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AN IMPROVED ENERGY-EFFICIENT CLUSTERING PROTOCOL USING CUCKOO SEARCH OPTIMIZATION AND K-MEANS CLUSTERING IN WIRELESS SENSOR NETWORK

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Abstract: A Wireless Sensor Network (WSN) is a self-organized network consisting of thousands of low-powered and lightweight systems, and these systems are extremely energy-restricted. The paths for data transfer are chosen to optimize network life in wireless sensor networks(WSNs) in a really manner that maximum power produced across the route is reduced. Sensor nodes are also clustered into disjoint, non-overlapping subgroups, name cluster , to make maximum usability and improved data aggregation. Energy therefore plays a vital role in communication among the nodes of the sensors, as lack of energy can impact the livelihood of the nodes. Energy conservation is also essential for preserving the durability of the network. The suggested clustering of K-means for minimizing energy consumption using cuckoo search (CS) is able to withstand the loss of sensor nodes to maintain uninterrupted communication. The sensor nodes in the cluster will aggregate data to cluster head which later transmit data to base station. The shortest path will be established from cluster head to base station using cuckoo search algorithm with the aid of heterogeneous network. In this work, a protocol for minimizing the energy consumption with efficient clustering using K-means and Cuckoo Search for wireless sensor network is implemented. We also compare the results of proposed approach with existing based on various parameters like number of alive nodes , throughput, minimum energy of sensor nodes ,number of dead nodes.

Index Terms: ***wireless sensor networks, clustering, energy efficient clustering, heterogeneous network, LEACH, cuckoo algorithm, network lifetime, energy efficient algorithms, energy efficient routing***

1. INTRODUCTION

In the development of WSNs, energy use is an important consideration that usually relies on accessible energy sources such as power batteries. WSNs are large-scale networks of tiny embedded systems, all with capacities for sensing, computing and communication. In recent decades [1-2], they have been heavily discussed .Sensor nodes in WSNs have been limited in terms of processing capacity, communication bandwidth, and storage space, requiring very efficient use of resources.

The sensor nodes are also clustered into separate disjoint sets named a cluster in WSNs, clustering is used in WSNs because it offers network scalability, resource sharing and effective use of restricted sources that offer consistency of network topology and qualities of energy saving[3]. Clustering systems provide decreased overheads for coordination and successfully. The distribution of resources thus decreases overall energy consumption and reduces conflict between sensor nodes [4]. The region with small clusters will be congested by a wide amount of clusters, and a very small set of clusters will consume the head of the cluster with a huge amount of messages sent from cluster members.

Restricted processing capacity, communication bandwidth, and storage space are the specific challenges of wireless sensor networks. This allows for new and special data management and information processing problems. It is important to establish in-network data processing strategies , like data aggregation, multicast, and broadcasting. The key features used for assessing the efficiency of any sensor network are network lifetime [5]. The residual energy of the device decides the lifespan of the network, so the key and most critical task for WSN is the effective utilization energy resources. Literature indicates that WSNs use all of the following methods to enforce energy savings: energy conservation system, power conservation framework, energy harvesting method, and energy efficient routing.

The rest of the paper is structured in following way : Section II presents an overview of clustering in WSNs. Section III presents a literature survey of clustering and energy efficiency. Section VI explains the present work. Section V explains the experimental results. Section VI explains the conclusion of the paper.

II. CLUSTERING IN WIRELESS SENSOR NETWORKS

In an area, sensors capture data and sends it either specifically or collaboratively via other nodes to a sink [6]. To accomplish scalability, durability and decreased network traffic, several sensor applications cluster the sensor nodes.
A Clustering Study Case is shown in Figure 1. Clusters with cluster heads are given here, and these cluster heads propagate the aggregated data to the base station or sink.

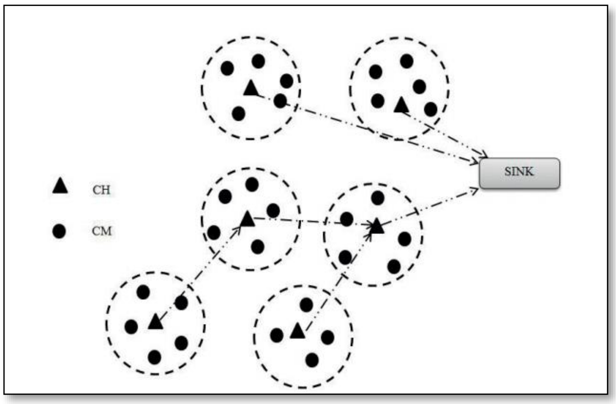


figure1. a clustered wireless sensor network [6]

The primary benefit [7] of clustering is the efficiency scalability around the growing networks of sensors. In contrast to this, the clustering technique offers several secondary benefits. Because of its localized approaches, it guarantees efficiency and prevents one-point failure. To effectively minimize power consumption, a clustering approach will imply a sleep / wakeup schedule for a WSN. All sensor nodes are not expected to be in a wake-up state and absorb energy in many sensing applications. Few sensor nodes may be positioned in sleep mode, in which no energy is captured, dependent on temporal and spatial dependencies. An efficient schedule via the sink or administrator could be formulated and transmitted to these sensor nodes.
Also, because of its semi-distributed nature, clustering guarantees usability of the application output. A clustering strategy, such as the energy-sensitive clustering method with sensor network transmission power control (EACLE) [8], provides a distributed strategy to the choice of ways to enter the sink. To boost energy efficiency, this performance measuring various levels of transmission power for intra-cluster and inter-cluster communications.

III. LITERATURE SURVEY

Dermi et al.,[9] An improved routing algorithm for energy-aware clustering procedure in the WSN is cuckoo search method was examined in this article. This change was focused on a preference of multi-objective cluster heads using a novel fitness function that takes multiple metrics like energy and distance into account. The experimentally result obtained have shown that, in spite of expanding network lifetime, amount of dead nodes, increasing the stability time period and network throughput, the suggested methodology appears to be better than LEACH.
Mishra et al.,[10] In this research strategy, suggested a cluster head approach selection framework focused on a confidence factor that assures that all nodes are trustworthy and authentic throughout communication. In order to accomplish this, direct confidence, along with the use of the k-means clustering method, is determined using variables like the residual energy and the distance among the nodes. The simulation findings indicate that the suggested solution outclasses the Clustering algorithm in spite of network lifetime, packet delivery ratio, packet drop rate, and energy consumption.
Mandeep Dhami et al.,[11] With the idea of Virtual Grid-based Dynamic Routes Adjustment (VGDRA), an energy-efficient genetic approach -based model was developed that improves the overall efficiency of wireless sensor networks. Compared to LEACH, the suggested method has higher energy efficiency because it is a dynamic technique that is not static, controlled load and optimization provides more probability of improved results in less loops that other strategies do not allow. In MATLAB, the simulation outcome of the suggested system is implemented.
Yarde et al.,[12] A comparative node life time analysis among the Low Energy Adaptive Clustering Hierarchy (LEACH) and its LEACH Two Level Cluster Head (LEACH-TLCH) variant configuration is performed in this report on the account of energy consumption, residual energy and dead nodes. A modern energy efficient routing method also introduced is Tertiary Head-Low Energy Adaptive Clustering Hierarchy (TH-LEACH). In terms of the amount of dead nodes and overall energy consumption in the system, this routing framework enhances behaviour, improving network life.
Aliout et al.,[13] The aim of this paper is to develop a method for hierarchical routing. The authors began by developing a technique named the distributed clustering of effective energy-aware (EEADC). The simulation results demonstrated that EEADC could produce very small or very large clusters. A new approach called fixed effective energy-aware distributed clustering (FEEADC) was developed by the authors to reduce this issue. The simulation findings demonstrate a significant improvement over the well-known low-energy adaptive clustering hierarchy and threshold-sensitive energy-efficient techniques in spite of energy consumption and network lifetime.
Bongale et al.,[14] An intra-cluster data aggregation methodology (ICA) for WSNs is suggested in this paper. In an energy efficient manner, ICA builds the intra cluster data aggregation path from a source node to its CH node. Data packets are integrated by transitional relay nodes across the aggregation path, before the message reaches the required CH node. The contrastive study of the ICA, LEACH and LEACHC approaches takes into account variables including the amount of live nodes, the depletion of energy, and the number of data packets received by BS. The finding suggest that ICA plays best than the methods of LEACH and LEACH-C.

Elshrkawey et al.,[15] Suggest an optimization plan to decrease energy usage and increase the life of the network. It has been achieved by increasing the energy balance between all sensor nodes in clusters to minimize the dissipation of energy throughout network communications. The enhanced method relies on the selection method of a cluster head. Furthermore, an updated TDMA timetable has been introduced Finally, the implementation method shows improvements in spite of network life, cluster head numbers, energy consumption and the set of packets transmitted to BS relative to LEACH and other similar methods . The efficacy of the suggested solution is demonstrated by statistical modeling and MATLAB 2015a simulation findings. WSN's energy usage was decreased by up to about 60 percent and the network life cycle was increased by 73 percent relative to LEACH.

Zaman et al.,[16] In this study , a cross-layer architecture technique named "Location Sensitive Routing Protocol" (PRRP) was introduced to architecture a routing scheme. The aim of PRRP is to reduce the energy expended by every node by (1) decreasing the time a sensor node is in an idle sensing state and (2) minimizing the average distance of contact over the network. In the sense of network lifespan, throughput, and energy usage of the network per person level and per data packet basis, the efficacy of the suggested PRRP was critically analysed. The findings of the study were analysed and benchmarked toward the well-known approaches LEACH and CELRP. In terms of energy efficiency and overall quality of the WSN, the findings indicate a substantial improvement in the WSN.

IV. PRESENT WORK

This research work proposed in a in this wireless sensor networks, sensors are created into finite set .After that, k-means algorithm is using to partition of the whole network. After completed this process, cuckoo search algorithm is using to find route from source to destination.

The method of vector quantization, beginning with the signal processing, is the clustering of k-means. The goal of k-means clustering is to divide n events into k clusters in which each observation corresponds to the nearest mean cluster, acting as a cluster prototype. k-means algorithm to identify or group objects based on attributes and features into k number of classes.

4.1 Steps in Proposed Technique

1. Generate wireless sensor network with finite set of sensor nodes.
2. Partition of whole network into finite amount of clusters via K-mean.
3. Select the route from source to destination with cuckoo search .
4. Choose reliable path from source to destination.
5. Initialization of Cuckoo Search parameters.
6. Initial generation of host nest population.
7. Assess fitness function for formation host nest population.
8. Evaluated the new solution.
9. If the condition is satisfied then Transmit Data on selected path which with the help of heterogeneous network and send data from source to destination and otherwise it Move all cuckoos towards better environment.

4.2 Energy consumption Model

Designers used a first-order radio method for forecasting electricity. The free space system is used as shown in (1) if the distance among the transmitter and receiver sensor node is low than the threshold distance, unless the multi-path design is used as seen in (2). Therefore, the energy consumed to relay a k-bit message over distance d is,

E_{Tx}(k,d) =kE_{elec}+ k$e_{fs}d^2$, if d<d_0 (1)

E_{Tx}(k,d) =kE_{elec}+ k$e_{fs}d^4$, if d≥ d_0 (2)

Here E_{elec} is the per bit energy dissipated to run the transmitter or receiver circuit E_{fs} or E_{mp} is the per bit energy dissipated to run the transmit amplifier. The energy used to receive message, as shown in (3)

E_{Rx}(d)=kE_{elec} (3)

The energy used for aggregating m messages with k-bit is seen in (4)

E_A(m,k) = m*k*E_{DA} (4)

Here E_{DA} is the energy needed to aggregate message signal per bit.

4.3 Modified Threshold Probability

The threshold probability is essential for the selection of CHs. It indicates whether or not a node can become a CH .A node can be behave , as a CH .

$$T(s_i) = \frac{Pi}{1-Pi*mod(r,round\frac{1}{Pi})} \quad \text{if } S_i \in G \qquad (5)$$

4.4 Algorithm of Proposed Technique

Step1: Generate 'k' cluster using k-means clustering
Step2:For i =1:k
For j= 1:N
Each Node (j) generate random no
Compute probability using cuckoo search
Calculate threshold value
If random no<threshold value
Nodes becomes cluster head
Else
Node becomes cluster member
End if
End for

End for

Step 3: Each cluster head informs the node about TDMA schedule

Step 4: Aggregate node data at cluster header.

Step 5: Cluster head forwards data to the base station as the nearest cluster head.

V. EXPERIMENTAL RESULT

This section presents result of the proposed technique. Results of the proposed technique is evaluated on the basis of the parameter.

1. Number of alive nodes
2. Minimum energy of network

Number of alive nodes : The number of alive nodes was determined for each round in determine the energy efficiency of the network. The number of alive nodes was determined for each round in determine to find the energy efficiency of the network. From the comparative analysis of Figure 5.4 , evaluate that the number of alive nodes in proposed newer protocol is growing compared senile protocol.

table 5.1: showing comparison of proposed technique with existing technique on the basis of number of alive nodes.

Number	Network size	Sensor node	Sink location	[Existing] Cuckoo+ leach	Proposed
1	100m×100m	100m	50m,50m	1800	2900
2	150m×150m	150m	75m,75 m	1750	2750
3	200m×200m	200m	75m,75 m	1700	2800

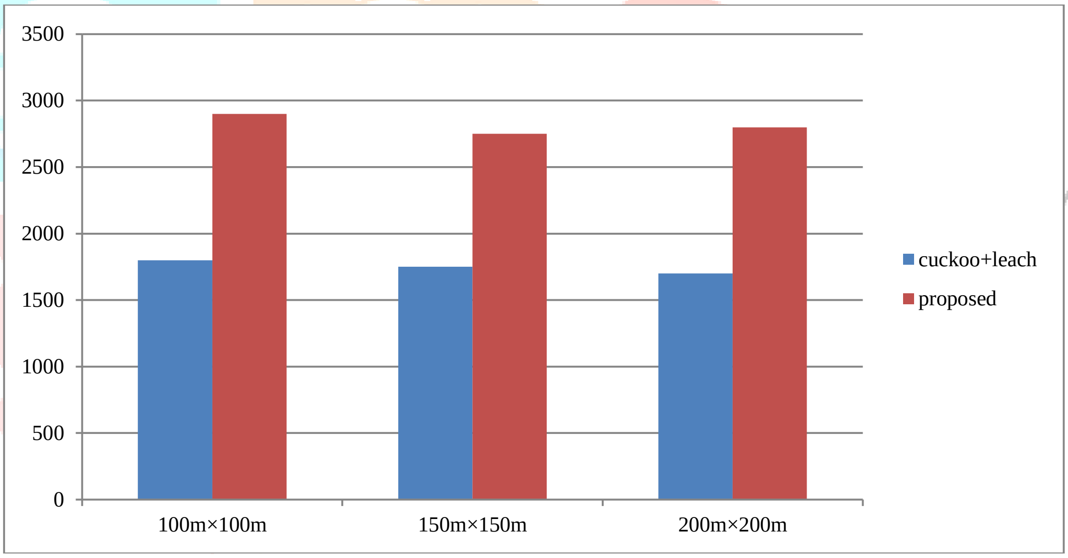
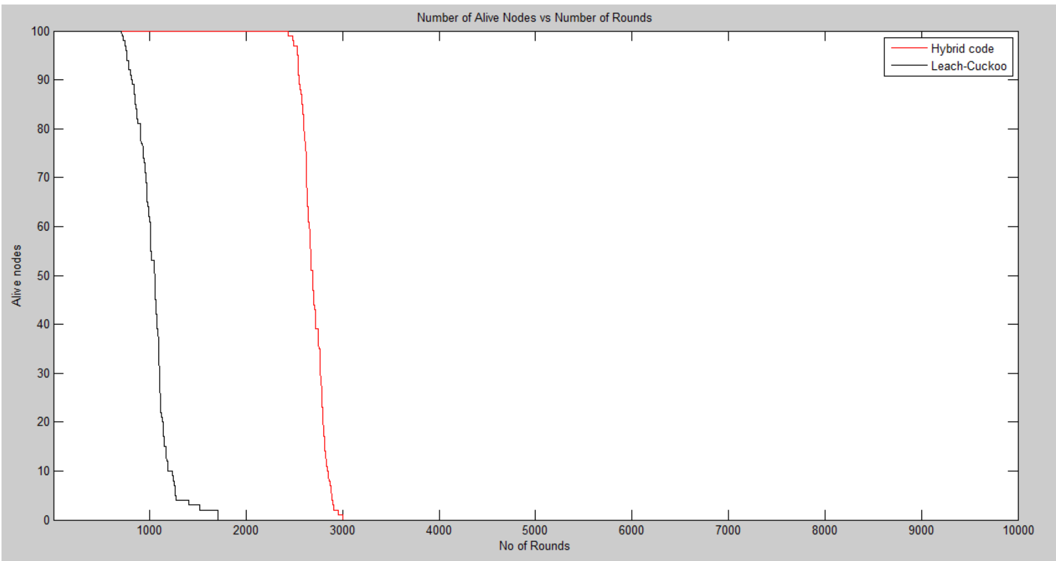
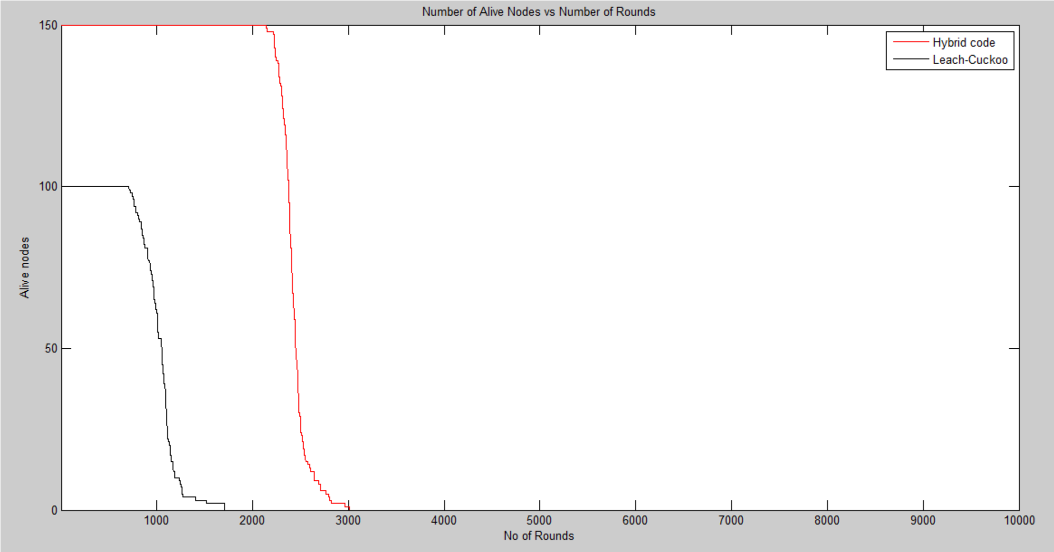


figure 5.3: showing comparison of proposed technique with existing technique on the basis of number of alive nodes.



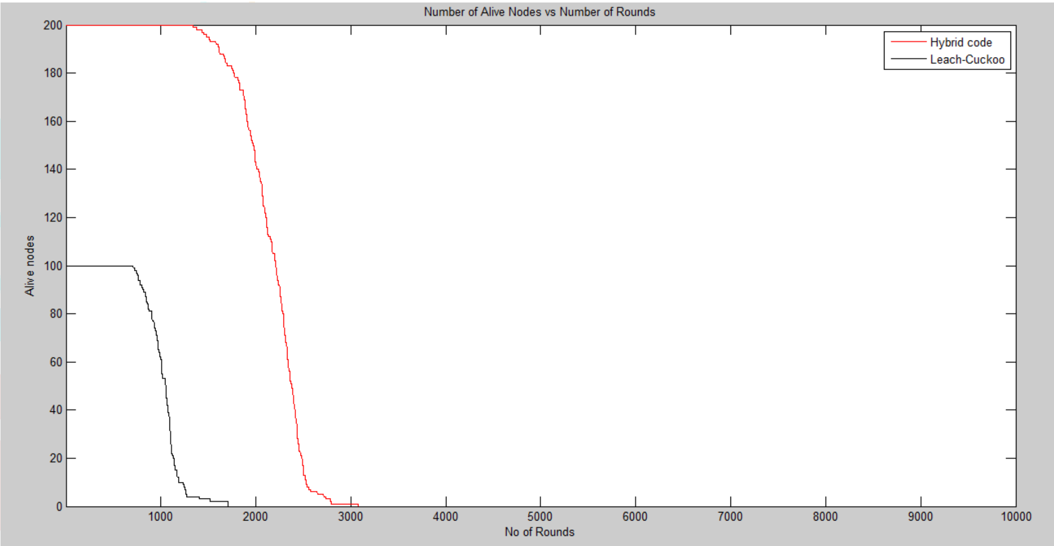
rounds

figure 5.4: alive nodes versus different rounds in the first scenario



rounds

figure 5.5: alive nodes versus different rounds in the second scenario



rounds

figure 5.6: alive nodes versus different rounds in the third scenario

5.2.2 Minimal energy of network

The study explains how the overall amount of energy consumption increases with respect to total number of rounds. Residual energy is the key parameter for the network life of the sensor. Figures5.8 displays the effects of the average residual energy per round for the proposed solution and current algorithm for case studies. Simulation outcomes show that our strategy improves the network lifetime and enhances the network stability by handling remaining energy delivery relatively uniform among sensor nodes.

table 5.2: showing comparison of proposed technique with existing technique on the basis of minimum energy of network.

Number	Network size	Sensor node	Sink location	[Existing] Cuckoo+ leach	Proposed
1	100m×100m	100m	50m,50m	1250	2900
2	150m×150m	150m	75m,75 m	1200	2500
3	200m×200m	200m	75m,75 m	1150	2450

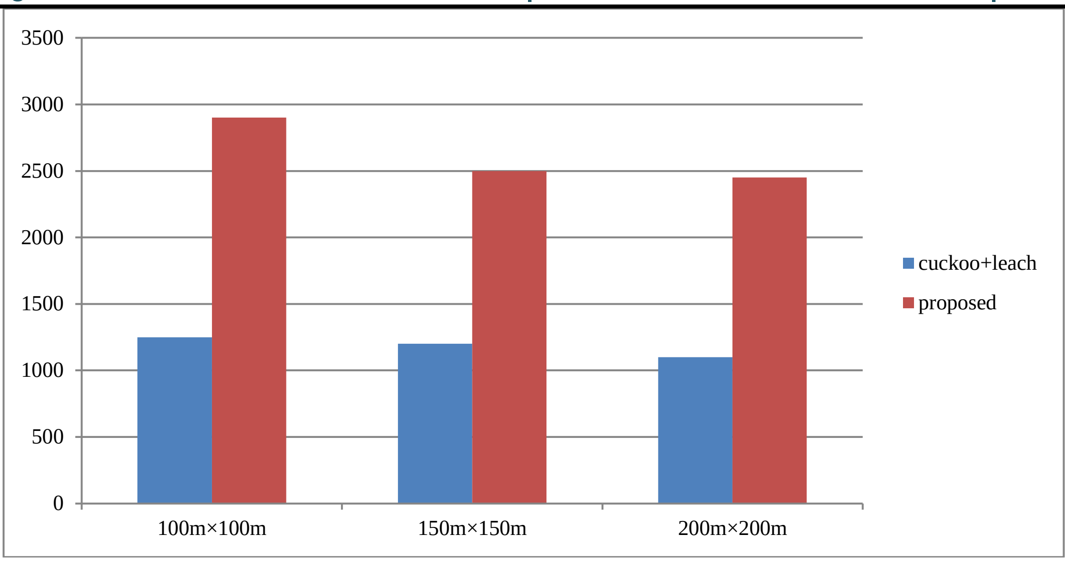
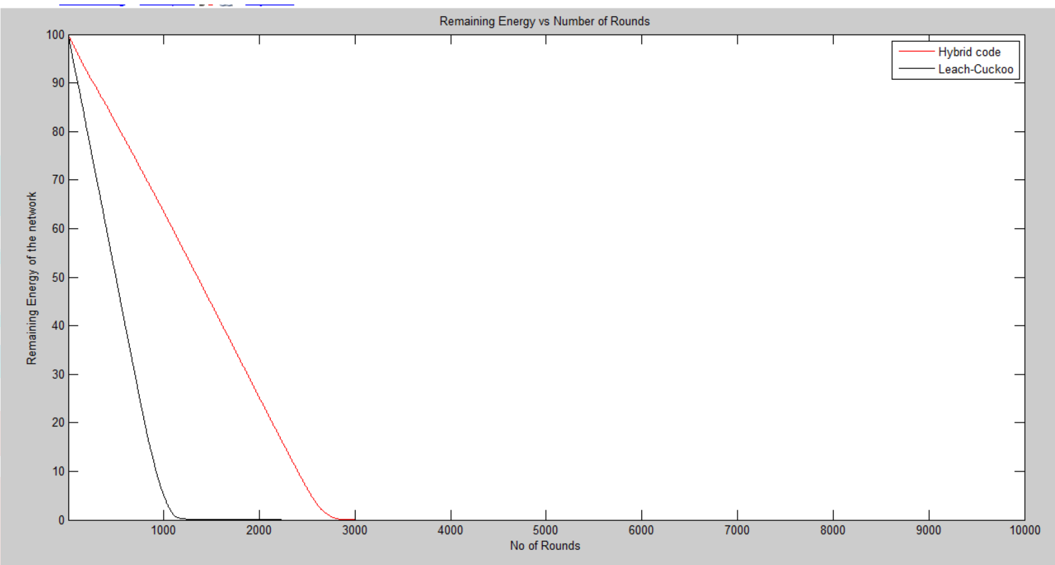
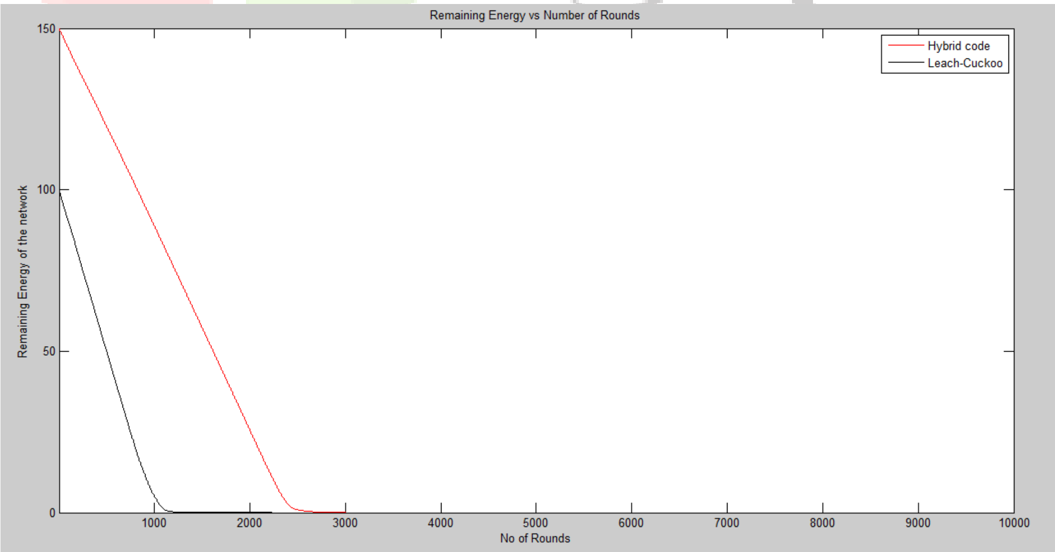


figure 5.7: the bar graph showing comparison of proposed technique with existing technique on the basis of minimum energy of network.



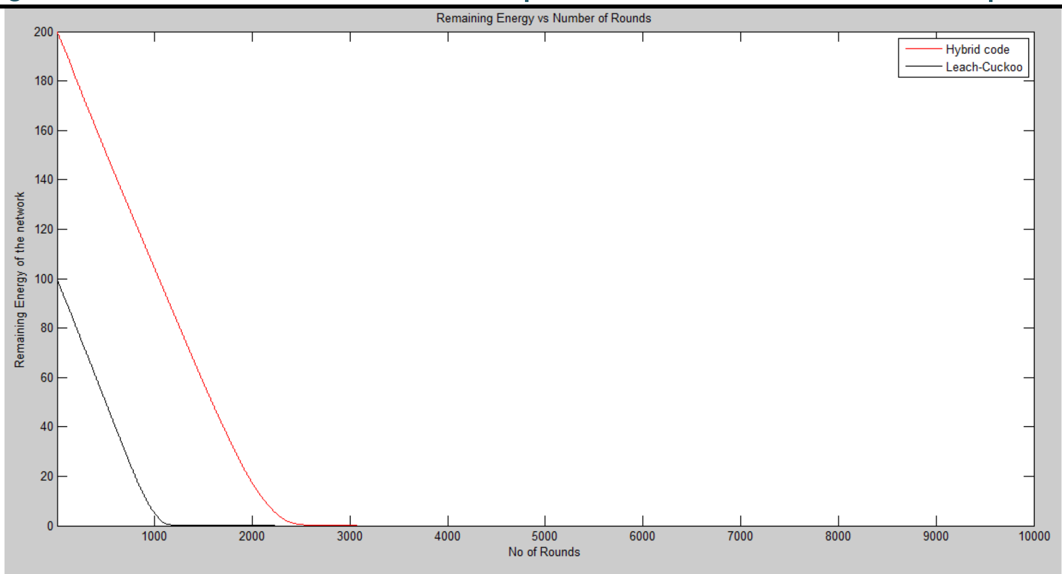
rounds

figure 5.8: the minimum energy of network versus different rounds in the first scenario



rounds

figure 5.9: the minimum energy of sensor nodes versus different rounds in the second scenario



Rounds

figure 5.10: the residual energy of network versus different rounds in the third scenario

V1. CONCLUSION

Wireless sensor networks are more complex in their specifications, and awareness program of the existence of apps, power limitations of sensor nodes, tradeoffs between performance objectives specifications, and constraints of new technologies is needed to offer clustering approaches for them. K-means algorithm is best way for the formation of clustering because clustering –based methods partition network nodes into cluster. Distributed energy efficient protocol is an energy aware adaptive clustering protocol which is designed to deal with nodes of heterogeneous WSNs and this protocol uses initial and residual energy level of nodes. It helps to evaluates the ideal value of network life-time, which is used to calculate the reference energy that each nodes should dissipate throughout a round and every sensor node independently elects itself as a cluster-head based on its initial energy and residual energy. In this paper, improves the energy-efficiency as compared to previous protocol. Hence , the consumption of energy by residual energy must be as minimal as possible. The remaining energy of the network is more than when compared to cuckoo algorithm. This article identifies the literature analysis of the energy efficiency method clustering used in current papers to extend the life of the wireless sensor network, which is useful for future studies.

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