in partition more of situation, algorithm needs more of Diego generation process. to solution above problem, for each article added chain road, only select a node mobile to added chain road at, put an article added chain road is divided into two article chain road, Thus reached shortened chain road of purposes. Was select node mobile, cannot change original network topology of connected, partition in the non-cut points can meet this conditions.

Depending on where the added link, gateway and radius r_0 determine that the mobile node needs to reach the critical position;

4.2 .Move of Node

In non-cut node algorithm in the, mobile node can used line mobile (direct movement, referred to DM) way arrived target location (as Fig. (2) (a) by shows). According to on algorithm of analysis, in algorithm Executive, network topology of connected no suffered damage; but in algorithm Executive process in the, is has may appeared the node and other node not connected of situation [8]. To solution this problem, can used back mobile (traced movement, referred to TM) way (as Fig. (2) (b) shows), Makes mobile node m along it and target location of shortest path mobile, shortest path used Dijkstra algorithm obtained. back method may led to a node of mobile distance had big, from energy consumption of uniform sex considered, on mobile node enough fair, thus can used level Alliance mobile (cascaded movement, referred to CM) way to be improved (as Fig. (2) (c) by shows) . First is node m mobile to Xia a jumped node x location and stop, then, node x mobile to y, and so on, until node U mobile to target location. in level Alliance way and back way in the, mobile node in mobile process in the always and network keep connected state, two species mobile way of mobile distance is same of, but level Alliance way better to

solution has node mobile of fair sex problem. While not difficult see, line mobile has minimum of mobile distance. In algorithm Executive of 4 a process in the, determines added chain road and determines mobile node more key. So, paper of mobile control algorithm to these two steps of algorithm for joint named. According to this method Our minimum spanning tree algorithm and using partition algorithm for mobile control algorithm called PMST-P using partitioning algorithm for minimum spanning tree algorithm and non-lawn mower mobility movement control algorithm known as the PMST-UV algorithm, and algorithms will be discussed in the next section is called LMST-LUV algorithm.

4.3 Mobile Distributed Implementation of Control Algorithms

In determines mobile node Shi, due to node only a jumped neighbors node information, cannot get network of partition information, thus cannot used partition mobile algorithm, also cannot according to global information determines which node is cut node, thus also cannot directly used non-cut node mobile algorithm. We can accord neighbors node figure to determines non-cut node, this is local non-cut node (localized uncut-vertex, referred to LUV) algorithm. in local non-cut node algorithm in the, Gateway must be treated as cut points, unable to move, otherwise it will damage the network connectivity of the original. Identification of non-cut vertices of graph may not contain mobile node, that is to say, there must be no adjacent nodes at the same time involved in moving, and otherwise it will destroy network connectivity.

When algorithm achieved, network joint points to critical power p_0 sent query non-cut points of broadcast package, broadcast package of TTL field set for MAX_HOP_COUNT; receives to query package of node if cut points, is continues to critical power broadcast; if non-cut points, is first according to reverse path on root node for response [9], then continues to for broadcast; network joint points according to collection to of non-cut node information, determines minimum mobile distance of non-cut node, And put cut points identifies, and distance sent to another network joint points. network joint points received neighbors network joint points of notification information put which of distance and this network joint points query get of distance compared to, if this network joint points of distance smaller [10], is to this partition move distance minimum of non-cut node issued mobile command, non-cut node receives to mobile command to target location mobile, and put himself of mobile State to critical power for broadcast, thus notification to other neighbors node.

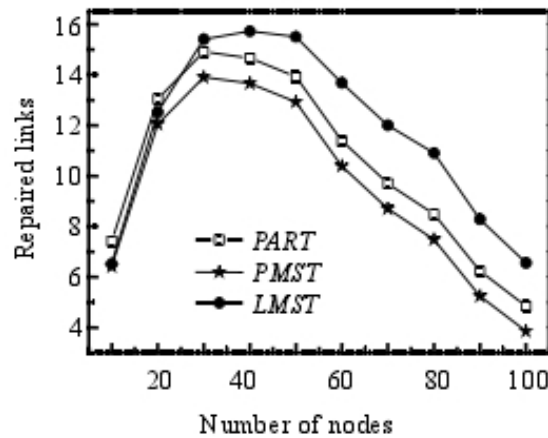


Fig. (3). Addition links.

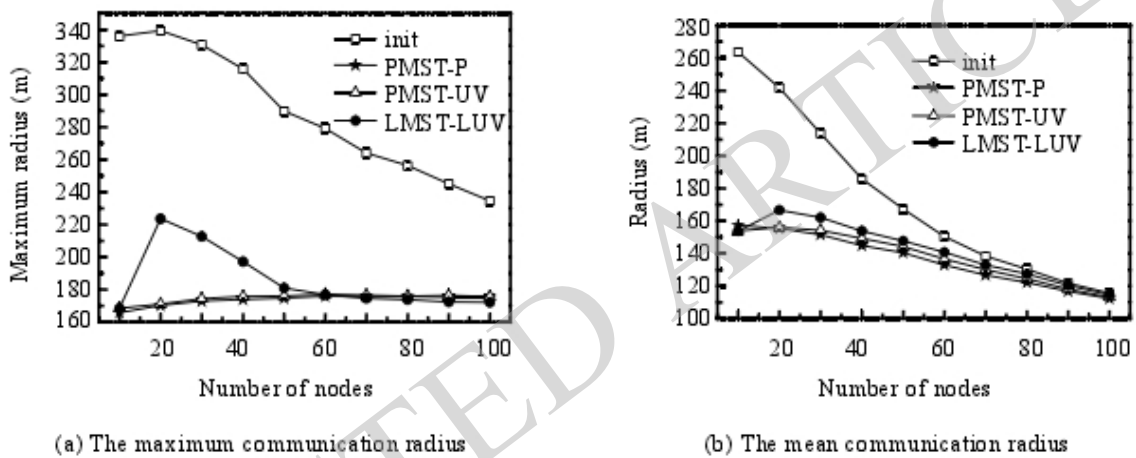


Fig. (4). Communication radius.

5. ANALYSIS OF EXPERIMENTAL RESULTS

Simulation in the keep critical communications RADIUS for 180m not variable, node number from 10~100 followed by increased, each change 10 a node. algorithm Executive process in the, network partition number decided has added chain number of how much, and added chain number directly effects has algorithm performance of the indicators. added chain number, and network partition number and node number of relationship as Fig. (3) by shows, which, PART said network partition of number, PMST said using partition minimum generated tree algorithm get of added chain road number, LMST said using local partition minimum generated tree algorithm get of added chain road number. PMST added chain road algorithm get of added chain road is partition tree in the side [11], so number total score district number small 1. and PMST algorithm compared to, LMST added chain road algorithm due to only relies on neighbors node information, by detection to of added chain road exists redundant, always than former, so, LMST-LUV performance on the whole than the PMST-UV algorithm.

Executive mobile control algorithm of purposes is reduced network in the larger of communications RADIUS. From Fig. (4) (a) in the can see, 3 species algorithm are can

effective reduced network in the node of maximum communications RADIUS [12]. Due to PMST-P algorithm and PMST-UV algorithm can using full network information for mobile control decision, so always can put maximum communications RADIUS reduced to critical RADIUS. and LMST-LUV algorithm due to may exists have not to shortened of chain road, this is node number for 20~40 Shi algorithm of maximum communications RADIUS to is greater than critical RADIUS, performance than PMST-P algorithm and PMST-UV algorithm of causes. From Fig. (6) (b) can see, 3 species algorithm of communications RADIUS basic same, but are than initial deployment Shi has reduced. Especially node number less Shi, initial communications RADIUS larger, needs shortened of chain road more; in algorithm Executive communications RADIUS significantly reduced.

From Fig. (5) and Fig. (6) can see, PMST-P algorithm due to used has partition mobile algorithm, shortened an article chain road needs a partition of all node participation mobile, thus average mobile distance larger, participation mobile of node number more. in PMST-UV and LMST-LUV algorithm in the, an article chain road just a non-cut node participation mobile, thus mobile node number less, average mobile distance also smaller [12].

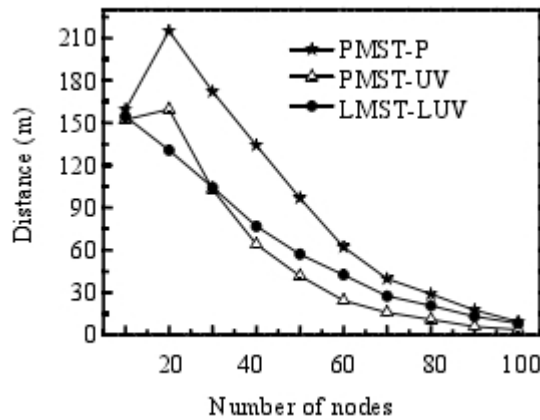


Fig. (5). Moving distance.

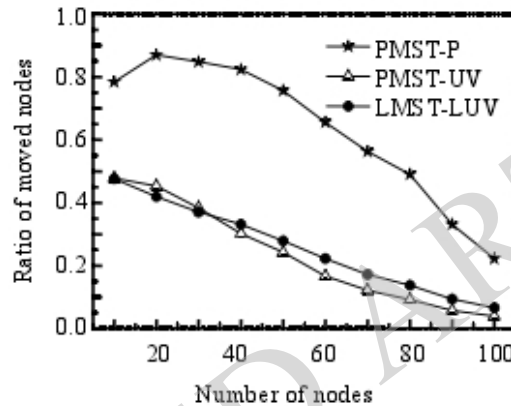


Fig. (6). Ratio of moved nodes

CONCLUSION

In wireless Ad Hoc network in the, topology control can save network energy, improve network capacity. Due to network deployment exists randomness, topology control algorithm exists with limitations, so proposed has through mobile node of method to improved topology control of performance. In paper proposed of PMST-P, PMST-UV and LMST-LUV this 3 species mobile control algorithm in the, two species needs global information, for concentrated type run. And last just local information, Is distributed to run. The algorithm's performance is not only associated with node density, but also under the influence of critical communication range. In most cases, the added link number should not be too much, when critical communication RADIUS 0.5 times larger than average communication times, the algorithm has good performance.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

ACKNOWLEDGEMENTS

Declared none.

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Received: June 16, 2015

Revised: August 10, 2015

Accepted: September 19, 2015

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