WIRELESS SENSOR NETWORKS: A SURVEY ON RECENT ALGORITHMS AND TECHNIQUES

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Abstract - *It's captivating how Wireless Sensor Networks (WSNs) play a major role in revolutionizing the world by its sensing technology.*

The research interest in WSNs has increased as a result of the potential for their widespread use in many different arenas. Those which include right from home automation, security and environmental monitoring to confidential sectors like military surveillance and many more. Despite the successes gained, the widespread adoption of WSN's particularly in remote-inaccessible places where their use is most beneficial is hampered for various reasons. The major challenge being the "inefficiency in energy consumption"! This paper, introduces different aspects to improvise the lifetime network and efficiency of the network. Insights are given to various other energy management schemes and approaches that include variations in clustering and routing of data. It also provides a brief and simulated study of different techniques and algorithms in the field of WSNs. This paper contributes in a fashion about introducing the WSNs in different sectors of its operation and reflecting its significance.

***Key Words*: Wireless sensor networking, cluster head, clustering, energy, grid Based, cluster**

1. INTRODUCTION

A typical wireless sensor network contains hundreds and thousands of sensor nodes who can communicate among themselves using radio signals. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components. To pull in a nutshell, Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. WSNs mainly includes three basic components: sensor nodes, cluster head(elected from sensor nodes), base-station. The working of WSN goes like; randomly distributed senor nodes collect data from the surrounding, multiple observed and analyzed. All the techniques and protocols are then applied to the this structure of WSNs as an add-on, so as to gain the best possible and optimal results!

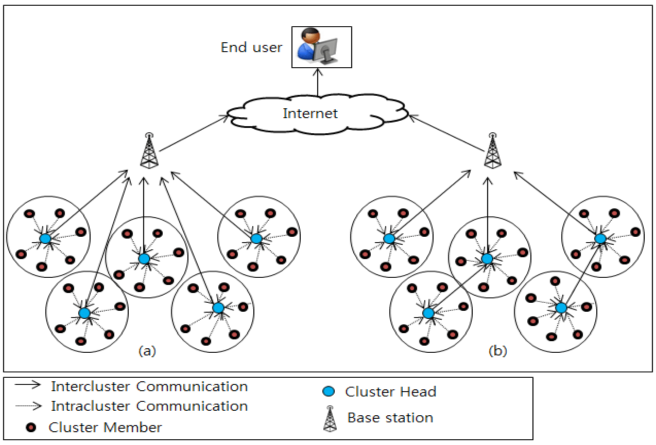

Fig -1: Basic architecture of WSN

2. RELATED WORK

IN [1],

The main aim of algorithm that has designed is:

1. To prolong the network survival time by considering active and sleep state
2. To enhance the reusability of each CH node
3. To decrease delay

Formulae Used:

- Path-loss between each transmitter and receiver in dB:

$PL = FSPL + 10\tau \log10(s) + X\zeta$, where, s Is the distance between the receiver and the transmitter, τ is the path-loss exponent, $X\zeta$ incorporates the large scale signal variation.

- Free space path loss: $FSPL = 20\log10(4\pi f/c)$,

where f = carrier freq. c is light speed

- Energy Consumption in each round:

$Ernd = t(N * PL + N * \theta * DS{-}C + \theta * DC{-}B)$ where,

t is the total taken by each round, DS−C is the distance between the SNs the current CH, DC−B is the distance between the current CH and the BS, θ is the total re-transmission losses.

Concept Used:

In algorithm, first of all received power is compared with threshold energy. If sensor node satisfies this condition then its channel gain and residual energy values are analyzed. Those sensor nodes satisfy this condition is considered as number of CHs nodes. SNs with the highest rank are selected as a CH. If the residual energy of CH goes below the hand-off threshold δ, handoff process initiated by base station. After this hand-off stage, the sensor node changes its state from active to sleep mode and starts to harvest. From this proposed algorithm, improves the energy consumption and reduces the delay effect in the transmission by using a mobile sink during the hand- off stage, which increases the lifetime of network. The improvement was about 33% factor of another algorithm that was compared.

Graphical Result:

Average energy of each node is improved and CH selection efficiency is increased as compared to DCHSM

In [2],

The clustering algorithm in WSN based on the DE in 3D scene And 3 stages are cluster head selection, clustering and path planning. DE is mainly used for solving global optimization problem. It is divided into initialization stage and evolution stage.

- Initial population is generated by the calculate formula they have designed.
- DE Strategy Equation is also calculated, in that: x represents population vector, v represents offspring variation vector. F represents scaling factor.
- The fitness function is determined by: (K/ rho)*avg(distance)

Graphical representation:

Dead number of cluster heads were less than the other algorithms compared with this. Dead number of cluster head was less and network lifetime increases, improve the clustering strategy and further increase the utilization rate of system energy.

In [3],

Problem: Hotspot (cluster head takes data from sensor nodes and it has also to transmit this data from it to another CH so it has much load on itself. It leads to hotspot problem.) EEUC algorithm is improved for the process of cluster head election and cluster building. Each sensor node uses the RSSI method to calculate its distance from node to the base station. RSSI is Received Signal Strength Indicator method.

- $RSSI(in\ dBm) = A - 10nlg\ d$ A is received signal power, n is path loss.
- $d(in\ cm) = 10\hat{}((A - RSSImax)/10 * n)$

Process:

First base station assign a parameter mew to sensor node value between 0 and 1. Then threshold value is calculated and compare with mew. If mew<T then it is selected as candidate of CH. If not then it is set as ordinary node and keep as an energy saver node.

Candidate node calculates competition radius by measuring distance d and formula Rc. For another selection of CH, candidate having more energy selected as CH. Message is broadcasted to all nodes again by candidate CH. For another cluster formation again broadcast radius is set to Rc.

Problems in EEUC:

- Energy consumption is unequal because number of members are different in each cluster.
- When density of nodes is high, traffic will be high and greater will be energy consumption.
- The node which left behind, join the nearest cluster so it makes traffic.

Improved Algorithm:

- In EEUC negotiation mechanism was used but here time scheduling is used for message broadcasting.
- The nodes with higher remaining power and shorter distance to the base station required shorter election time. They will broadcast messages of successful elections earlier than other candidate cluster head nodes and become cluster head with high probability. Those are failed to become member directly goes to sleep mode so that traffic will not be there.
- Cluster nodes farther from BS have more number of SN and closer CH have less number of SN.

In [4],

1. Heterogeneous WSN model

a. Creation of Cluster

i. Us of LEACH Protocol

b. Optimum number of clusters

i. optimum number of clusters kopt for our cluster based network, having n sensor nodes distributed randomly in a (MxM) sensor field is as

kopt=√(n/(2pi)) x √(Efs/Emp) x (M/d2)

ii. the optimal probability of a sensor node to become cluster head can be calculated as

popt =kopt/n

2. Proposed Model:

a. cluster head election process:

i. battery power

ii. residual energy of the node

iii. moderate and advanced nodes have higher probabilities to become a cluster head in a particular round than the normal nodes.

b. The proposed heterogeneous network model doesn't effect on the spatial density of the network but changes the total initial energy of the network.

c. approached to assign a weight to the optimal probability of a sensor node (popt) to become cluster head in a particular round.

Weight= Einitial of each node / Enormal node

3. Results:

1. can increase the number of alive nodes

2. Throughput is better than SEP

3. throughput is stable enough up to around 2300 rounds

In[5],

1. Protocol: an improved form of AZ-SEP protocol 2. Network Architecture:

a. nodes are randomly organized in the field b. divide the sensor field into three zones(z0,z1,z2)

c. Normal Node: low energy placed near to BS(z0)

d. Advanced nodes: s placed far away from BS(z1,z2)

3. Operation of AZ-SEP

a. Direct Communication: from node to BS directly

b. Communication Via CH:

i. Multi Hop communication 1 to 2 to 3 to 4

c. selection of CH is same as LEACH

4. Implementation:

a. Communication of CH with BS

i. AZ-SEP protocol introduce multi-hop approach

ii. CH to CH data transmission

b. CH selection:

i. Residual energy of the node

ii. Distance from the BS

In [6],

1. Optimal Clustering:

a. distributed randomized clustering algorithm for organizing the sensors in the wireless sensor network in clusters while maintaining the hierarchy of cluster heads

b. The results show that total energy usage is reduced with increasing the number of levels in the cluster while transmitting the data to the data processing center

c. SEP approach proposes two different weighted optimal election probability: i. For normal nodes ii. For advanced nodes

2. EM-SEP:

a. improves the stable period of clustering hierarchy in the sensor networks by maintaining well balanced energy consumption

b. we choose the advanced nodes to become cluster heads more often than the normal nodes as the SEP protocol does

3. Analysis:

a. Time interval=>EM-SEP>SEP by 05%

b. prolongs the life time of the network by 5%

c. EM- SEP throughput is little bit less than SEP throughput, but EM-SEP is much better to lengthen the sensors time

d. better number of alive nodes per round.

In [7],

1. QRRP protocol divides the sensor field into square shaped grid cells. A sink moving around the sensor field transmits

queries to the boundary cell header, which further forwards them to the RoIs. Then cell header of the enquired region transmits data to the sink. Peripheral movement of mobile sink aggravates the load on boundary cell headers, and consequently makes them susceptible for hot spot problem.

2. Phase 1: Ring construction

Step 1: Sensor field partitioning QRRP divides the sensor field into k equi-distant, concentric rings R1, R2,....,Rk of radii r1, r2, ... , rk respectively number of rings =X, if Y ≤ Rc X + 1, otherwise where X=[L/Rc] and Y = [L/X]

Step 2: Candidate rendezvous node election

Step 3: Rendezvous node selection and joining

3. Phase 2: Sink location updation

Step 1: If sink lies outside of all the rings, then it broadcasts a Sinkinfo MSG towards network center, otherwise in the opposite direction of network center

Step 2: If the node receiving Sinkinfo MSG is a normal sensor node, then it forwards the message to rendezvous node.

This procedure continues recursively until a rendezvous node receives Sink info MSG from both of its neighboring rendezvous nodes.

4. Phase 3: Query and Data forwarding

Angle based routing

Algorithm1: Ring construction

Algorithm2: Angle Based Routing Algorithm3: Query Forwarding

5. Phase 4: Ring re-construction

Algorithm 4: Data Forwarding

In [8],

1. Assumptions Sensor nodes are supposed homogeneous and its geographic location are fixed and known in advance. Nodes are assumed to be static and deployed randomly into two different distributions

2. Algorithm the lowest cost edge, evaluated according the average amount of energy consumption for the transmission and either minimum number of hops or minimal distance, is considered iteration within a communication range R to expand the tree with another new node.

3. Performance minimum hop-routing has better performance than the distance based routing and improves the minimization of number of sensor nodes implicated in the transmission of data packets.

4. Unequal cluster based algorithms

The EEDUC improves the popular clustering method namely EEUC. EEDUC node generates hello message for clustering purpose. Each node calculates waiting time by utilising relevant parameters. parameters considered

1. Residual energy

2. Node degree.

a. CH decision goes in favour of highest weight node. balances energy consumption of nodes along with optimizing the hot spot issue

b. Spilts the nodes in unequal sizes of clusters to reduce hotspot problem

c. UCR include two works:

1. energy efficient unequal clustering algorithm (EEUC)

2. energy aware routing protocol for multi-hop routing process

d. Each cluster head unequal range value and hence unequal clustering occurs.

e. Cluster member joins the cluster head for which the signal strength is highest.

f. Environmental noise reduces the performance of the protocol.

In [9],

Here 5 important Factors are taken into consideration for CH SELECTION:

- delay
- CH coverage
- CH lifetime
- average distance to CH
- maximum power of nodes

PROPOSED METHODLOGY: 3 phases in each round

PHASE 1: Cluster Formation

clusters are made on probabilistic approach.

Best CH is selected.

PHASE 2: CH Identification

Here we calculate the values of the above mentioned factors every time:

a. Delay :

Delay = ((Einitial−Eresidual) Einitial + r) ∗ RT D,where r- Random number 0 to 1 RTD- Round trip delay

b. Cluster Head Coverage of Nodes:

CH Cov=(Total Nodes(min(Distance(Nodei-CHs)<0))) nodes cluster

Nodes(Min(Distance(Nodei−CHs))≤d0)) nodes cluster

c. Cluster Head Lifetime:

ClustHd Life = Eres CHi Average Transmission Energy Required

d. Average Distance to CH: Average CHs Dist = Pnodes cluster i=1 Distance(nodei−CH) nodes cluster

e. Maximum Power of Nodes:

PowerMax=max(Trans.Power(Nodei−CH)

PHASE 3: Re-cluster:

When CHs are selected then all clusters are again formed on the basis of distance which is measured on the basis of intensity of signal received from member nodes to the selected CHs.

Next, for routing they use the optimized path selection on the basis of initial distance.

Algorithm :

Step 1- for all nodes p,

CASE 1- m is a member, transmit the gained info to THE RESPECTIVE CH.

Step 2- CASE 2- If m is a CH,

If (dist_to_basestation << initial d (do))

Transmit info to BS

If NO Find a CH having lower and near distance to d0, if no CH found then pass it to near CH;

Step 3- CASE 3- if m is an obstacle Use SPA on sensor m; 15 Dijkstra's (G, src)

STEP 4- All sensors from G , store in a list As long as the list isn't empty, k=sensor in List having lowest distance(k) extract k from List for every nearest node 's'of k

do

temp= d to(k)+distance(k,s)

if (temp < d to(s)) then

d_to(s)=temp

previous nodes(s)=k;

return previous nodes();

Here, comparison can be made with LEACH and it outperforms. Comparison on the basis of dead nodes and Eres Here optimal clusters are made so that every member node joins with nearest CH, this helps in reduction of communication cost between member node and respected CH.

In [10],

Initially, In SEP protocol, nodes in WSN are classified into two factors i.e.

a)advanced nodes and

b) common nodes according to energy levels.

For increasing the performance of SEP, the rotation cycle is: **1+ μα /p** where, p is the optimal probability and advanced nodes is α times that of common nodes. Threshold is calculated by:

The probability of node with different energy being selected as cluster head is (P/(1+a*m)) for normal nodes and (P*(1+a)/(1+a*m)) for advanced nodes.

SEP Protocols:

Residual Energy factor: It is calculated by residual energy of each node divided by total number of nodes.

Signal Strength Factor is determined by taking factors like:

Ptra (transmitted signal power)

λ (propagation factor)

d(distance from node to sink).

Density Factor: Ratio of N nei(n) is the amount of elements in the set nei(n), that is, the quantity of effective communication nodes of node n.

In this protocol SEP is compared with SEP-M. By experimenting it, it was found that first node die was earlier in SEP as compared to SEP-M and lifetime of network is increased. Alive nodes were more than that of SEP.

Graphical results: Energy consumption is reduced and average energy of each node is improved than SEP.

In [11],

EEUC (Energy Efficient Unequal Clustering) uses multi hop network concept for routing with unequal clustering methods.

In initial stage, sensor node calculate its distance from node to base station on the basis of strength of signal received from base station. By considering this parameter node decides transmission power to destination. The parameter Radius Rc is also calculated. dmax and dmin are the maximum and minimum distances from the node in the network to the base station, d (s, BS) is the distance between the node is and the base station. After considering radius, members are selected to make CH. The node constructs its neighbor candidate cluster head set CH S according to the received broadcast message. After round, comparing the remaining power of Sch, CH gets selected.

Time schedule is the factor calculated by taking parameters like remaining energy, distance from source to BS, x, threshold value, etc.

Diagrammatic View: By comparing it with LEACH, Energy consumption of this method is less than that of LEACH. Network lifetime is better than CH. Stability of generating CH is better than CH.

In [12],

K medeoids algorithm is related to k-means algorithm for partitioned the data or clusters into groups. In this paper MST is used for shortest path and K medeoid technique.

K medeoid is like if we have a data and if we want to take centre then instead of finding mean we take central value from cluster.

K medeoid Algorithm:

a. Select k points as initial representative objects b. Repeat until criteria fulfilled

i. Assign each point in cluster with closest medeoid.

ii. Randomly select non representative object

iii. Compute total cost S of swapping medeoid m with o.

iv. If S<0, then swap m with o to form new medeoid

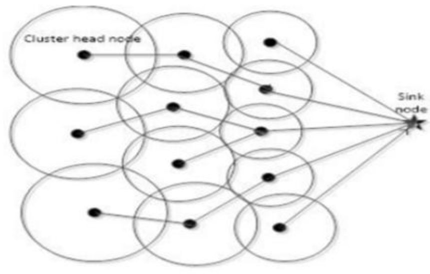

Figure 1 Routing protocol based on unequal clustering

Algorithm steps:

Step 1: Start

Step 2: Place sink node at (0, 0) coordinate

Step 3: Put all nodes randomly in two form i.e. 30 and 100 nodes

Step 4: Divide the network into clusters

Step 5: Apply K medoids algorithm

Step 6: Involve the network graph G(V, E), k is no. of clusters to be shaped, where V as well as E is

Step7: Select k nodes arbitrarily as first cluster heads, also usage m to mean set of those k cluster heads

Step 8: CH performs by distance computation

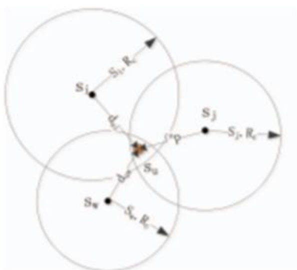

Fig. 2 Member node selects cluster head

Step 9: Formation of Minimum Spanning Tree

Step 10: Data transmission performed through cluster head

Step 11: Repeat

Step 10 until it reached destination node

Step 12: Stop

In [13],

PROPOSED METHODLOGY:

- Initial phase

- Set-up phase
- Communication phase

INITIAL PHASE :

Here sensors obtain the necessary information from their neighbours to form network. sensors can only get their own location by GPS and record the information of residual energy. Then sensors begin to exchange their own information with their neighbors until the sink obtains the information of all the sensors. When the information exchange is finished, the system enters set- up phase.

SET-UP PHASE:

After all the preparations are finished, set-up phase will start. In set-up phase, the network topology is determined by- - AP (Affinity Propagation) -modified K-medoids. Goal-To find the CHs and divide all the sensor nodes into appropriate clusters. The AP algorithm is firstly introduced to find out the optimal cluster number and the position of initial cluster centers. Then K- medoids algorithm is used to achieve the final clustering result.

Communication phase:

This is the routing phase. The network then enters into the communication phase and data transmission is conducted in this phase.

Step 1- Here the clustering algorithm is executed in a distant server and the result of the clustering is sent to each sensor by broadcasting. When sensor nodes receive the clustering message, the real network architecture is established.

Step 2-In each round, the member nodes communicate with their corresponding CHs to upload the monitored data and their own residual energy.

Step3 -Each CH gather the monitored data of their members and then data fusion is conducted to filter the redundant data.

Step 4- the compressed data is transmitted to the BS. At the end of each round, the BS uploads all the data of this round to the remote server.

Step 5-Finally, the remote server will quickly calculate the topology of next round of the network and return it to the BS. The BS determines whether it is necessary to send the reconstructed message by comparing whether the topology information of the previous round and current round are consistent.

Step 6-The next round starts with a message from BS and the network repeats the process from the set-up phase.

ANALYSIS:

In the traditional K-medoids algorithm, the initial cluster centers were randomly selected which means that the algorithm needed to iterate more time to get together. Additionally, the traditional K-medoids would run easily into local optimal solutions. With the purpose of solving the mentioned problems, AP is adopted to figure out the initial cluster centers to enhance the performance of K-medoids. Network lifetime of this algorithm in comparison with other algorithms gives a performance gain as :

- 16.23% - UCR-H
- 31.39% - LEACH-AP
- 51.9% - EDDUCA

Simulation results performance gain :

- 33.33% - UCR-H
- 52.5% - LEACH-AP
- 54.21% - EDDUCA

In [14],

This paper is basically based on grid based clustering algorithm to solve the hotspot problem in the network. So this technique will help to improve the network lifetime. At start the whole network is divided into several grids as every grid is of size calculated by their formula.

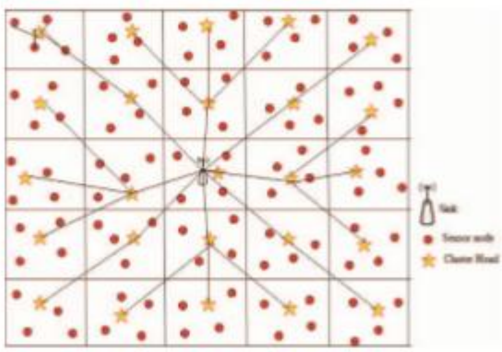

Fig. 2 The organization of GCMRA

There are three phases basically in the grid base clustering:

1. Initialization phase: Construction of grids
2. Setup phase: CH selection process
3. Routing phase: Multihop routing technique

Each grid selected as cluster and In each cluster, we select a normal sensor node as the CH, which has minimal distance from other sensor nodes within the cluster and has residual energy more than threshold value.

Total distance is the sum of distances from one sensor node i to all the sensor nodes within the cluster, which is calculated.

The minimum total distance of grid g is also calculated by their formula.

In multihop routing, one CH will search for next grid CH which is closest and send data to it and then to sink.

Comparative study: As compared with LPGCRA and EBCA, network lifetime of grid base clustering has been increased. Energy consumption is reduced.

3. CONCLUSION

This case study talks about various approaches to clustering and routing in WSNs. Comparing various algorithms outputs it proves how some techniques like EM-SEP overcomes SEP in terms of time constraint, SEP-M retains its first node for a longer time while SEP does not, EEDUC improvises EEUC, reducing the hotspot problem and many more. With a view to highlight significance of research aspect in WSN, a brief introduction for every algorithm, all of it' issues, simulated comparative study have been discussed. All of the research and implementation challenges existing in designing the WSNs for modern applications are presented. It can thus be concluded that WSN has revolutionized almost every sector of modern era.

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