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Research Article

A Power Efficient Clustering Routing in Wireless Sensor Networks through MIN-MAX Approach

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Abstract: The aim of this study is tobecome aware of the overall performance challenges regarding to Wireless Sensor Networks then analyzes their influenceof the overall performance concerning routing protocols. A several clustering routing methods exist for data gathering of wide applications for WSNs. Sensors bring out useful data onto the surroundings; this data has to be routed through various intermediary motes to arrive at the destination. That data may essentially, reaches the destination is one of the prime functions of sensor networks. This study proposes, A Power Efficient Clustering Routing Protocol for WSNs, which conserves energy using MIN-MAX approached for cluster head selection. Clustering produces enough space for extending the lifetime of a sensor networks. The research seeks to compare with the well-known routing protocols namely: LEACH, PEGASIS and TEEN. Simulation results shows proposed protocol APECRP gives better results than the existing clustering routing protocols.

Keywords: Clustering, energy, lifetime, medium access protocol, power efficient, routing metrics

INTRODUCTION

Wireless Sensor Networks (WSNs), Akkaya and Younis (2005) comprise a several motes with ability of sensing, computation and wireless transmission. The motes hearing data, or collect statistics about the happening near that mote, then the motes circulate data to other motes or Base Station (BS), if required then motes can accept data from other motes. This way the motes form a network and communicate with each other in the network. A significant number of motes permit for sensing over big geographical regions with good precision. Use of WSN needs a basic knowledge of methods of joining and managing motes with a communication network of extensible and resource-powerful ways. The most difficult problem with sensor networks is limited rechargeable energy source. Alongside energy constraints, scalability, fault tolerance, hardware constraints etc., are problems that produce challenges to enhance performances of WSNs by Stankovic (2004). A new protocol developed for enhancing performance of WSN, faces many difficulties. Therefore, developing a protocol for WSNs, these problems have to be kept in mind; otherwise, the protocols will fail to fulfill their motive. The range of review present's many ways to handle problems in WSN, few of them propose periodic sleeping of motes, energy efficient MAC methods and energy efficient routing methods, fault tolerant routing, deployment of multiple sink are some of such proposals that can be found in reviews.

In the present work, to handle challenges, energy efficient dynamic clustering technique is deployed. These approaches transform here to overcome the challenges. The small groups of motes are known cluster and support data aggregation through efficient network organization. Clustering is a key method that is used to enhancethe lifetime of sensor networks, Pal *et al*. (2012). Clustering form the network enhance able and minimize energy consumption of the motes. Thus for, many clustering schemes have been announced. In clustering the motes are grouped into small cluster regions. The head mote of a cluster region is introduced as Cluster Head (CH). Entire motes in a cluster send their sensed information to relative CH. CH control the group communication with the BS by Rajagopalan and Varshney (2006) (Fig. 1).

The benefits of clustering schemes in WSN are in many ways such as more scalability, less load, less energy consumption and more robustness. In WSNs, wide ranges of applications are used like disaster management, military, environmental monitoring, health and biomedical research, habitat monitoring from Mainwaring *et al*.(2002), industry, tracking and other commercial areas by Flamminiet *al*. (2009). Several intendedapplications of WSN are still under-

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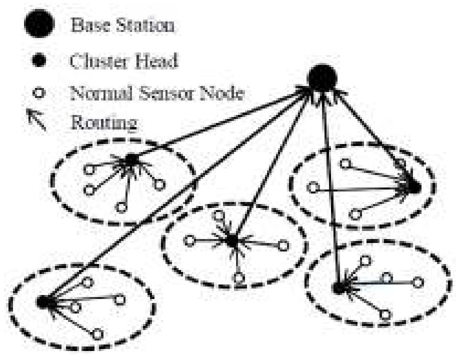

Fig. 1: Clustering in WSN (Wang *et al*., 2013)

research and development. In WSNs, the focus of routing algorithms should check condition of proper routes that remain on the mission network, create routing tables and create routing decisions.

In above, gives an overview of WSN, describes characteristics of WSN, points the challenges, gives the benefits of clustering protocols and briefly describes the application area of WSN.

LITERATURE REVIEW

In these days, the value of WSNs cannot be ignored. The huge diversity of motes provides WSNs with a broad scope of applications in industry, security, military and environmental research given by author's Meesookho*et al*. (2002). The big challenge in WSN is the restricted battery energy as these are spread in areas where it is not possible to replace the battery, so it is a dynamic area of research and there are many existing routing protocols. Here, we provide a brief review of clustering routing protocols. Currently, in WSNs have assisted too many new protocols specially designed for WSN, where energy awareness is a key consideration. However, approaches like Direct Communication and Minimum Circulation Energy, Shepard (1996) do not promise balanced energy supply among the motes. In Direct Communication Protocol motes relay information straight to the BS, anyhow of distance. As an output, the motes out-most from the BS are the ones to die first by Heinzelman*et al*. (2000). However, Minimum Transmission Energy (MTE) routing schemes data are carried through intermediate motes. Therefore, each mote acts as a router for other motes data in insertion to observe from environment. Motes near BS are the first to die in MTE routing. Until-now, cluster-based technique is one of the approaches that strongly enhances the lifetime and solidity of whole sensor networks. Here, we briefly describe clustering protocols, used in WSNs.

Author's Heinzelman*et al*. (2002); proposed Low Energy Adaptive Clustering Hierarchy (LEACH) routing protocol, is one of the most popular cluster-based routing algorithm from Tyagi and Kumar (2013). LEACH uses distributed approach and global information of the network is not required. The basic idea of LEACH has been a vision for many upcoming clustering protocols from Mahapatra and Yadav (2015). The main goal of LEACH is to balance the energy load division among the CHs. The working of LEACH is split into rounds and each round is divided into two phases, that is known as the set-up phase and the steady-state phase. In the set-up phase, the clusters are well ordered, while in the steady-state phase, data are sent to the BS. The Steady-state phase is forever lengthy than the set-up phase to reduce overhead. During the set-up phase, each mote decides whether to turn a CH for the current round. This choice is based on the recommend percentage of CHs for the network and the number of times the mote has been a CH until now. This choice is made by the mote by selecting a random number between 0 and 1. During the steady state phase, the motes grasp and transmit data to the CHs. The CHs shrink the data incoming from motes that belong to the right cluster and send an aggregated data directly to the BS. For collisions avoidance, LEACH uses Time Division Multiple Access (TDMA) concepts. After a fixed time, which is fixed on a round length, the network moves back into the set-up phase again and get in another round of CH election.

In LEACH protocol, any mote that performed duty as a CH in a definite round cannot be picked as the CH again, so each mote can uniformly share the load that applies to CHs to some extent. Although, LEACH can't make sure real load-balancing in the case of motes with different load of initial energy because CHs are picked in probabilities without energy considerations. Moreover, the random system of selecting the CHs does not ensure even distribution of CHs over the network, given by authors Arboleda and Nasser(2006). LEACH supposes that every mote can communicate directly with the BS that is an impractical assumption in many practical situations due to the communication range limitations of the motes by Saleem *et al*. (2011) and Zungeru*et al*. (2012).

Power-Efficient Gathering in Sensor Information Systems (PEGASIS), proposed by Lindsey and Raghavendra (2002), authors are present enhancements of the LEACH protocol. The basic goal in PEGASIS is to form a chain among the motes so that each mote will accept from and transmit to a neighbor in a fixed and homogeneous network. CHs take rotates transmitting to the BS. Therefore, the average energy consumed by each mote per round is minimized. It guesses that all motes have generally knowledge of the network. It applies a greedy algorithm to form the chain. In chain aggregated mote at any time a mote dies, the chain will be rebuilt and the threshold, which is flexible to the remaining energy levels in motes, can be altered to control which motes can be the leader. Motes take turns being the leader not similar to LEACH, a chain for multi-hop routing is built. It needs dynamic topology adaptation since a mote on the chain needs to know the energy level of its neighbors in sequence to know where to route its data. To conclude, the single leader can become a bottleneck.

Threshold Sensitive Energy Efficient Sensor Network Protocol (TEEN), authors Manjeshwar and Agrawal (2000); present for time-critical applications. In time-critical applications, it is key task to reply sudden alters in the sensed attributes such as temperature. TEEN is a hierarchical scheme using a data-centric technique. The TEEN architecture is built on a hierarchical grouping where adjacent motes form clusters; this clustering method is repeated in the second level until the BS is reached. When all clusters are built, the CHs relay two thresholds to the motes known as a hard threshold and a soft threshold for sensed attributes. The hard threshold is the lowest possible value of an attribute to trigger a mote to move on its transmitter and transfer to the CHs. It permits the mote to transmit only when the sensed attribute is in the range of interest. Therefore, it minimizes the several transmissions significantly. The soft threshold also reduces the several transmissions that might happen when there is small or no change in the sensed attribute. Thus, the user can control the deal between energy efficiency and data accuracy. However, TEEN does not support applications where regular reports are needed. Thus, the user may not get any data at all if the thresholds are not passed.

All the aforesaid protocols try to minimize the energy consumption mistreatmenttotally different algorithms. These algorithms providea decentanswer since they choose the mote with the upper residual energy within the cluster because the CH for followingspherical. However, this doesn't assure the utmost prolongation of the network period. Therefore, if the mote with the best residual energy may be a mote situated at the aspect of the cluster, this will lead different motes to paygoodish amounts of energy to succeed in that mote thatcannot be energy economical for the complete network. This can bethe explanationwe tend to propose a protocol that elects as CHs motes that minimize the whole energy consumption in a cluster. Our proposed protocol modified the topology by using min-max clustering algorithm to reduce the energy consumption.

MATERIALS AND METHODS

When and where the study was conducted: Duration March'16 to Aug-16 and SRM University, NCR Campus Modinagar, Ghaziabad, Deptt of Computer Science and Engineering.

Proposed power efficient algorithm: The proposed approach based on clustering using MIN-MAX clustering algorithm for grouping N motes into k groups. In this section, an improved power efficient clustering routing protocol, named APECRP, is presented. APECRP selects CHs in the network using a model, as most of the previously proposed protocols. However, the main difference with other protocols is that this one uses a more efficient mechanism to select a mote as the CH. This is performed by considering the minimum and maximum residual energy of the mote, in order to maximize the network lifetime. APECRP model the network and the energy spent by the motes as a linear system and using the MIN-MAX algorithm, selects the CHs of the network. In next subsection, describe basic energy model and routing model of APECRP.

Description of energy model: In this study, the first order radio model has been used for energy dissipation analysis. According to the first order radio model, the energy required for transmitting K-bits at a distance d is given as:

$$E_{Tx}(k, d) = K.E_{elec} + K.E_{fs} * d^2 \text{ if } d < d_0 \quad (1)$$

Or

$$E_{Tx}(k, d) = K.E_{elec} + K.E_{amp} * d^4 \text{ if } d \geq d_0 \quad (2)$$

The energy required for receiving K-bit message is given as:

$$E_{Rx}(K) = K.E_{elec} \quad (3)$$

where, d refers to the distance between cluster-member-node and CH or between CH and BS and d_0 is threshold distance, E_{elec} is the transmitter/receiver electronics' energy expense and E_{fs}, E_{amp} are transmitter-amplifier energy-expenses by a node when $d<d_0 and d \geq d_0$ respectively.

$$d_0 = \sqrt{}E_{fs}/E_{amp} \quad (4)$$

Description of the proposed routing model: In APECRP, the BS is assumed to have limited energy residues and communication power. It is also assumed that the BS is located at a fixed position, either inside or away from the sensor field. The longer the distance between the BS and the center of the sensor field, the higher the energy expenditure for every mote transmitting to the BS. All the network motes, that are assumed to be located within the sensor field, are grouped into clusters. One of the motes within every cluster is elected to be the CH of this cluster. These CHs are capable of direct transmission to the BS with reasonable energy expenditure. Moreover, to achieve energy consumption and extend the network's lifetime, the election of the CHs is done in turns based on MIN-MAX algorithm. The main characteristic of APECRP is

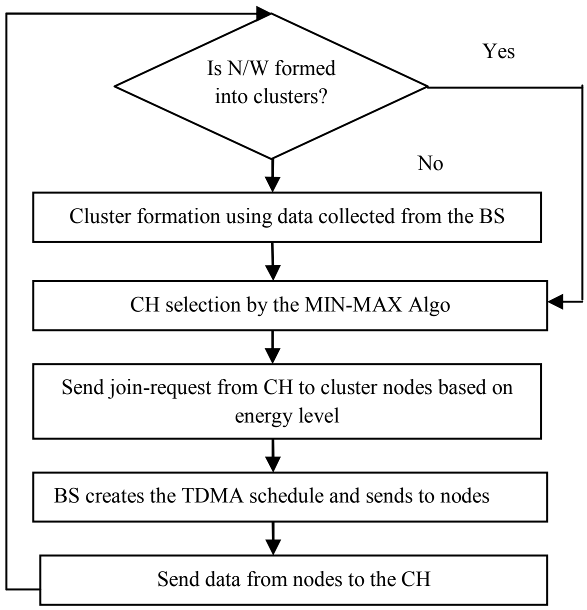

Fig. 2: Cluster formation and data sending in APCERP

the head selection process. In this protocol, to elect a CH, the routing information and the energy spent in the network are formulated as a linear system, the solution of that is computed using the MIN-MAX algorithm. Therefore, CHs are elected as the motes that minimize the total energy consumption in the cluster. The steps in order to setup clusters and then to elect CHs are the following and the flowchart of APECRP is shown in Fig. 2:

1. The BS requests the motes to advertise.
2. Each mote broadcasts a message with its energy. Here, motes are CH candidates with unique ID.
3. After advertisement, the BS runs the min-max algo and computes average energy at which every mote may be a CH. Pseudo code for CH selection.
   If (Motes $_{\text{Energy Level}}$ > = Avg$_{\text{Energy Level}}$)
   then
   Mote become CH
   If (Mote = Max $_{\text{Energy Level}}$)
   Working as a CH
   Else
   Not suitable for CH
4. The BS broadcasts the unique IDs of the newly selected CHs and their members. The motes use this information to form and enter a cluster.
5. Each CH creates a TDMA schedule and broadcasts this schedule to the motes in its cluster; in order each mote of the time-slot that it can transmit.
6. Then, start data transmission. The motes, based on the allocated transmission time, send the data concerning the sensed events to their CHs.
7. If change in the network topology, the BS uses again the min-max algorithm to appropriate CH election.
8. The execution stops when the motes in the network run out of energy.

RESULTS AND DISCUSSION

Network simulation: Here, done statistical network simulation to evaluate and compare with the performance of the clustering protocols. Table 1, summarized the simulation parameters and following network performance metrics are using to analyze the simulation results: Average Energy, Throughput, End to End delay and Packet Delivery Ratio.

Simulation results: The performance analysis of clustering routing protocols done using ns-2. We have used the above discussedparameters for our simulation and now we compare with using various performance metrics mentioned earlier. The simulation results are shown in a different table. Table 2 shows APECRP protocol outperformed to other protocols. The values show that APECRP routing protocol consumes less energy, compare with other protocols. Based on Table 3 we observe that in APECRP using 802.11 and random MAC are give better results than other protocols, but APECRP using S-Mac is decreases the throughput. Result shows on Table 4 statistics, we observe that in APECRP is less delay in compare with other protocols.

Overall statistical comparison: After simulation we obtain thevalues shown in Table 5. The result shows

Table 1: Simulation parameters

Parameters	Values
No of nodes	50
Simulation time(s)	15
MAC protocols	802.11/SimpleMac/SMac
Idle power dissipation	0.0
Rx power	0.3
Txpower	0.6
Initial energy(j)	90

Table 2: Average energy

MAC Type /Protocols	802.11	Random Mac	S-Mac
LEACH	17.26	03.60	10.18
PEGASIS	17.10	03.70	04.33
TEEN	16.84	03.60	04.12
APECRP	14.50	03.55	03.99

Table 3: Throughput

MAC Type/Protocols	802.11	Random Mac	S-Mac
LEACH	52.00	34.71	47.34
PEGASIS	54.34	17.72	53.23
TEEN	53.23	35.04	37.52
APECRP	157.16	113.68	33.66

Table 4: Average delay

MAC Type/Protocols	802.11	Random Mac	S-Mac
LEACH	287.48	12.10	0.00
PEGASIS	540.44	753.53	0.00
TEEN	467.70	15.30	0.00
APECRP	119.87	06.33	0.00

Table 5: Combined analysis

Protocol/Metrics	LEACH	PEGASIS	TEEN	APECRP
Energy	17.25	17.10	16.84	14.50
Through	52.00	54.34	53.23	157.16
Delay	287.48	540.44	467.7	119.87
PDR	0.660	0.6914	0.983	0.6111

APECRP protocol outperformed to other routing protocol. However, in PDR, the performance of APECRP protocol is lower shown in Table 5.

CONCLUSION

The core issues in designing protocols for WSN is efficient use of energy to enhance the lifetime of WSN. In this study we have done a statistical comparative analysis of popular clustering routing protocols, as like LEACH, PEGASIS, TEEN and proposed APECRP using different MAC protocols for WSNs. This statistical analysis shows APECRP protocol gives better result than other protocol, but in case of PDR is not better. The statistical study shall also be useful for researchers to efficient designing of routing protocols.

CONFLICT OF INTEREST

The author declares that there is no conflict of interests regarding the publication of this study.

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