ISSN 2320 – 2602
Volume 3, No.8, August 2014
International Journal of Advances in Computer Science and Technology
Available Online at http://warse.org/pdfs/2014/ijacst02382014.pdf

Gaussian Firefly Algorithm Based Unilateral Wakeup Scheme in Mobile Adhoc Networks

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ABSTRACT

A mobile adhoc network is an infrastructure less network that make possible to the mobile nodes to communicate with each other. But in the mobile adhoc networks, it is very complicated to accomplish energy efficiency and communication cost. In this research, Gaussian Firefly Algorithm Based Unilateral Wakeup Scheme (GFUW) is introduced to improve the energy efficiency. In this method, the best path is selected by utilizing the concept of Gaussian firefly algorithm. The firefly optimization algorithm is used to identify the best transmission range over the networks. The fireflies moves one place to another place in order to estimate nodes and evaluates more transmission range within less time of the interval. After identifying the optimal path, the Unilateral-(Uni-) scheme is applied for the mobile adhoc networks. By using the unilateral wakeup scheme the nodes with slower moving speed to sleep more without losing the network performance. This scheme is used in both entity mobility and group mobility of nodes. The main intent of this research is to enhance the energy efficiency with less computation overhead in the mobile adhoc networks. An experimental result shows that when compared to the existing method, there is high energy efficiency and less computation overhead in the proposed Gaussian Firefly Algorithm Based Unilateral Wakeup Scheme.

Keywords: Mobile adhoc network, unilateral wakeup, group mobility, firefly algorithm

1. INTRODUCTION

A mobile adhoc network is a self-organizing network which permits the mobile nodes to act as a router or host to communicate with each other. This mobile adhoc network is used in various applications such as disaster area monitoring, battlefield, road traffic monitoring, and wildlife conservation. One of the main targets in the mobile adhoc network is to improve the energy efficiency and extend the lifetime of the network. At the physical layer, if the node is not involving in the transmission the transceiver keep in the idle state and also concurrently listens whether there is incoming transmission or not. So, the energy consumed for the listening process [1] [2] is slightly lesser than the communication process. Suppose if there is infrequent transmission there is high amount of energy wastage. So, to overcome this problem the method of asynchronous wakeup is suggested. Instead of idle listening, this asynchronous wakeup method facilitates a station to sleep state to defer the transceiver if there is data transmission.

The advantage of the asynchronous wakeup is that the station can determine when to sleep in a dispersed manner whereas being able to communicate with each other during the awake periods. The time axis of every station is uniformly divided into beacon intervals. During every beacon interval, a station may be in awake or sleep state. By using a wakeup method and selecting an integer value the station acquires a cycle pattern. This cycle pattern indicates an awake/sleep schedule during n continuous beacon intervals. In the mobile adhoc networks it is very challenging to achieve high energy efficiency and reduce the computation complexity.

In this work, the Gaussian firefly algorithm is used to find the optimal path. Commonly, the firefly algorithm depends on the two parameters to find the best results like lightness and attractiveness. But the issue is it does not modify the change time intervals and fixed number of variables .It doesn't store values of best in memory once solution founds it eliminates in memory. So, to overcome this Gaussian firefly algorithm is used to estimate nodes and evaluates more transmission range within less time of the interval from each and every fireflies moves one place to another place of node to another place of nodes in the network. After identifying the optimal path in the network the unilateral wakeup scheme is used that facilitates the nodes with less mobility to save high energy by selecting a higher cycle length unilaterally regardless of its relative speed to the others.

2. PREVIOUS RESEARCH

Chih-Min Chao et.al suggested an adaptive Quorum-Based Energy preserving protocol in the mobile adhoc networks. In this work, for a particular host the possibility of making a tradeoff between the delay and the awake time is considered in which the host wakes up less frequently with a small enlarge in latency, in order to preserve energy. A quorum based protocols is presented which allows the device to sleep in the consecutive beacon intervals in order to extend the battery life of the host. The main idea is to enlarge the sleep duration of the host for improving energy efficiency but there is high delay. So, by using the traffic load of a host the wake up frequency is decided. Balancing the power efficiency and latency is accomplished by using different quorum size.

Wenli Chen et.al presented Ad hoc network management protocol in adhoc networks. This protocol utilizes hierarchical clustering of nodes for diminishing the number of messages exchanged between the manager and the agents. This adhoc network management protocol gives a better solution to the management problem. This protocol develops a flexible security method which is based on simple management protocol. The effectual clustering algorithm is suggested for supporting distributed management. The main feature of this algorithm is to disseminate between node movements inside the cluster and across the cluster boundary. But the drawback of this method is les overhead and high energy consumption.

Bong Jun Choi et.al presented power management method for delay tolerant network. The two asynchronous clock-based sleep scheduling protocols are suggested which is distributed, adaptive and energy efficient. In the multi-hop wireless networks, the asynchronous clock-based sleep scheduling method is developed. After that an adaptive asynchronous sleep scheduling protocol is presented for the delay-tolerant network which facilitates the multiple levels of power saving and also energy efficient under the irregular connectivity for reducing energy consumption.

Inn ER et.al suggested a distributed algorithm called MobDHop which forms stable clusters in a dynamic manner. In this work, a mobility based d-hop clustering method is presented which forms d-hop clusters according to the mobility metric. The mobility pattern of nodes decided the cluster formation in order to improve the stability. In the mobile adhoc the mobile user's movement is observed which is known as group mobility. Consequently, this algorithm attempts to detain group mobility and by using this information to form more stable clusters. In the MobDHop, the non-overlapping two-hop cluster is formed. After that the clusters initiate an integration process among each other if they could snoop to one another through gateways. As a result, MobDHop is considered to form *d*-hop clusters that are more flexible in cluster diameter. MobDHop is uncomplicated and less overhead.

Xiaoyan Hong et.al presented a novel group mobility model-Reference Point Group Mobility (RPGM) for providing the association among the mobile hosts. The main intent of this work is to investigate the impact of the mobility model for the specific network. This model categorizes the mobile hosts into groups based on the logical relationships. When compared to the group models, the random model creates higher rate of change in the network connectivity. Like that, the random and overlap models cause more intermixing. In the mobility models, various routing protocols have various reactions. In the AODV and HSR protocol are limited within the scope of the group. But in the DSDV protocol, there is little sensitivity to group mobility.

Shouwen Lai et.al suggested heterogenous quorum-based asynchronous wakeup scheduling schemes for wireless sensor networks. This method makes sure that the two nodes accept different quorum systems as their wakeup schedules can hear each other at least once in bounded time intervals. The two methods like cyclic quorum system pair (cqs-pair) and grid quorum system pair (gqs-pair) are presented for enhancing the energy efficiency. The cqs-pair includes the two cyclic quorum systems which provide the optimal solution for improving energy efficiency. By using the heterogenous quorum system pair, the nodes can accomplish the good trade-off between energy efficiency and the delay.

P. Basu, N et.al suggested a new mobility metric for the mobile adhoc networks. It is based on the ratio between the received power levels of consecutive transmissions calculated at any node from all its neighboring nodes. By using this mobility metric the cluster is formed which is used for enhancing the scalability of services like routing in the mobile adhoc networks. A weight based clustering algorithm is named as MOBIC which uses the presented mobility metric for creation of clusters that are at most two hops in diameter.

A. Bruce McDonald et.al suggested a new framework for dynamic organizing of the mobile nodes in the adhoc networks. The main purpose of this work is to present the (α, t) cluster framework, which defines an approach for dynamically organizing the topology of an ad hoc network in order to adaptively balance the tradeoff between proactive and demand-based routing by clustering nodes according to node mobility. This can be accomplished by specifying a distributed asynchronous clustering algorithm which maintains clusters which satisfy the (α, t) criteria that there is a probabilistic bound on the mutual availability of paths between all nodes in the cluster over a particular interval of time.

3. UNILATERAL- (UNI-) SCHEME

Energy efficiency is an important consideration in the mobile adhoc networks. In order to provide energy efficiency, the Unilateral- (Uni-) scheme is presented for the mobile adhoc networks which permit the node with slower moving speed to save energy by selecting a longer length unilaterally in spite of of its relative speed to the others. Particularly, the uni-scheme guarantees that two adjacent stations adopting cycle lengths m and n, respectively, can determine each other within O (min (m, n) beacon intervals. It is sufficient for any of these two nodes to choose a small cycle length to make sure the in-time neighbor discovery. By requiring a faster moving station has a shorter cycle length and a slower to have a longer, to demonstrate that the entire nodes in a network can acquire cycle lengths consequent to their individual speed rather than the highest possible relative one. As the normal nodes mobility is slower than the fastest one, this extends the cycle lengths on the majority of nodes, and saves the overall energy consumption. This unilateral scheme is the first wakeup scheme which is capable to provide the O(min(m, n) neighbor discovery delay and allow a network to save energy by taking advantages of the nodes' diverse mobility. Additional the Uni-scheme can be eagerly applied to the environments where either the entity mobility or group mobility. The unilateral method can be extended to make sure that: 1) the nodes are in dissimilar groups usually having high relative speed can discover each other in time; 2) for preserving energy, the nodes in the similar group can pick their cycle lengths corresponding to the highest relative speed within the group rather than that between different groups.

4. GAUSSIAN FIREFLY ALGORITHM BASED UNILATERAL WAKEUP SCHEME

4.1 Gaussian firefly algorithm

The Gaussian firefly algorithm is used to select the optimal path. To identify the best broadcasting nodes, particular location information of the nodes is used to broadcast their information to other nodes with pruning parameter results. For this, local broadcasting schema is considered. The set of vertices is represented by V and the edges are represented by E. If the entire edges in the nodes assures if and only if all $|usv| \leq R$ where |use| measure distance between all nodes by using firefly optimization methods. The Gaussian firefly algorithm is used to compute nodes and estimates the more transmission range within less time of the interval from each and every fireflies moves one place to another place of node to another place of nodes in the network. The step length of the variable is used to adjust the values of the firefly from one node to another node during transmission to identify best transmission range. The another one of the firefly is modify their behavior of each and every nodes in the movement via direct interaction among one node to another nodes on a distribution function that associates to Gaussian function. The nodes in the mobile adhoc network move one place to another place to discover the finest transmission range and also with less communication cost. So, according to this the optimal path is selected.

4.2 Entity mobility wake up scheme

The Gaussian firefly algorithm is used to find the best path. After that, the wake up scheme is applied only on the nodes in the selected path. To improve the network connectivity, the unilateral method permits the nodes with slower moving speed to sleep more.

The two adjacent nodes select the cycle lengths m and n accordingly to form the quorums Q (m) and Q (n). If there is long cycle length there is larger discovery delay. For the positive integer z, each and every cycle length n, $n \geq z$ preferred by a station, a quorum is defined as S (n, z) a subset.

It is adequate for any of the two nodes to decrease $l_{S(m,z),S(n,z)}$ by selecting a small cycle length. The delay can be controlled unilaterally. With this observation H_0 and H_1 can simply have their n_i such that,

$$l_{S(n_i,z),S(n_i,z)} \leq \frac{r-d}{2S_i}$$

The two nodes are represented as H_0 and H_1. The radius of node coverage and discovery zone is represented by r and d. n is a cycle length. To make sure the in-time neighbor discovery as,

$$l_{S(n_0,z),S(n_1,z)} = \min\left(l_{S(n_0,z),S(n_0,z)}, l_{S(n_1,z),S(n_1,z)}\right) \leq \frac{r-d}{2\max(s_0, s_1)} \leq \frac{r-d}{s_0+s_1}$$

In this equation, s_0 and s_1 denoted as the moving speed of H_0 and H_1. n_0 and n_1 signifies the cycle length of H_0 and H_1. According to the individual speed, all the nodes in the network selects the cycle lengths. Most nodes will obtain longer cycle lengths. The overall energy efficiency can be enhanced.

4.3 Architecture Diagram

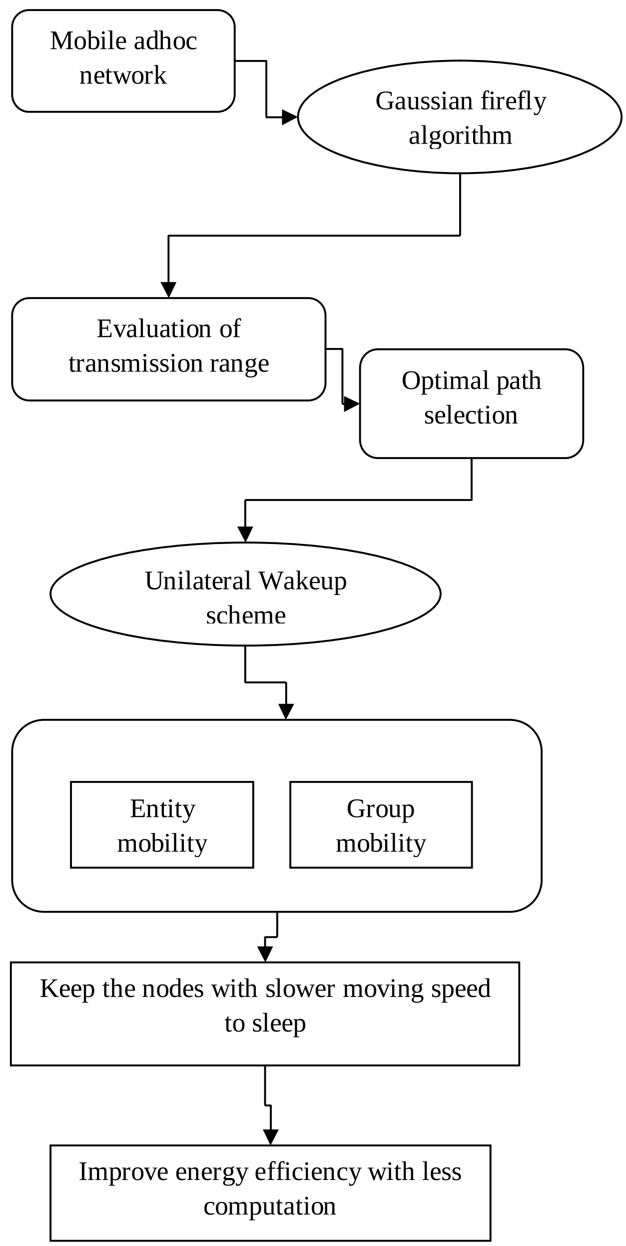

Figure 1 shows Architecture diagram for Gaussian Firefly Algorithm Based Unilateral Wakeup Scheme

4.4 Group mobility wake up scheme

In the mobile adhoc networks, group mobility is one of the well-known characteristics and also it is a main factor for the route establishment, and clustering. The common idea is nodes in the similar group have slow relative speed independent of their absolute speed. This permits the nodes in the group to acquire the cycle length equivalent to the relative speed of nodes within that group, rather than their individual absolute speed, to save energy. In the clustered networks, the wakeup schemes disseminate the quorums between members and cluster heads and facilitate the members to sleep more for improve the network connectivity. Particularly, for a given integer n, a new quorum is defined for the members, a subset of $\{0,1,..n-1\}$ as,

$$A(n) = \{e_0, e_1, \dots e_{p-1}\},$$

Where $e_0 = 0, 0 < e_i - e_{i-1} \leq \lfloor\sqrt{n}\rfloor$ for all $1 \leq i \leq p-1$ and$p = \lceil n/\sqrt{n}\rceil$. The advantage of A (n) is that its size is less than half of that of the quorums on cluster heads/relays. Once the cluster is formed, a member can be informed of the cycle length n decided by its cluster head and adopt A (n).

$$l_{S(n,z),A(n)} \leq \frac{r-d}{S_{rel}}$$

Where S_{rel} denotes the highest relative speed between the clusterhead and members. The npdes moving in the similar group normally have slow relative speed independent of their absolute speed. The clusterhead decides the cycle lengths and the members can be constantly long in spite of of the mobility of their cluster. While members are the majority of nodes in a network, the overall saving in energy consumption can be improved.

4.5 Algorithm

Gaussian Firefly Algorithm Based Unilateral Wakeup algorithm

1. Define objective function to broadcast nodes $f(u) = (u_1, u_2, \dots u_d)^T$
2. Initialize a population of number of nodes in the graph as fireflies $u = (u_1, u_2, \dots u_n)$
3. Define light absorption coefficient γ is transmission range
4. While $(t < MaxGeneration)$
5. For $i = 1{:}n$ (all n fireflies)
6. For $j = 1{:}i$
7. Light intensity is determined by $f(u_i)$
8. If $(I_i > I_j)$
9. Move nodes i towards j in all d dimensions
10. Else
11. Move nodes firefly i towards best solution in that iteration
12. End if
13. Attractiveness varies with distance via transmission range
14. Created a local list $list_n(m)$
15. End for j
16. End for i
17. Rank the nodes and find the current best transmission range with less communication cost
18. Define normal distribution
19. For $k = 1 \dots n$ all n fireflies
20. Draw a random number from defined distribution and apply Eq. (3).
21. Evaluate new solution$(new_cost(k))$
22. If $((new\_cost(k) < cost(i)) \&\& (new\_cost(k) < last\_cost\_iteration(k)))$
23. Move firefly i towards current best
24. Else
25. Repeat steps 4 to 14 again
26. End if
27. End for k
28. End while
29. Select the optimal path
30. //Apply unilateral scheme in the optimal path
31. // Entity mobility
32. Based on the cycle lengths the quorum set is defined
33. Define a quorum set $S(n, z)$
34. Choose the node with smaller $l_{S(n_i,z),S(n_i,z)} \leq \frac{r-d}{2S_i}$ // where and d represents the radiuses of node coverage and discovery zone. n is a cycle length.
35. Choose the cycle lengths based on their individual speed
36. // Group mobility
37. Clusters are formed in the network
38. Choose the node with smaller $l_{S(n,z),A(n)} \leq \frac{r-d}{S_{rel}}$// S_{rel} is the highest relative speed between the clusterhead and members.
39. Put is sleep mode

5. EXPERIMENTAL RESULTS

The performance is evaluated for the proposed system. The optimal path selection is achieved by Gaussian firefly optimization algorithm. After that the Unilateral Wakeup scheme is applied in the nodes which are in the optimal path. The performance is evaluated for the existing and proposed system by both the theoretical analysis and simulation.

5.1 Energy Consumption

Energy consumption is defined as the energy consumed for the processing. Figure 2. Shows that the energy consumption of existing local broadcasting method and the proposed local broadcasting with firefly algorithm. This graph shows that the proposed local broadcasting with firefly algorithm has less energy consumption.

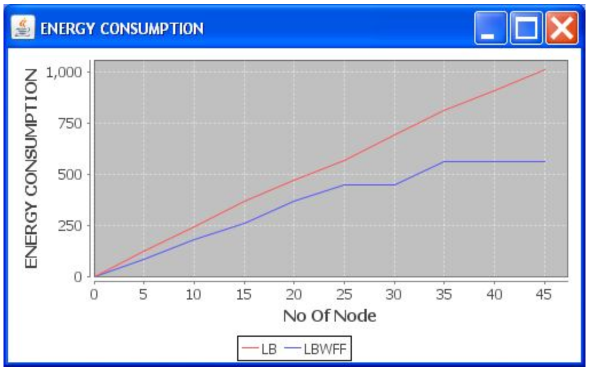

Figure 2 shows Energy consumption

5.2 Packet delivery ratio

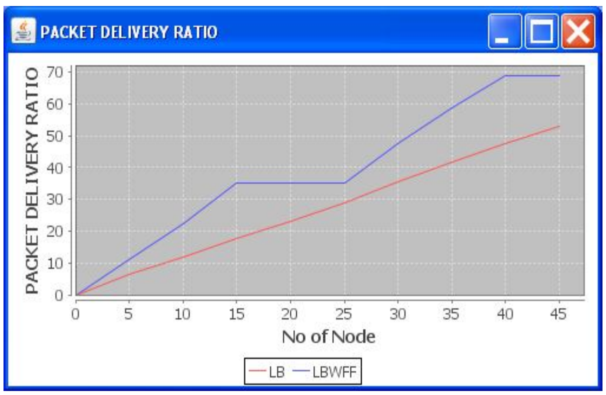

Figure 3 shows Packet delivery ratio

Packet delivery ratio is defined as the ratio of the number of delivered data packet to the destination. Figure 3. Shows that packet delivery ratio of existing local broadcasting method and the proposed local broadcasting with firefly algorithm. This shows that the proposed method has high packet delivery ratio when compared to the existing method.

6. CONCLUSION

Energy efficiency is an important concept to improve the performance in the mobile adhoc networks. In this work, Gaussian Firefly Algorithm Based Unilateral Wakeup Scheme (GFUW) is introduced. In this method, firstly by using the Gaussian Firefly Algorithm the best path is identified. In the Gaussian firefly algorithm the fireflies moves one place to another in order to find the best transmission range within less time of the interval. So, there is high energy efficiency and less

. For future work, to implement the Uni-scheme-based wakeup protocols on real sensors in the future.

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