Biosc.Biotech.Res.Comm. Special Issue Vol 13 No 13 (2020) Pp-209-213

BBRC
Bioscience Biotechnology Research Communications

Gateway Based Hybrid Hierarchical Routing Scheme with Time Synchronization in WSN

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ABSTRACT

Wireless Sensor Network are spatially distributed sensors intended to monitor different physiological conditions. Sensing and communicating data from one place to another consumes more energy, therefore the management of sensor energy is very important factor. Energy utilization, synchronization and lifetime of the network is the main criteria in WSN. More energy is lost by sensors which are far from the base station.The cluster head is deployed to collect and relay information from nodes to the base station or gateway nodes to resolve this problem. To decrease energy consumption, gateway nodes are deployed between the cluster head and the base station. In this paper, a hybrid approach is used to increase the overall efficiency of the network in WSNs with time synchronization which increases the throughput of the network. The efficiency in terms of network lifetime, residual energy, data packets, throughput of the network has been improved as shown in simulation results. The performance of WSN of the proposed scheme is compared to other classical routing scheme and proposed algorithm has proved its merit.

KEY WORDS: BASE STATION (BS), CLUSTER HEAD (CH), GATEWAY NODE (GN), ROUTING PROTOCOLS, WIRELESS SENSOR NETWORK (WSN).

INTRODUCTION

Presently there have been development in Micro-Electro-Mechanical Systems (MEMS) in tandem with major developments in digital signal processing (DSP) which has. led to growth of micro-sensors. Previously few industries use wired sensors, implementation provides deployment of sensor nodes more viable than before. Previously, there has been study regarding applications of WSN such as environmental monitoring, agricultural field, military surveillance and home automation (Pavithra et al., 2019).

Deep research on routing protocols efficiency was done considering the power constraints in WSNs and there was vast deployment of nodes on large-scale , to ensure reliable and real-time data transmission. Recently there has been exposure in the field of WSNs and their applications because they are easy to deploy and are of low cost, have flexibility. a WSN have distinctive set of resource curtailment like finite on-board battery power, limited processing ability and limited communication bandwidth. Since sensors are battery-powered, energy efficiency is of vital importance in WSNs. Algorithms are used to solve the problem of power constraint without altering the standard. Local collaboration among sensors, suppression, data compression, redundant data ,avoidance of direct transmission to far distant sensors are of the major factors that influence algorithm designers to device unique distributed, scalable and energy efficient solution for Wireless Sensor Networks.

ARTICLE INFORMATION

*Corresponding Author: raghunandangh@bmsit.in
Received 11th Oct 2020 Accepted after revision 29th Dec 2020
Print ISSN: 0974-6455 Online ISSN: 2321-4007 CODEN: BBRCBA

Thomson Reuters ISI Web of Science Clarivate Analytics USA and Crossref Indexed Journal

NAAS Journal Score 2020 (4.31)

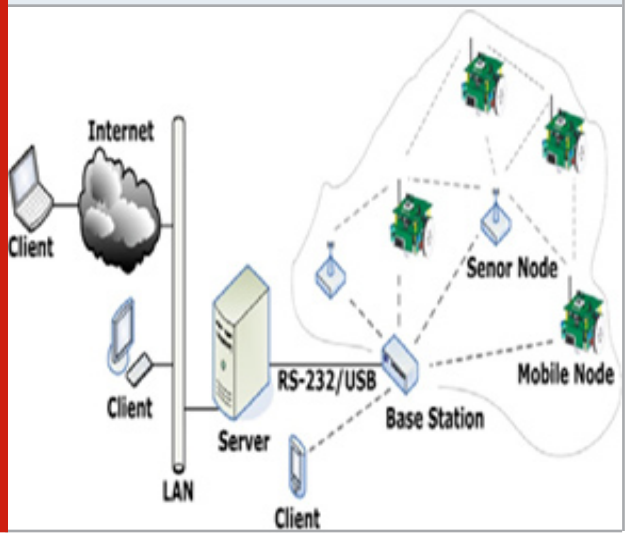
Online Contents Available at: http//www.bbrc.in/
Doi: http://dx.doi.org/10.21786/bbrc/13.13/29

.In common, the sensor nodes measure environmental conditions,. The sensor node extract some useful information by processing the raw sensor signals . The output of this processed signal is transmitted the through direct communication or multi-hop communication with access point across other sensor nodes. In some situations, repeaters (RPs) are used for multi-hops, to support sensors installed outside the radio range. One of the components of the WSN is the base stations which has more energy, computational ,communication resources. Forwarding of data from wireless sensor network on to a server is done by the BS which acts as a gateway. Energy is a limited resource of WSN , and it determines the lifetime of WSNs. The computation subsystem has less energy consumption when compared to the communication subsystem has. The energy required for transmitting one bit may consume as same as executing a few thousands instructions. Hence, communication must be traded for computation. In different environments, together with remote and hostile regions, where ad-hoc communications are a key element WSNs is to be deployed in large numbers .For this reason, algorithms and protocols should concentrate on the subsequent issues:

- Lifetime maximization: Sensor nodes should be energy efficient and consumption of energy of the device should be less due to the limited energy resources. The radio power supply when not in use should shut off to conserve power of the node
- fault tolerance and Robustness .
- Self-configuration.

Figure 1 shows the arrangement of WSN.

Figure 1: Schematic of WSN



Hierarchical routing algorithms are more efficient algorithm. In this, CHs are responsible for collecting the data and send it to GN and then the GN sends the information to the BS. If the members of the cluster are far, then there is a wastage of energy. To solve this problem, the Centrality approach is used. In this method, the distance between one node to every other node is calculated using the Pythagoras theorem. The node which is equidistance to all other nodes along with high energy will be selected as the cluster head. This will reduce energy consumption. Error during communication can be reduced by using time synchronization in communication. This will reduce the packet collision during data transmission. In this paper, a new synchronization method considering a new broadcast sequence is used. This determines the order of the nodes that transmit timing information, this Eliminates collision. Section II presents a summary of the existing systems. The framework of proposed system is explained in Section III . The system is evaluated in Section IV based on simulation and implementation. Section V, addresses the future scope and demands. The paper concludes with section VI.

Existing Systems: A wireless sensor network consists of distributed sensor nodes. Sensor nodes include of sensing unit based on application, processing levels. In the existing system, many limitations or difficulties cause less efficiency of the system. It includes Energy limitations storage or environmental limitations, communication constraints, and other limitations. Transfer of information to nodes needs more energy. Hence sensor nodes are affected by energy limitations. Sensor nodes are small devices and hence their capacity to store the data is less. Nodes of the network may get affected by many environmental conditions physical obstacles, unpredictable errors, and also communication interferences.

Communication constraints are limitation of bandwidth, frequent routing changes, channel error rates, and also unreliable communication. LEACH (Salah et al., 2016) is the main protocol under hierarchical routing protocols which includes set-up phase, and steady-state phase. In the first phase some nodes are selected at random probability as cluster heads (CHs) and nodes are ordered into clusters. In the second phase, the data is transmitted to the BS. CHS has to lose more energy when compared to other normal nodes. A drawback of this system is cluster head consumes more energy and sensor nodes die faster.

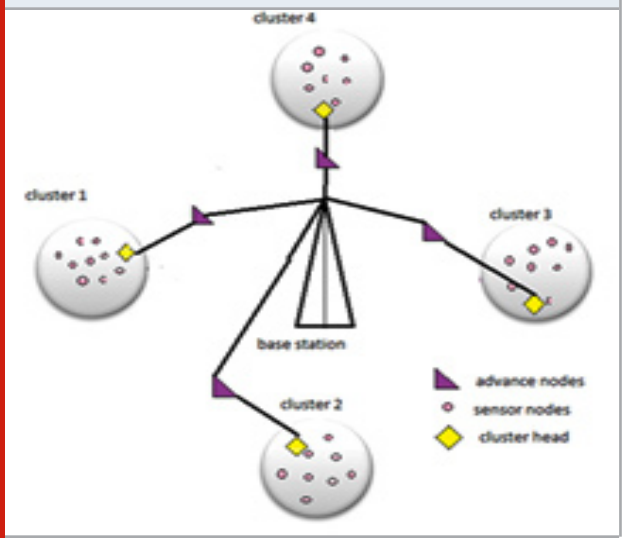
In (Djenouri et al., 2012) they proposed a protocol that mainly deals with the technique of the cluster head (CH) selection that makes balanced energy consumption among the sensors, and which leads to enhancement of lifetime of the sensor network. In (Sang et al., 2012) for transmission of data to the Base Station majority of the energy of sensor nodes is used. Thus, there is a fast depletion of energy. Here agglomerative to limit the energy utilization of cluster heads a portable base station is utilized along with cluster approach. But the movement of the Base Station is not always feasible. In (Ruqiang et al., 2014) this it discusses up several technical challenges and many application possibilities that occur when the sensor networks interconnect several nodes when wide networks are established. These wireless sensor networks communicate using multiple -hop wireless communications systems.

To (Raghunandan et al., 2011) guarantee reliable multi-hop communication and to maintain the routes in the network routing protocols for WSN are used. It provides us with an idea of routing protocols for WSN and compares their relative strengths and limitations to provide better energy efficiency or increase wireless. In (Raghunandan et al., 2012) mainly concentrates on synchronization schemes where a multichip extension is used which use a final local estimates, without any forwarding of synchronization signals. In the existing system, there are many routing challenges and design issues. In designing routing protocols one should consider the uniform distribution of sensor nodes; otherwise, we should go for clustering. Production costs also should be less and the quality of service should be good.

Proposed System: In a hierarchical approach, some sensors are classified as lower energy nodes and some sensors are grouped as higher energy nodes. The higher energy nodes become cluster heads (CHs) and lower energy nodes become the normal sensors that perform the ensuing operation only.
CH is decided with a different probability (D Djenouri et al., 2012) by following equation.

$$T(n)= [p/(1-p)] \times(r \bmod p-1) \quad (1)$$

Figure 2: Concept of proposed techniques



But the cluster heads deal with the collection of information from sensors, data aggregation of these data and transmission of processed data to the next level. Figure 2 shows the concept of the proposed technique. The main aims of this protocol are to reduce power consumption, data aggregation, and time synchronization. The main aim of the proposed technique is to increase energy efficiency, improving the time synchronization in communication between each node and the receiver, and enhance the network lifetime of sensor nodes. This paper is mainly motivated to overcome the problem of higher energy consumption of sensor nodes and extending the lifetime of wireless sensor networks to provide good transmission and data sense. Since Sensor nodes away from base stations hence they consume more energy during transmission of data to a base station. Hence gateway nodes are introduced. Gateway nodes receive the data from sensor nodes and then send them to the base station. Time synchronization is an elementary part of any network-oriented organization and system. In our proposed system grouping of sensor nodes is done called clustering. The energy consumed by the transmitter for transmission of message to a distance is given by,

$$E_T(k,r) = \begin{cases} k\left(E_{TX} + E_{fs} * r^2\right) & \text{if } r < r_o, \\ k\left(E_{TX} + E_{mp} * r^4\right) & \text{if } r \geq r_o. \end{cases} \quad (2)$$

The energy dissipated by a receiver to receive bit message is given by

$$E_R(k) = k * E_{RX}, \quad (3)$$

Threshold distance is given by,

$$r_o = \sqrt{\frac{E_{fs}}{E_{mp}}}. \quad (4)$$

Clustering is done to construct the appropriate topology of the network. The clustering-based network reduces the cost of the routing algorithm and the flooding broadcast. In this cluster-based routing approach, sensor nodes that are in a particular radio range are grouped which forms a cluster. Each group or cluster has one cluster head (CH). This CH collects all the data from sensor nodes in a cluster and it performs data fusion and sends it to the nearby gateway node. CH is selected based on the centrality approach. In this method distance of nodes between each other is determined; the node which is equidistance from the other node and the node having more energy is selected as CH. After CH selection aggregation of data is performed by removing redundant data. Data aggregation is the process of removing redundant data during transmission. This will increases the lifetime of the network.

In the proposed system base station (BS) is fixed. The same algorithm can also be applied to a movable base station. During the data communication phase, the data packets are transmitted from CH to gateway node and from gateway node to BS. This process is called multi-hop communication. The proposed technique uses the receiver-to-receiver concept implemented by the reference broadcast Synchronization which minimizes the time-critical path when compared to the sender-to-receiver method.

Implementation: The proposed system is simulated using MATLAB software. We consider 100 sq.m area and 100 nodes are distributed randomly. MATLAB Simulation is done for 4500 rounds. The proposed algorithm is compared with DR-LEACH. Fig.3 Initial network topology for LEACH. The figure 3 shows deployment of sensor and clustering of the network area in DR-LEACH.

Figure 3: Initial network topology for LEACH

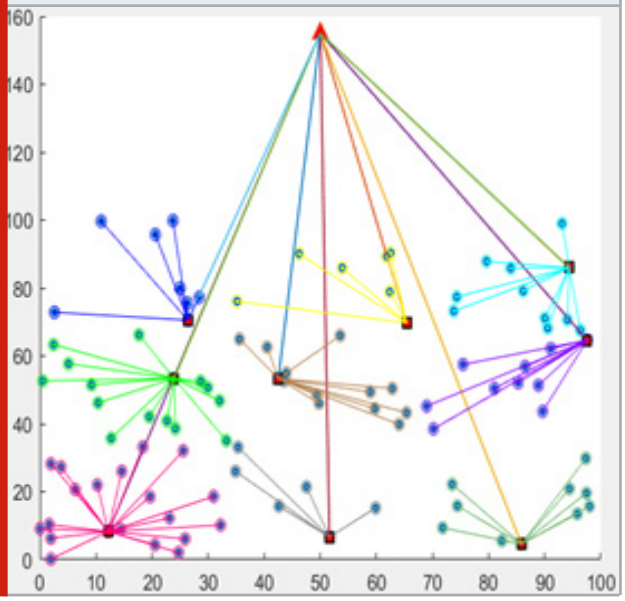


Figure 4: Network framework for Proposed Technique

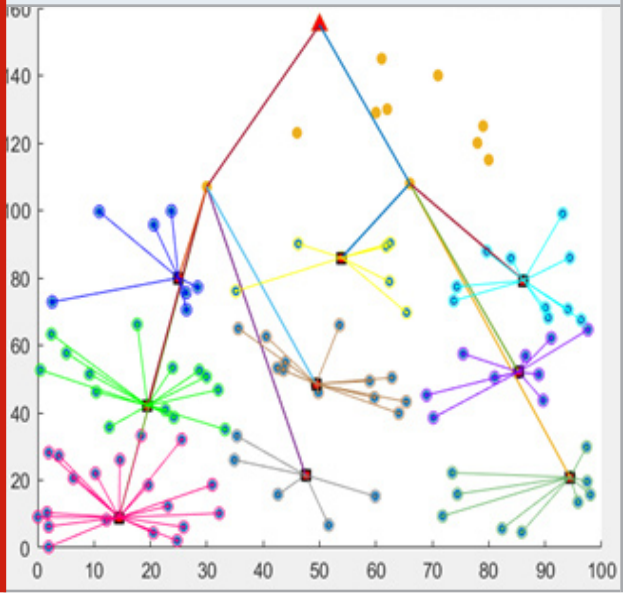


Figure 5: Comparision of packets sent of Proposed System vs. DR-LEACH in multiples of 10^4

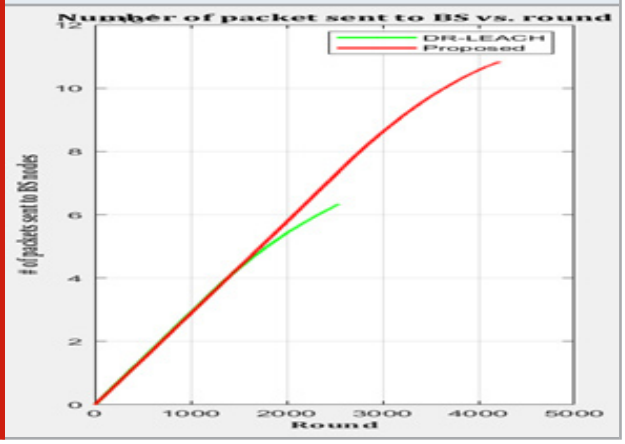


Figure 6: Comparison of number of dead sensors of Proposed System vs DR-LEACH

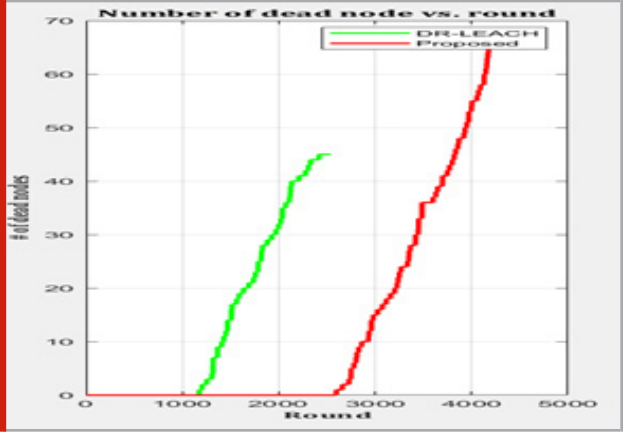


Figure 7: Comparison of Residual energy of results of Proposed System vs DR-LEACH

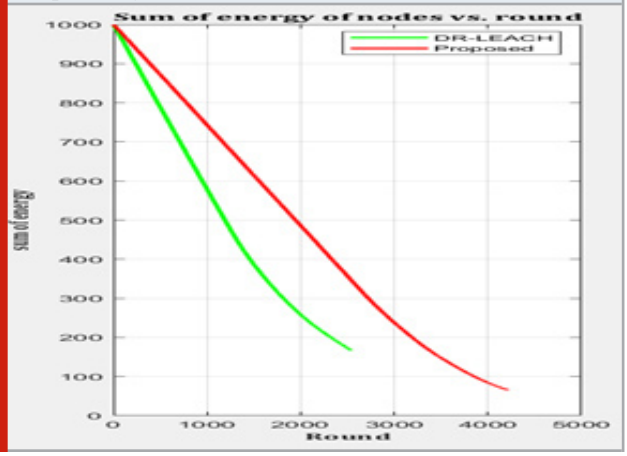
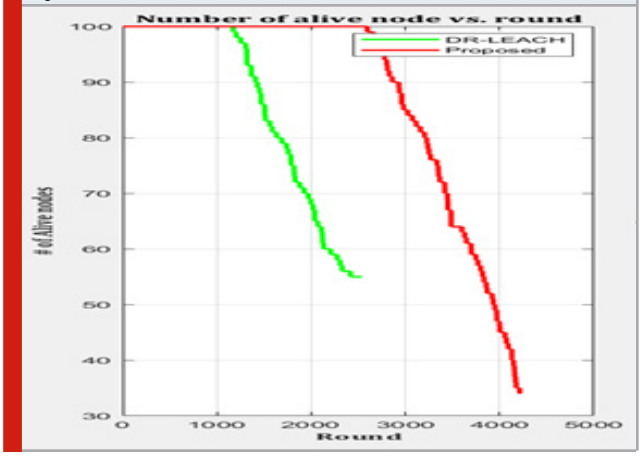


Figure 8: Comparison of Network Lifetime of Proposed System vs DR-LEACH



The connectivity between individuals to CH, CH to the gateway node, and GN to Base station are shown in figure 4 of proposed system. Figure 4 shows network framework of Proposed Technique. Figure 5 packets sent of Proposed System vs. DR-LEACH. Figure 6 shows the Comparison of number of dead sensors of Proposed System vs DR-LEACH. Figure 7 Comparison of Residual energy of results of Proposed System vs DR-LEACH. The implementation results in a hybrid model comprising of energy conservation, data aggregation, and time synchronization. The results in the graph show improvements in the lifetime of the network along with time synchronization. With respect to simulation results numbers of dead nodes are less on comparison with rounds of DR-LEACH protocol. This shows that the lifetime of network using proposed system is enhanced compared to DR-LEACH which leads to maximum transmission of data. Hence the WSN using the proposed technique works with more powerfully on comparison to the DR-LEACH.

CONCLUSION

Energy consumption by sensors is a major parameter for network lifetime in WSN. In hierarchical clustering methodology, the cluster head selection plays an important role. When the complete network is considered, then the optimization of energy consumption can be done by the changing of the cluster head based on priorities at the cluster level. In this proposed system, we establish a connection from sensor nodes to CH, CH to GN, and from the gateway node to the base station. The energy utilization can be decreased by properly designing the CH selection mechanism.

The selection of cluster head proposed in this paper is a new technique discussed concerning distance from the base station and centrality approach at the cluster level. Along with that time synchronization is achieved using reference broadcast synchronization. The implemented protocol shows an improvement in the lifetime network, and the life of nodes will be extended to the maximum period. Here we are comparing the proposed system with the DR-LEACH protocol and it proves that the proposed system is more efficient than DR-LEACH.

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