Energy-Efficient Management by New Algorithm Based on 2-Hops Neighborhood Information in Wireless Ad hoc Networks

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Abstract— a wireless ad hoc network consists of mobility nodes that are equipped with energy limited batteries. As mobility nodes are battery operated, an important subject in such a network is to minimize the total power transmission for each node. Transmitting a message between two nodes has an associated energy and moreover this energy can depend on the two nodes (the distance between them among other things). Topology control is to determine the transmission power of each node so as to maintain network connectivity and consume the minimum transmission power. Cooperative Communication (CC) is a new technology that allows multiple nodes to simultaneously transmit the same data. It can save transmission power and extend transmission coverage. However, prior research on topology control with CC only focuses on minimizing the transmission power of each node, not that coverage extension of source node with 1-hop neighborhood to reduce total power consumption. This study We propose a novel algorithm that select energy efficient 1-hop neighbor nodes, which assist a victor of source nodes to communicate with a destination nodes to reduce the energy transmission of broadcast application for wireless ad hoc networks. Proposed algorithm can be performed in distributed mode while maintaining the globally efficient paths. The results of the researchers show that proposed algorithm can significantly reduce the total energy consumption for each successfully transmitted packet between 2% to 5%, and prolong the life times of nodes, In addition increase energy efficient transferred in the neighborhood with a 1-hop node, especially in high mobility environments.

Keywords— Wireless Ad hoc networks, Topology Control, energy consumption, Energy-Efficient, distributed algorithm, Minimum spanning tree.

1. INTRODUCTION

Wireless ad hoc network has been receiving growing attention during the lately decade for its various advantages such as instant deployment and reconfiguration capability. In general, a node in a wireless ad hoc network suffers from connectivity instability because of channel quality variation and limited battery life time. Therefore, an efficient algorithm for controlling the communication links among nodes is essential for the construction of a wireless ad hoc network. Recently, the optimization of the energy utilization of wireless nodes has received significant attention [1]. One of the key challenges in the extension of wireless networks is how to prolong the lifetime of the networks [2]. Therefore, energy efficiency is critical for the wide deployment of wireless networks. Different techniques for power management have been proposed at all layers of the network protocol stack. Power saving techniques for ad hoc wireless networks can be broadly classified into two categories [3], [4], and [5]:

- A power saving protocol aims to put wireless nodes into periodical sleep state in order to reduce the power consumption in the idle listening mode.
- Power control for transmission manages energy consumption by adjusting transmission ranges.

In a topology control scheme, communication links among nodes are defined to achieve certain desired properties for connectivity, energy consumption, mobility, network capacity, security, and so on.

In this paper, we propose a novel algorithm with topology control schemes that aim to increase the energy efficiency by 1-hop neighbor nodes and the network connectivity simultaneously. Topology control is one of the key energy saving techniques which have been widely studied and applied in wireless ad hoc networks [6], [7], [8], and [9].

To support peer-to-peer communication in ad hoc wireless networks, the network connectivity must be maintained at any time. This requires that for each node, there must be a route to reach any other node in the network. Such a network is called strongly connected. In order to reduce the energy consumption, we take advantage of a physical layer design that allows combining partial signals containing the same information to obtain the complete data. Topology control lets each wireless node to select certain subset of 1-hop neighbors or adjust its transmission power in order to conserve energy meanwhile maintain network connectivity. As an example of topology control, proposed Minimum Spanning Tree (MST) based topology control algorithms in order to maintain the network connectivity and minimize the number of links [16]. In this paper, proposed a novel algorithm to reduce energy consumption of wireless networks. A novel algorithm to the effective use of partial signals containing the same information to obtain the complete data to reduce the transmission power and extend the transmission coverage As a result packet can be delivered with less transmission power. Proposed algorithm, use 2-hop neighborhood information where each node tries to reduce the overall energy consumption within its 2-hop neighborhood without losing connectivity under the topology model. In addition the algorithm used a 1-hop neighborhood to achieved this important and reduce power level of set of 1-hop neighborhood until all nodes in its 1-hop neighborhood are connected.

This paper is organized as follows: In Section 2, we review related work and various topology control algorithm techniques. In Section 3, we explain the Define the problem network. In section 4, we explain the network model and briefly describe of the process of creating expressed Network. In Section 5, proposed algorithm is investigated. In Section 6 some simulation results are presented.

2. Related Work

Topology control has been addressed previously in literature in various settings. In general, the energy metric to be minimized is the total energy transmission or the maximum energy consumption per node. Sometimes topology control is combined with other objectives, such as to increase the throughput or to meet some specific quality of service (Qos) requirements.

In general, topology control protocols can be classified as [10], [11]:

- Centralized and global versus distributed and localized
- Deterministic versus probabilistic.

Most protocols are deterministic. The work in [14] is concerned with the problem of adjusting the node transmission powers so that the resultant topology is connected or disconnected, while minimizing the maximum power usage per node.

Kirousis and Clementi studied the problem of minimizing the sum power consumption of the nodes in an ad hoc network and showed that this problem is nondeterministic polynomial time (NP) hard. Because the sum power minimization problem is NP hard [12] and [13]. Ramanathan and Rosales-Hain, in proposed two topology control schemes that minimize the maximum transmission power of each node with bi-directional and directional strong connectivity, respectively [16]. When the number of participating nodes is very large, it is definitive to reduce the transmission delay due to multi-hop transmissions. To maintain the total transmission delay within a tolerable limit, Zhang and partners studied delay constrained ad- hoc networks in and Huang proposed a novel topology control scheme in by predicting node movement [23] and [24].

In [12-13], [16], and [23-24], it was assumed that there exists a centralized system controlling nodes so that global information such as node positions and synchronization timing is known by each node in advance. However, such an assumption can be too strong, especially in the case of ad hoc networks. For this reason, a distributed algorithm has been widely considered [17] and [29], where each node has to make its decision based on the information it has collected from nearby neighbor nodes.

Li and partners proposed a distributed topology control scheme in and proved that the distributed topology control scheme preserves the network connectivity compared with a centralized one. Because the topology control schemes in guarantee only one connected neighbor for each node, the network connectivity can be broken even when only a single link is disconnected. Li and Partners devise another distributed and localized algorithm (LMST) for topology control starting from a minimum spanning tree. Each node builds its local MST independently based on the location information of its 1-hop neighbors and only keeps 1-hop nodes within its local MST as neighbors in the final topology [17].

Among probabilistic protocols, the work by Santi and Partners. assumes all nodes operate with the same transmission range. The goal is to determine a uniform minimum transmission range in order to achieve connectivity [18]. They use a probabilistic approach to characterize a transmission range with lower and upper bounds for the probability of connectivity. Some variants of the topology control problem have been also proposed by optimizing other objectives. Hou and Li in [19] present an analytic model to study the relationship between throughput and adjustable transmission range. The work in [19], puts forward a distributed and localized algorithm to achieve a reliable high throughput topology by adjusting node transmission

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power. Cooperative communication (CC) models have been introduced recently in [15], [20-22].

Cardei and Partners first studied the topology control problem under cooperative model (denote by TCC) which aims to obtain a strongly connected topology with minimum total energy consumption. They first showed that this problem is NP-complete and then proposed two algorithms that start from a connected topology assumed to be the output of a traditional (without using CC) topology control algorithm and reduce the energy consumption using CC model. The first algorithm (DTCC) uses 2-hop neighborhood information of each node to reduce the overall energy consumption within its 2-hop neighborhood without hurting the connectivity under CC model. The second algorithm (ITCC) starts from a minimum transmission power, and iteratively increases its power until all nodes within its 1-hop neighborhood are connected under CC model. Observing that the CC technique can also extend the transmission range and thus link disconnected components [20].

Yu applied CC model in topology control to improve the network connectivity as well as reduce transmission power. Their algorithm first constructs all candidates of bidirectional links using CC model to connect different disconnected components, then generates MST structure to further reduce the energy consumption [22].

Hereafter, we differentiate the terms of *energy consumption* and *energy efficiency* over a topology to represent two important but different energy concepts in topology control for wireless networks. *Energy consumption* of a topology is usually the total transmission power of all nodes or links in the topology; while *energy efficiency* of a topology is defined as whether the topology is an energy spanner to support energy efficient routing. Both concepts are important aspects for saving energy in wireless networks (one focuses on maintaining costs, while the other focuses on routing costs). These two concepts are contradicted in topology control. A denser topology usually achieves better energy efficiency but may lead to higher energy consumption.

A wireless ad hoc network can be disconnected due to low node density, power constraint, and node mobility. CC technology enhances connectivity among disconnected networks, but there has been no definitive answer given to topology control research considering coverage expansion with CC. Because of these various advantages, the idea of cooperative communications has been widely considered in recent studies on topology control to maximize capacity [18], improve routing efficiency [18], and mitigate interference from nearby nodes [26-30].

5th Iranian National Conference on Electrical Engineering and Intelligent Systems – Islamic Azad University, Najafabad Branch - 27and 28 February 2019

3. DEFINE THE PROBLEM

First, it is assumed that the method for the expression of said are classified as *amplify-and-forward*, *decode-and-forward*, and *selection relaying*. In the *amplify-and forward* version, a node that receives a noise version of the signal can amplify and relay this noisy version. The receiver then combines the information sent by the sender and relay nodes. In *decode-and-forward* methods, a relay node must first decode the signal and then retransmit the detected data. Sometimes the detection of a relay node is unsuccessful and cooperative communication can detriment the data reception at the receiver. One method is to have a node decide if it relays data based on the signal-to noise ratio (SNR) of the received signal. In *selection relaying*, a node chooses the strategy with the best performance.

The model considered in this paper belongs to the *decode and- forward* category, where a node makes the relaying decision based on the SNR of the signal received. Such a model requires each node to have a memory that can store several packet amounts of data and a signal processor that can estimate the SNR of each received packet [24]. By effectively using partial

Signals, a packet can be delivered with less transmission power.

However, it is assumed that messages are packetized. A packet contains a preamble, a header, and a payload. A preamble is a sequence of predefined uncoded symbols assigned to facilitate timing acquisition, a header contains the error-control coded information sequence about the source/destination address and other control flags, and a payload contains the error-control coded message sequence. it is assumed that the header and the payload of a packet are the outputs of two different channel encoders and that the two channel codes are used by all the nodes in the system. The separation of a header and a payload in channel coding enables a receiver to retrieve the information in a header without decoding the entire packet. The use of the same channel codes enables a receiver to enhance the SNR at the input to the channel decoder by combining the payloads of multiple packets containing the same encrypted message [20].

When the *ith* node transmits a packet data to the *jth* node, The destination node can be associated with the noise signal receive by:

$$\gamma_{ij} = \frac{a_{i,j} E_i}{N_0} \tag{1}$$

Where $a_{i,j}$ is the gain of the wireless link from the *ith* Node to the *jth* node, E_i is the energy of the transmitted signal by the both nodes, and N_0 is the noise density. The gain $a_{i,j}$, includes the effects of propagation loss, antennas and amplifiers, and channel fading and shadowing.

When there are *i* node transmitting packets at the same time, a receiver suffers the degradation in the SNR due to the interference. So the SNR of the packet transmitted by the *ith* node and received by the *jth* node is given by:

$$\gamma_{ij} = \frac{a_{i,j} E_i}{N_0 + \frac{1}{N} \sum_{i'=1, i' \neq i}^{i} a_{i',j} E_r} \quad (2)$$

Where N is called the processing gain, which determines the level of interference suppression.

However, when the processing gain is very large or the scheduling algorithm is designed to avoid the collision of packets, the formula (2) becomes the same as formula (1).

We consider two parameters related with SNR [24]:

- γ_p , which is the threshold needed to successfully decode the packet payload, and
- γ_{acq}, which is the threshold required for a successful time acquisition.

The system is characterized by $\gamma_{acq} < \gamma_p$. The ratio of these two parameters according to the formula (3) Where it is assumed that the threshold required to successfully decode a header, less than or equal to the threshold γ_{acq} .

$$k = \frac{\gamma_{acq}}{\gamma_p} \quad (3)$$

Given the signal to noise ratio, the status of a packet the receiver may be one of the following ways:

- Fully received, if $\gamma_p > \gamma_{ij}$.
- partially received, if $\gamma_{acq} < \gamma_{ij} < \gamma_p$, and
- Unsuccessfully received, if $\gamma_{ij} < \gamma_{acq}$.

Therefore, when a packet is fully or partially received

($\gamma_{acq} \leq \gamma_{ij}$), the header information is successfully decoded.

When the *ith* node transmits a packet, the amount of reception by the *jth* node is quantified by the coverage of the *jth* node defined as $C_{ij}(\frac{\gamma_{ij}}{\gamma_p})$.

Where $C_{ij}(\beta)$ is the coverage function given by:

$$C_{ij}(\beta) = \begin{cases} 1, & \beta > 1 \\ \beta, & k < \beta < 1 \\ 0, & 0 < \beta < k \end{cases} \quad (4)$$

The *jth* node is fully covered by the *ith* node, if the coverage is equal to 1.

A channel gain is often modeled as a power of the distance (power transmission), resulting in

$$\beta = (\frac{r}{d_{ij}})^{\alpha} \quad (5)$$

Where α is a communication medium dependent parameter, r is the communication range of node *i*, and d_{ij} is the Euclidean distance between the nodes *i* and *j*.

For example, consider $k = 0.25$ and $\alpha = 2$ .Let us assume node *i* transmits a packet. For a node *j* with $\beta = 0.6$, the coverage is 0.15 .

4. NETWORK MODEL

section, we evaluate the proposed algorithms for topologies up to 300 nodes. The simulation topology shown in Fig. 2 and Fig.3 is a 400 m × 400 square area (meter) where nodes are randomly deployed in We consider an ad hoc wireless network with n nodes equipped with omnidirectional antennas. The nodes in the network are capable of receiving and combining partial received packets.

We represent the network by a directed graph $G = (V, E)$, where the vertices set V is the set of nodes corresponding to the wireless nodes in the network and the set of edges E corresponds to the communication links between nodes. Between any two nodes *i* and *j*, there will be an link, if the transmission from node *i* is received by the node *j* with a $\gamma_{acq} \leq \gamma_{ij}$. Every node $i \in v$ has an associated transmission power level, $P_t = r^{\alpha}$. Where, r is the distance between the transmitter and the receiver and α is the path loss exponent between 2 and 4, depending on the characteristics of the communication medium.

For each edge $ij \in E$, the coverage provided by node *i* to node *j* is defined as

$$C_{i,j} = \begin{cases} 1 & \frac{P_t}{d_{ij}^{\alpha}} \geq \gamma_p \\ \frac{P_t}{(d_{ij}^{\alpha} \times \gamma_p)} & \gamma_{acq} \leq \frac{P_t}{d_{ij}^{\alpha}} < \gamma_p \\ 0 & \frac{P_t}{d_{ij}^{\alpha}} < \gamma_{acq} \end{cases} \quad (6)$$

We assume that a equals 2 and 4 also $\gamma_p = 1$ which implies that if SNR of a received signal is greater than or equal to 1, then the signal can be successfully decoded. γ_{acq} is taken to be 0 for the rest of the paper because γ_{acq} is practically so small that the partial coverage provided by signals having SNR below γ_{acq} does not contribute much in energy saving.

5th Iranian National Conference on Electrical Engineering and Intelligent Systems – Islamic Azad University, Najafabad Branch - 27and 28 February 2019

5th Iranian National Conference on Electrical Engineering and Intelligent Systems – Islamic Azad University, Najafabad Branch - 27and 28 February 2019

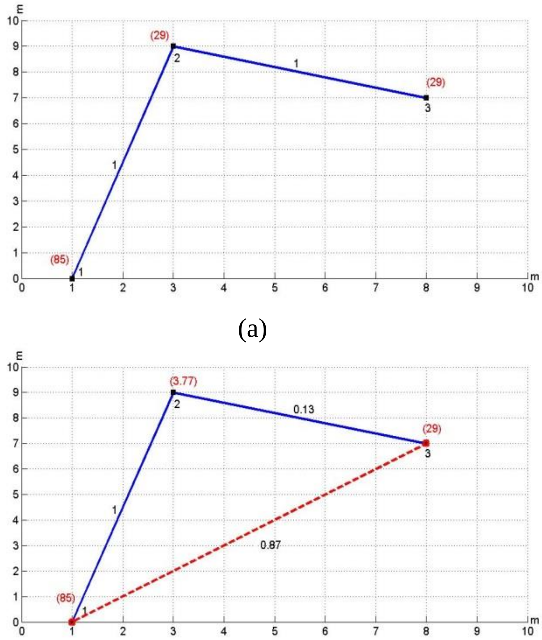
5. THE PROPOSED ALGORITHM ANALYSIS

In this section we have discussed the details of the proposed algorithm performance. At first, in Fig. 1 presents a simple example of proposed algorithm, where $\gamma_{acq} = 0$. It is assumed, that the power required communicating between two nodes to be the square of the distance between them. The number on each edge represents the coverage provided by the source node to the destination node. In Fig. 1a, a minimum spanning tree (MST) is formed among the three nodes, where each bidirectional link corresponds to two unidirectional links. Each node sets its power to reach its furthest neighbor on the MST. For example, node 2 must set its power to $5^2 + 2^2 = 29$ to reach node 3. The topology is strongly connected if, having any node as the source of a message, all the other nodes can get this message directly or by forwarding. In Figs. 1b, communication power of a node can be reduced to partially cover some neighbors as long as several partial messages can be combined for a successful message receipt at those nodes. In Fig. 1b, node 1 has a power of 85 to fully cover node 2 $(9^2 + 4^2 = 85)$ and to 0.87 percent cover node 3 $(85/7^2 + 7^2 = 0.87)$. Since node 2 has received the complete message, it can forward the message to node 3, providing 0.13 percent coverage with the power level set to $29 \times 0.13 = 3.77$. Thus, node 3 get the complete message.

In describing the algorithm, we use the notations in Table 1. Each node independently "locks" its 1-hop neighborhood to perform power adjustment to save energy. The algorithm starts by constructing a Minimum Spanning Tree (MST) for a given network using either Kruskal's algorithm, because of its good performance.

Table 1. Proposed algorithm notations

N	Set of all nodes in the networks
p_i	Transmission power level of node i
$P_{level}(i)$	Set of Transmission power level of node i
$P_{coverage}(i)$	Coverage of node i in percent
$CH(i)$	Set of 1-hop neighbors of node i
$grandCH$	Set of 2-hop neighbors of node i
$g_i(p)$	Gain of node i at power level p
$p^{inital}_{CH(i)}$	Initial power level of node 1-hop neighbor
$p^{reduce}_{CH(i)}$	Reduce power level of node 1-hop neighbor
$d_{i,grandCH(i)}$	Distance between node 1-hop neighbor and 2-hop neighbor



(a)

(b)

Fig.1. A proposed algorithm example. (a) Initial power transmission based on MST. (b) Power trasnmission with (1) as the source.

At each step the algorithm picks a fully covered node say i whose power level has not been determined till then, and decides its power level. While deciding the power level of node *i*, only its child and grandchild nodes are considered.

We assume that each node i has all the distance information within its 2-hop neighborhood and the p_j values of all 1-hop neighbors. Note that this kind of information is usually available after the traditional topology control algorithm completes. Node i maintains p_j values for all its 1-hop neighbors. Whenever p_j for a node *j* changes, node *j* broadcasts this change to its neighbors. The goals of the proposed algorithm, by starting from an initial power level of victor source nodes, are to decide the final power assignment to minimize the total power. Next, we describe the technique used by each node in order to decide its final power level.

The gain $g_i(p)$ of node *i* (source node) is defined as the decrease in the total energy of the broadcast data obtained by reducing the power level of some of the transmitting nodes in the MST, in exchange for the increase in node *i* transmission power level to p. In other words, when the power level of source node increases. it provides partial and full coverage to more nodes in the networks. Then an increase in the partial or full coverage of node 2-hop neighbor may facilitate reduction of the power level of node 1-hop neighbor that can provide less coverage to node 2-hop neighbor.

The reduction in power level of some of the nodes reduces the overall energy consumption of the tree. Gain $g_i(p)$ is given by the following equation:

$$g_i(p) = \sum_{\forall j \in CH(\mathrm{i})} (\mathrm{P}_j^{initial} - P_j^{reduce}) - P_S^{Inc} \quad (7)$$

Where $p_j^{initial}$ is the initial power level of node *j* (1-hop neighbor node) , p_j^{reduce} is the reduced power level of node *j* due to the increase in the power level of node *i* and P_S^{Inc} is the increase in power level of node *i*. In order to calculate, first calculates p_j^{reduce} the coverage provided by source node at power level p to the child nodes of node j (2-hop neighbor).

The coverage provided calculated by the following equation:

$$P_{Coverage}(CH,\mathrm{S}) = \frac{P_{t(CH,\mathrm{S})}}{d_{grandCH,S}^{\alpha}} \quad (8)$$

Where, CH are set node of in the 1-hop neighborhood to the source node, $grandCH$ are set nodes of 2-hop neighborhood to the source node and S is the source node. $P_{Coverage}(CH,\mathrm{S})$ is just a temporary variable required to calculate gain achieved by node i at power level p. After calculating the area Covered, the amount of required energy level reduce by Set of nodes in the 1-hop neighborhood to the source node are calculated by the following equation:

$$P_{CH}(grandCH) = (1 - P_{Coverage}(CH,S)) \times d_{CH,grandCH}^{\alpha} \quad (9)$$

Saying it is important that the proposed algorithm to obtain the reduced level of energy there must first examine the link between the CH and $grandCH$ node, then according to Link to calculate the energy levels reduced.

Because different routes may be created in the network graph of 1-hop neighbor to 2-hop neighbor $P_{Coverage}(CH,\mathrm{S})$ Is selected in such a way that it can according to your energy level packets to the furthest nodes in its collection. Finally p_j^{reduce} is given by:

$$P_{CH}^{reduce} = \max P_{CH}(\mathrm{grandCH}) \quad (10)$$

$P_{CH}^{reduce} \leq 0$ implies that all the child nodes of node 1-hop neighbor of source node are already covered so p_j^{reduce} is made equal to 0.

After calculated p_j^{reduce}, it can calculateby $g_i(p)$ putting the values in Equation (7).

If there is no power level p such that $g_i(p) \leq 0$, then p_i will not change.

Items expressed, summary of the process of reducing the energy level in the proposed algorithm. Using the proposed algorithm can be the reduced amount of energy consumed by existing nodes in the 1-hop neighborhood and then reduced the total power consumption of network. Advantage The proposed algorithm than previous methods using multiple nodes as the source node and change the way the algorithm is applied

6. SIMULATION RESULTS

In this the network. For convenience, we set the path loss factor $\alpha = 2$ and the SNR threshold $\gamma = 1$. The value of $P_{\max}$ is set to 8000 so that the maximum transmission range of a direct link is approximately 89.5. And another state, we assume $P_{\max}$ is equal to $\frac{d^{\alpha}}{5}$, where d is a maximum distance value between two nodes. In the simulation, we consider the following tunable parameters:

- The node density. We change the number of deployed nodes from 40 to 300 to check the effect of node density on the performance.
- Maximum Power threshold. We change the maximum power threshold to check the effected of network topology and percent reduce energy reduction.

Figs. 4 shows two sets of topologies constructed by MST algorithm and proposed algorithm. Figs. 4 show the power consumption of traditional topology and MST algorithm depending on the number of nodes.

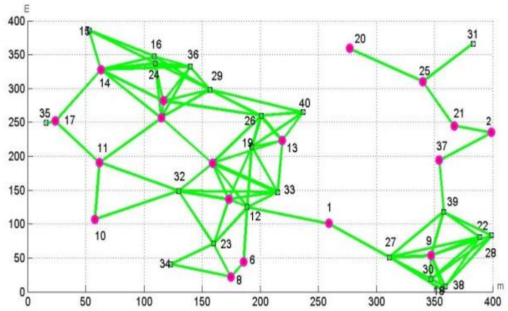
Figs 5 and 6 show reduces power consumption unit MST algorithm compared with proposed algorithm depending on the number of nodes. We observe that the overall power consumption can be at a rate of 5,000 to 6000 units reduced by using the proposed algorithm compared MST algorithm. The smaller γ_{acq}, the better performance because of little impact of power consumption.

Reduce Power consumed unit when $P_{\max} = 8000$ is less than when $P_{\max} = \frac{d^{\alpha}}{5}$. Because of when use the $P_{\max} = \frac{d^{\alpha}}{5}$. Actually uses the maximum range of per node for communicate of other nodes. Then

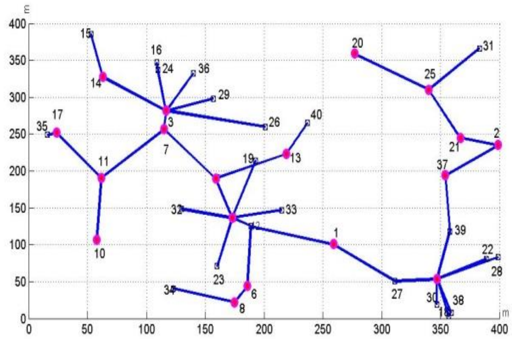
5th Iranian National Conference on Electrical Engineering and Intelligent Systems – Islamic Azad University, Najafabad Branch - 27and 28 February 2019

5th Iranian National Conference on Electrical Engineering and Intelligent Systems – Islamic Azad University, Najafabad Branch - 27and 28 February 2019

this makes leads to more energy as the source node accrues and finally the reduce more and more energy consumption unit compared with $P_{\max} = 8000$. This is an expression of this is important, the proposed algorithm can reduce to an acceptable total energy consumption by networks.in Figs. 2 and 3, source nodes denote with a red circle and a solid.



(a)



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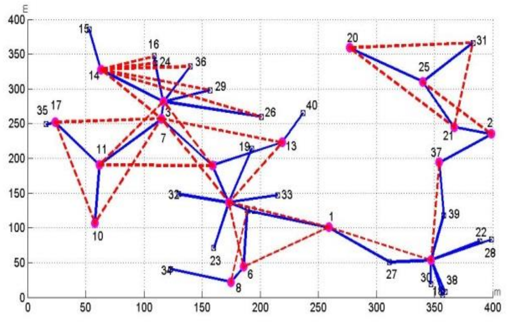
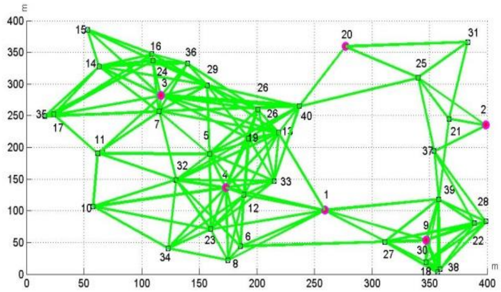


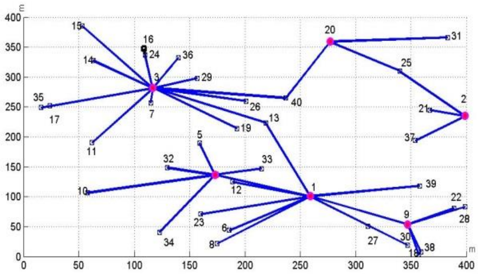
(c)

Fig.2. Topologies generated by different algorithms over the same random network when $P_{\max} = 8000$.
(a) Traditional topology generated that the green lines denote direct transmission in this algorithm.
(b) MST algorithm applied on the traditional topology that blue lines denote the direct transmission.

(c) Proposed algorithm applied on the MST algorithm that red dash lines denote 2-hop transmission.



(a)



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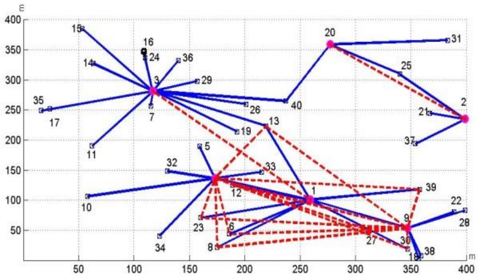
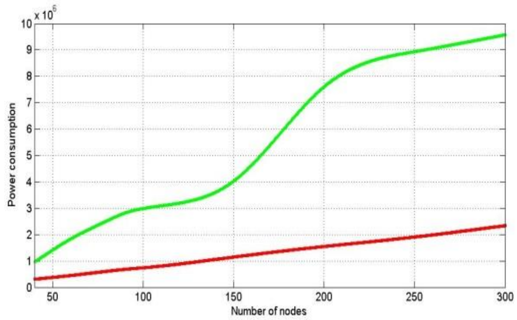


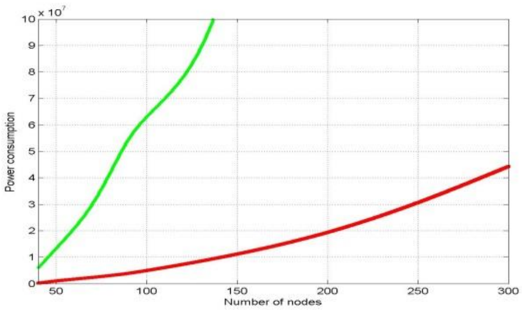
(c)

Fig.3. Topologies generated by different algorithms over the same random network when $P_{\max} = \frac{d^{\alpha}}{5}$.
(a) Traditional topology generated that the green lines denote direct transmission in this algorithm.
(b) MST algorithm applied on the traditional topology that blue lines denote the direct transmission.
(c) Proposed algorithm applied on the MST algorithm that red dash lines denote two-hop transmission.

In Figs.2 and 3, it can be seen when $P_{\max}$ is $\frac{d^{\alpha}}{5}$ the number of source nodes compared with $P_{\max}$ is 8000 reduced and the number of transmission link between every node increases. Because of in state Fig 3 the rate of transmission power for create like greater than the Fig2. Also 2-hop transmission link between source nodes and 2-hop neighbor are



reduced when $P_{\max} = \frac{d^{\alpha}}{5}$ compared with $P_{\max} = 8000$.



(b)

Fig.4. Power consumption by traditional topology and MST Algorithm, denote green line power consumption by traditional topology and red line MST Algorithm. (a) $P_{\max} = 8000$.(b) $P_{\max} = \frac{d^{\alpha}}{5}$.

The node density does not have much effect on the power consumption, especially when there are more than 250 nodes. This is because, when there are more nodes, the average distance between nodes is smaller and so is the average communication power. Therefore, the overall power consumption changes smoothly.

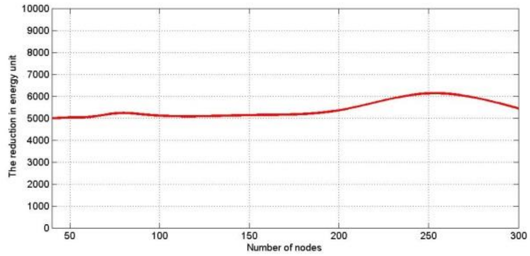


Fig.5. the Reduce Level of Energy Consumption of Proposed Algorithm Compared to MST Algorithm when $P_{\max} = 8000$.

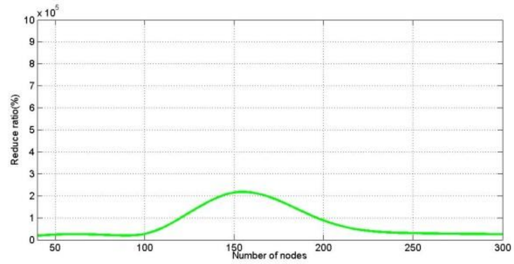


Fig.6. the Reduce Level of Energy Consumption of Proposed Algorithm Compared to MST Algorithm when $P_{\max} = \frac{d^{\alpha}}{5}$.

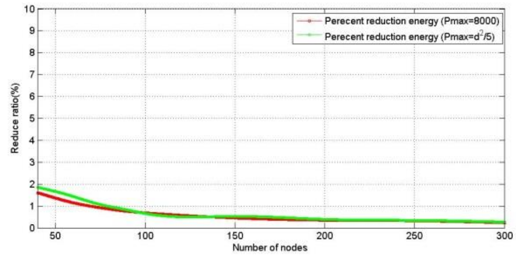


Fig.7. the Percent Energy Consumption of Proposed Algorithm Compared to MST Algorithm.

Fig.7 shows the Percent Energy Consumption of Proposed Algorithm Compared to MST algorithm. We can see the reduction percent of energy changes slightly between two thresholds.

Maximum energy consumption among all the nodes is an important performance metric. It shows whether the energy consumption among all the nodes is balanced or not. Table 2 shows the reduction ratio of MST algorithm and proposed algorithm in $P_{\max} = 8000$ taken over all the nodes in the network. We can see that, the increases number of nodes, the smaller the reduce ratio.

Simulation results can be summarized as follows:

- Using the proposed algorithm reduce the nodes' energy consumption in topology control by 2 percent for different threshold.
- The energy reduction ratio is not sensitive to the parameter γ_{acq} when γ_{acq} is very small.
- The energy savings produced by MST algorithm is comparable with proposed

algorithm producing slightly better result in general.

Table 2. Total Energy Consumption With $P_{\max} = 8000$

Number of nodes	Traditional algorithm	MST algorithm	Proposed algorithm	Reduce ratio (%)
40	765684.8	308059.2	303094.05	1.61
50	1183836.4	374392.8	369206.09	1.38
100	5046855.6	721120.4	716002.242	0.70
150	11157978.4	1148328	1143169.86	0.44
200	19331994.4	1548263.2	1542916.56	0.34
250	30596083.6	1905416.8	1899251.1	0.32
300	44233871.6	2338426	2332987.16	0.23

7. CONCLUSIONS

In this paper we considered the power assignment of nodes in an ad hoc wireless network, with objective of minimizing the total energy transmission while obtaining a strongly connected topology. Power control impacts energy usage in wireless communication with an effect on battery lifetime, which is a limited resource in many wireless applications. We proposed an algorithm be applied to MST algorithm in order to reduce the total power consumption. The first one uses a distributed decision process at each node that makes use of only 2-hop neighborhood information. The second uses the cooperative communication of nodes within a 1-hop neighborhood in order to set nodes transmission ranges. We have analyzed the performance of our algorithms through simulations, Indicates that a good level of progress with respect to reducing the energy consumption of nodes and longevity (life time) networks have reached.

Our proposed algorithm computational workloads on the nodes that have Energy levels appropriate to achieve the packets to the nodes In the 2-hops neighborhood, crossing the nodes on 1-hop Neighborhood, will not. As a result, the proposed algorithm Suggested is suitable for applications where saving Energy consumption is absolutely mandatory.

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