

Design & Development of an Energy Efficient Cooperative Routing Protocol for Wireless Sensor Networks in the Networking Field



Raghavendra Patil G.E, Thippeswamy M.N

Abstract— In this paper, a novel development of the design & development of an energy efficient cooperative routing protocol for wireless sensor networks in the networking field is presented. The simulation results shows the efficacy of the methodology that was developed by us in the field of wireless sensor networks.

Index terms: Cooperative Routing, Energy Efficiency, Packet Delivery Ratio, Throughput, Channel Quality Indicator, Wireless Sensor Networks (WSNs).

I. INTRODUCTION

The Wire-less Sensor Networks (WSNs) comprises of gathering of sensors with constrained battery assets they cooperates for a specific task. WSNs have a self-governing arrangement of hubs associated by remote connections, there is no fixed foundation and powerfully organize topology may change. In this way, it is normal after arrangement of sensors the battery lifetime may not stay alive for a more extended time. In remote sensor arranges, the steering is an intricate undertaking in light of the inconsistent diverts and the limitations in vitality assets.

Also, old style steering conventions [1] are not ready to adapt to the directing limitation of WSNs. Moreover, helpful correspondence comprises a potential option. Consider a WSN with N sensors haphazardly conveyed on an enormous territory. The data gathered by every hub is transmitted to the goal by means of a course. In co-employable sensor arrange condition, every sensor can go about as a source that sends data on its course, or as a hand-off that advances data of different sensors on different courses. A promising answer for upgrading the lifetime of WSNs is given by a Cooperative correspondence [2].

Agreeable correspondence proposes to utilize the

neighbors as assistants, on the off chance that they have better channels. Indeed, because of the communicate idea of the remote channel the neighbors can over-hear the bundle of the source, store it, and afterward transmits it to the goal when it is required. The Cooperative steering procedure replaces the narrow minded aggressive access to the medium. It demonstrated its effectiveness in sparing vitality and upgrading the utilization of the remote channel. In this work the participation and directing had been joined.

In [3] the routing protocols are used to find the transmission path between the send and receive node. The sensor nodes use a wireless channel as communication medium then expressed the problems and difficulties of routing protocols. Reliability of a channel that is Channel Quality Indicator (CQI) oriented routing will be considered for selecting the transmission path. The CQI oriented routing technique will reduces the routing problems. In [4] WSNs in the larger geographical area during the communication the individual node transmitting data to sink, huge amount of power will be consumed. To resolve this problem clustering mechanism is applied. In this proposed work the cooperation and routing protocol is combined in order to save the energy of sensor nodes of WSNs.

II. SYSTEM MODEL

The system of a distributed sensors are used to observe an area to discover, recognize, localize and follow the objects to monitor the environment, industrial automation, traffic control, and military applications. In order to transmit or receive information from remote location the distributed sensor nodes are necessary in WSNs. Since in wireless sensor networks the energy efficiency is a critical issue but the cooperative communication techniques can greatly enhance the range of communication and energy efficiency for this kind of energy-constrained network. The lifetime of the network can be enhanced remarkably through cooperative node selection, since the sensor nodes operate on extremely low power for a long period of time.

III. RELATED WORK

Some routing protocols have been designed to accomplish the required aspects of WSNs but all these protocols are not capable enough. In addition, many of the WSNs protocols are assessed by different aspects like energy efficiency, throughput, and packet delivery ratio.

Manuscript published on 30 September 2019

* Correspondence Author

Raghavendra Patil G.E, Research Scholar, VTU Research Centre, Nitte Meenakshi Institute of Technology, NMIT, Bangalore & Asst. Prof., ECE Dept., SDMIT, Shree Dharmasthala Manjunatheswara Institute of Technology, Dharmasthala Road, Near Siddhavana, Ujire, Karnataka, South Kanara, Karnataka.

Dr. Thippeswamy M.N, Professor & Head, Dept. of Computer Science & Engg., Nitte Meenakshi Institute of Technology, NMIT, Yelahanka, Bangalore, Karnataka

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

Design & Development of an Energy Efficient Cooperative Routing Protocol for Wireless Sensor Networks in the Networking Field

The routing protocols of WSNs are reviewed and discussed based on the comparison. The LEACH routing protocol works in such a way that the entire WSNs is divided into several clusters. The cluster head selection is random.

IV. PROPOSED METHODOLOGY AND DESCRIPTION OF PHASES

In this section, the architecture, algorithm, flow-chart, routing protocol description is presented.

V. ARCHITECTURE

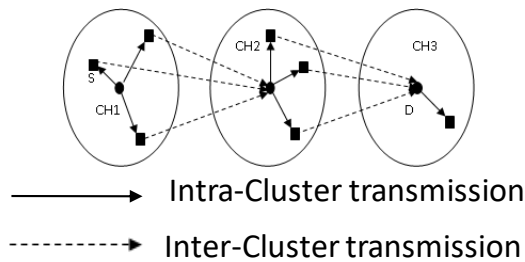


Figure -1: Proposed Model Architecture

Figure-1 shows the proposed communication model between two nodes. There are two cases in data transmission, first case is the intra-cluster transmission which is the communication within the same cluster and second case is the inter-cluster transmission which is the communication between different clusters. Data transmitted by the Source to its cluster head. Then cooperative nodes are selected by the cluster head in its cluster and transmit data to it. All these nodes transmit data collaboratively to the next cluster head. The cluster head selects the Cooperative nodes and then data is transmitted to it. This process will continue till the destination is reached.

VI. ALGORITHM

The steps followed are,

1. Randomly sensor nodes are deployed.
2. Based on the distributed localized clustering formation protocol Sensor nodes form a cluster.
3. Setting the Cluster head.
4. If a node S wants to transmit the data to the node D it sends the data to cluster head.
5. The cluster head find the path to D. The direction of data to D is given by routing algorithm.
6. Co-operative nodes are selected based on the multi-parameter based algorithm.
7. The data is received by the selected co-operative nodes.
8. In order to synchronize all the cooperative nodes the synchronization is applied because the nodes have to transmit collaboratively.
9. The nodes send the data to the next hop cluster head after synchronization.
10. The steps 6 to 9 is repeated until D receives the data in the network.

VII. FLOWCHART

Haphazardly sensor hubs are sent in light of the fact that the

majority of the occasions sensor organize arrangement is arbitrary in nature. In view of the Distributed limited bunching development convention Sensor hubs structure a group. In light of the group head determination convention sensor hubs structure a bunch head in the system. The hubs in the system join the closest header consequently bunches are shaped. Agreeable Node choice is done dependent on multi-parameter based calculation.

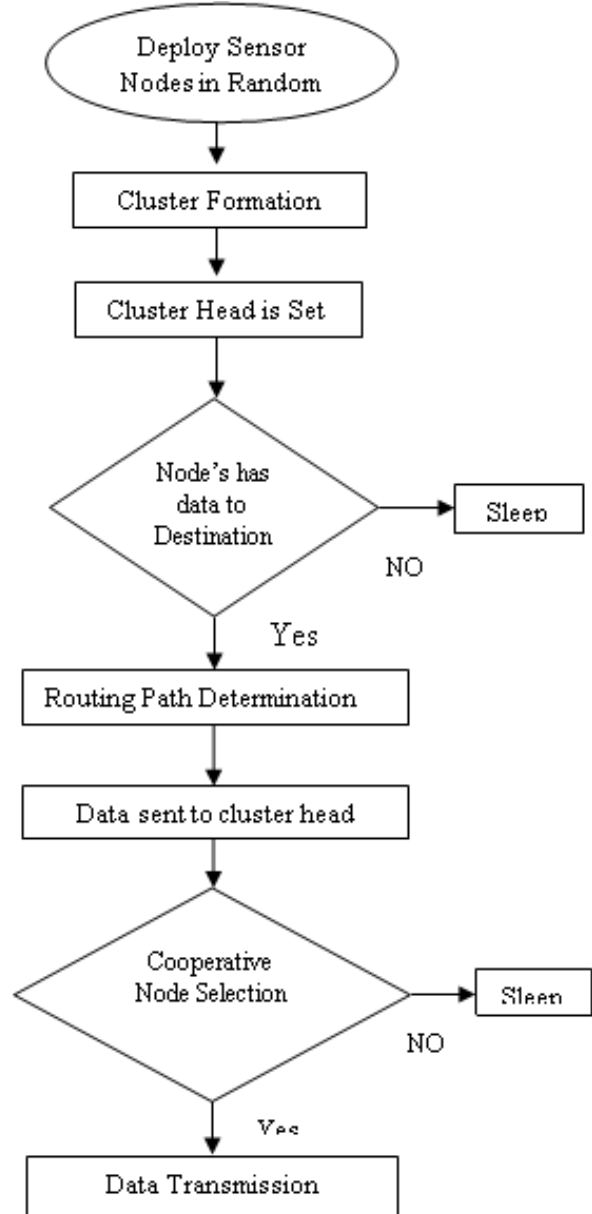


Figure – 2: Flowchart of the multi-parameter-based algorithm.

VIII. ROUTING PROTOCOL DESCRIPTION

Route request

An ideal way is figured utilizing a various parameter calculation and by proliferating a Route solicitation outline from the source towards the goal. A casing in a given middle of the road hub is a pointer to the past hub in the switch way to the source.

The structure of such a casing is given by Figure - 3. It contains seven fields. The main field is utilized to recognize the casing in the present hub. The subsequent field is a pointer to the edge that produced the present casing. The Distance I and Distance R fields contain the mean of the separation separately by the halfway hubs and the hand-off hubs.

The CQI field depicts the characteristics of the connections from the source to the present hub. The PP ID, Relay ID and Previous ID fields characterize the personalities of the past hubs in the two-bounce way. The Previous ID field contains the personality of the hub going before the present one in the way. The Relay ID field distinguishes the transfer between the present hub and the past one. At long last, the PP ID field contains the personality of the hub going before the past one. So as to trigger a course search, the source communicates a Route Request bundle containing an edge. It fills the Previous ID field by its location just as the Previous Frame ID field.

Route Reply

At the point when the goal gets a RReq, it checks the effectiveness of the casing. At the goal, the edges are added to the directing passage just if the at present utilized casing speaks to a ruled arrangement. From that point, the goal sends a Route Update (RUpd) parcel to educate the moderate hubs about the new way. At the point when a middle of the road hub gets a Route Reply or Route Update, It scans for the edge whose Id relate to the one got in the RRep or RUpd. It extricates from this edge the location of the following hub and the Id of the following casing. It makes another Route Reply (individually Route Update) bundle at that point sends it to the comparing hub. At the point when the bundle arrives at the source hub then the way is built up.

Route maintenance

Route maintenance is a mechanism through which a source node detects route faults along an established route to a destination node. This is performed only when a source is using the route for transmission of packets. The source node keeps the route in its route cache for some timeout period after use, and finally deletes it from the route cache when the time out period expires.

If any link breaks during packet transmission along the route, the node from which the link break is discovered sends a route error (RERR) packet to the source node about the broken link. On receiving the RERR packet, the source node invalidates the route in error from its route cache and uses an alternative route if it exists or reinitiates route discovery mechanism for another route to the destination node. The route maintenance mechanism verifies validity of the routes in use by the ECR protocol.

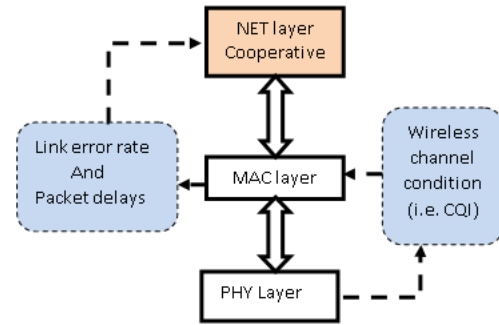


Figure 3 : ECRP Information exchange

Figure 4 illustrates the required information exchange for the routing metrics on which the routing cost function is based. Wireless channel link error rates are estimated from the CQI of the received signal from the physical layer and the reliability of a candidate route is then determined from the link error rates of individual links comprising the route. The wireless channel link conditions may vary instantaneously from time to time.

The requirement that a RREQ packet must reach the destination node in the ECR protocol ensures that the obtained metrics used to estimate the routing cost give correct status of the network about wireless channel links. The intermediate nodes replying to the request may otherwise provide stale values for the channel conditions. As mentioned in previous sections, a source node can record multiple disjoint routes to the same destination. This provides redundancy in case of route failures, in which case an alternative route will be readily available for immediate use.

Sample Scenario

The figure demonstrates the directing occurring between the source hub 1 and the goal hub 18. Directing table is encircled and the information arrives at the goal through multihop. The steering table is checked for the goal before each jump.

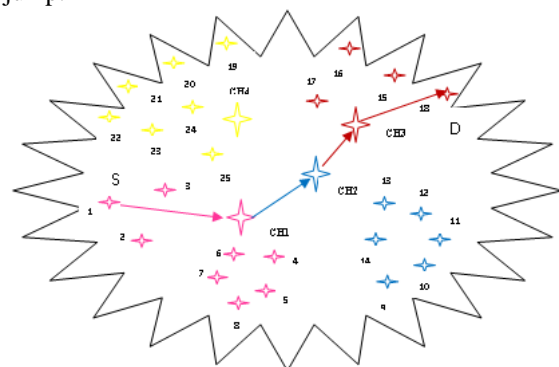


Fig. 4 : Sample Scenario

IX. EVALUATION OF PERFORMANCE & RESULTS

In this area the exhibition of our proposed Energy productive Cooperative Routing Protocol ECRP is assessed utilizing recreations. Our convention is actualized on the Matlab test system, in which it is contrasted and LEACH and PEGASIS conventions.



Design & Development of an Energy Efficient Cooperative Routing Protocol for Wireless Sensor Networks in the Networking Field

A system of size 1200m x 1200m is considered here, where in the field 100 sensor hubs are sent haphazardly at the (550m, 550m) co-ordinates area of the system the sink hub is set. 500 rounds were considered and hubs with 0.8J introductory vitality of hubs and 10m radio range were chosen.

Figure 6 demonstrates the bundles sent to BS of the ECRP convention with looked at conventions. The bundles sent by utilizing LEACH are the base relative to different conventions. ECRP gave the best outcomes as shown by the red plot line and PEGASIS is superior to LEACH however more terrible than ECRP convention.

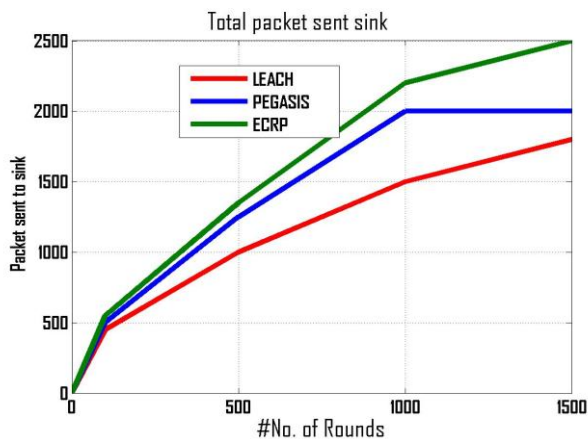


Figure 5 Total packet sent to Base station vs Network rounds

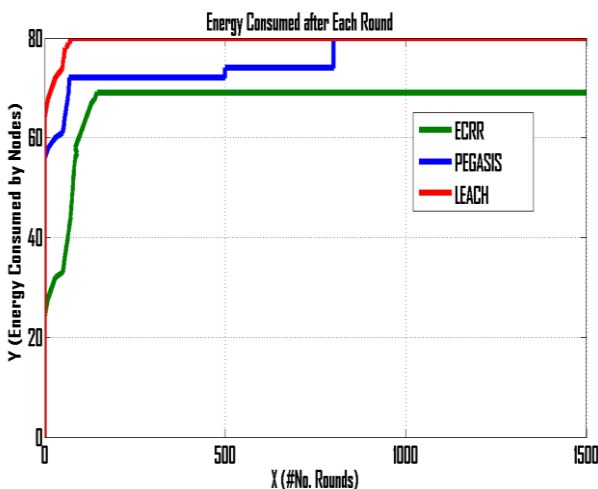


Figure 6 Energy consumed by nodes v/s Network rounds

Our proposed convention ECRP is much vitality effective in view of considering the likelihood of choosing a bunch head. In proposed convention the disseminated restricted bunching arrangement is performed which shows around 33% better organize lifetime relative to LEACH and PEGASIS, Figure 6 demonstrates the vitality utilization by number of hubs regarding number of rounds for the proposed convention alongside two chose steering conventions.

For each round the quantity of dead hubs in our proposed convention demonstrates the ideal outcomes in LEACH and PEGASIS are bigger; consequently our proposed work is considerably more productive as far as dead hubs per round as appeared by the plots. Figure 7 mirrors the quantity of alive hubs taken against the quantity of rounds in a system. As

expressed over the CHs in LEACH are over-burden. Subsequently it has least number of alive hubs as unmistakably appeared by blue bend. PEGASIS demonstrates significantly better outcomes than LEACH. Be that as it may, as clear from figure 7 our model has the most extreme number of alive hubs left till end of the rounds consequently it is much proficient and gives better outcomes when contrasted with different conventions.

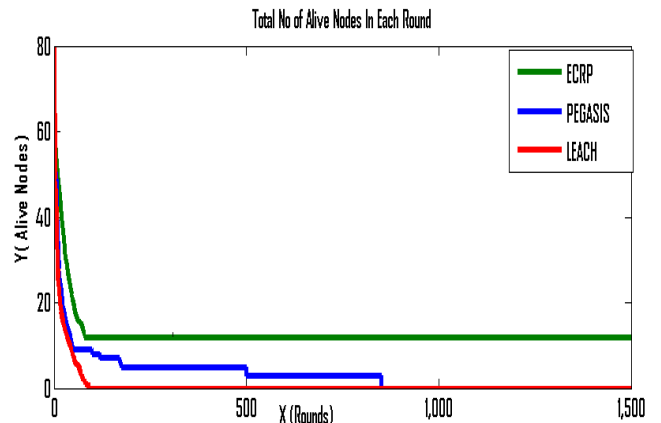


Figure 7 No of alive nodes v/s Network rounds

Fig. 8 demonstrates the plots of Throughput or parcels sent to Base Station and the tallness of the plots mirrors the conveyance proportion in which the proposed convention again have the best plots near to different conventions. The parcel conveyance proportion demonstrates an improvement of 43% relative to LEACH and 21% as near to PEGASIS as noticeable by the plots.

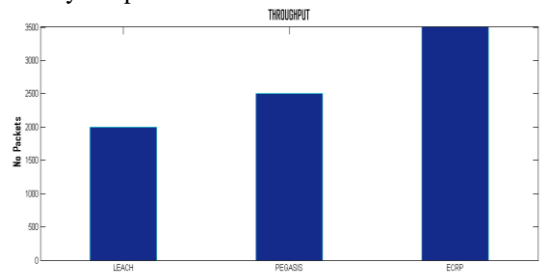


Figure 8 Throughput Comparison

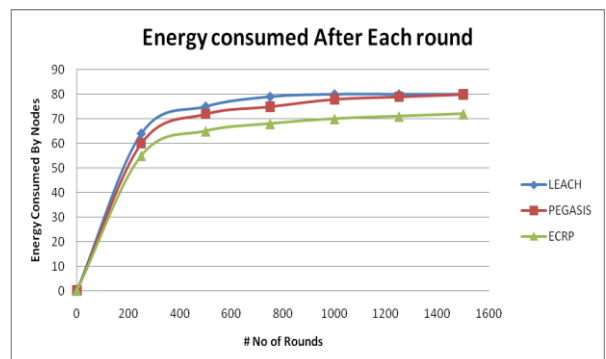


Figure 9 Energy consumed after each round

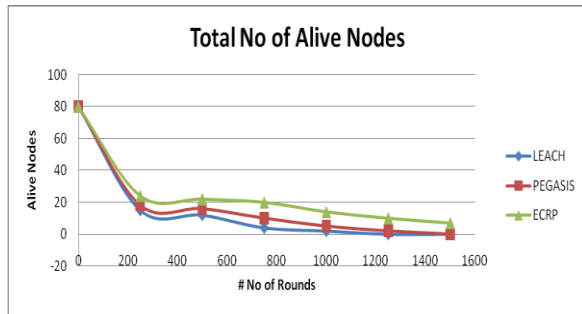


Figure 10 Total number of alive nodes

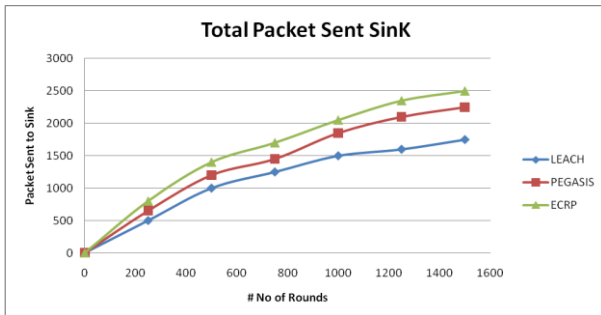


Figure 11 Total packets sent to the sink node

X. CONCLUSION

In this proposed work the routing protocol, ECRP that copes with WSN constraints. For the computation of route our proposed work will consider the existence of relay nodes and CQI that is able to enhance the channel utilization, in addition to the consideration of energy consumption. Simulation results are promising and show that our proposed work is also able to enhance the packet delivery ratio and minimize the delay.

REFERENCE

- Perkins, E. Belding-Royer, and S. Das, "Ad hoc on-demand distance vector (aodv) routing," United States, 2003.
- Liang, x., Chen, M., Xiao, Y, and Balasingham, (2010). MRL-CC: a novel cooperative communication protocol for QoS provisioning in wireless sensor networks. International Journal of Sensor Networks, 8(2), 98-108.
- Maria Sefuba, Tom Walingo, "Energy-efficient medium access control and routing protocol for multihop wireless sensor networks". IET Wirel. Sens. Syst., 2018, Vol. 8 Iss. 3, pp. 99-108.
- Ibriq, J., Mahgoub, I: 'Cluster-based routing in wireless sensor networks: issues and challenges'. SPECTS, 2004, pp. 759-766
- Shan. I., Dong. L., Liao. X., Shao. L., Gao. Z .. and Gao. Y(2013). Research on improved Leach Protocol of wireless sensor networks. PRZEGLD ELEKTROTECHNICZNY, ISSN, 0033-2097
- Al-Rahayfeh, A. A., and Almiani, M. M. (2014). Parameterized Affect of Transmission-Range on Lost of Network Connectivity (LNC) of Wireless Sensor Networks.
- Hussain, M and Mottalib. M. (2011). Energy-Efficient Hierarchical Routing Protocol for Homogeneous Wireless Sensor Network. IJCSNS International Journal of Computer Science and Network Security, 1 (D), 80-86.
- Huang. X Zhai. H .. and Fang. Y (2008). Robust cooperative routing protocol in mobile wireless sensor networks. Wireless Communications, IEEE Transactions on, 7(12), 5278-5285.
- Wang, J.; Kim, J.-U.; Shu, L.; Niu, Y; Lee, S. A distance-based energy aware routing algorithm for wireless sensor networks. Sensors 2010. 10. 94939511.
- Wail Mardini; Yaser Khamayseh; Shorouq AL-Eide. Optimal Number of Relays in Cooperative Communication in Wireless Sensor Networks, Communications and Network Journal in Vol. 4, No. 2 Issue (May 2012). ISSN 1949-2421. USA.