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An Approach for Base Station Control and Power Competent by WSN

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Abstract: Wireless sensor networks are a comparatively new technology for information gathering and processing. A sensor network usually consists of many, resource controlled sensor nodes. These nodes perform measurements of some physical phenomena, route data, generate bangs, and send these reports via multi-hop communication to a central information processing unit called base station. In WSN, energy efficiency and because of it, the lifetime of sensors, have a major impact on applicability and network performance. Applications range from battlefield or critical infrastructure surveillance over emergency response to health care scenarios. Depending on the application, the monitored environment can be covered by hundreds or even thousands of sensor nodes. In the clustered routing architecture, a number of nodes, based on their geographical location, are grouped as a cluster, and on out of these nodes in a cluster is selected as cluster head node, based on certain parameters, collects, processes, and forwards the data from all the sensor nodes to the base station as a single hop or a multi-hop. In this research, we have developed a routing protocol with name "Centralized Energy Efficient Hierarchical Routing Protocol" - CEEHRP. This protocol is base station centralized i.e. this protocol utilizes a high-energy base station to set up clusters and routing paths, performing rotation of cluster heads, and carrying out other energy-intensive tasks. The research demonstrates the change of states undergoing in the network and how the energy level of each node changes with time. It shows the no. of nodes dead in each round and the energy consumption each round. The process of clustering and finding the appropriate cluster head is a major improvement and has major impact on energy consumption. The cluster head is selected on basis of its energy level and optimum location so as to minimize the energy consumption while hopping. All these aspects are compared for proposed method and existing routing protocols to demonstrate the efficiency of proposed method.
Keywords: Clustering, WSN, Sensor nodes, energy consumption, routing protocol.

I. INTRODUCTION

OVERVIEW OF WIRELESS SENSOR NETWORK

A sensornetwork is composed of a huge number of sensor nodes, which are closely organized either inside the phenomenon or very close to it. In WSN, sensor nodes monitor physical situations such as sound, pressure, temperature etc. and to pass their data over the network to main position. The more modern networks are bi-directional, also allowing control of sensor movement. In the clustered routing architecture, a number of nodes are grouped as a cluster, and cluster head node, which is selected, based on certain parameters, collects, processes, and forwards the data from all the sensor nodes to the base station as a single hop or a multi-hop. In this architecture, nodes are grouped into clusters, and a dedicated cluster head node collects, processes, and forwards the data from all the sensor nodes within its cluster. In this research, the proposed routing protocol is with name Centralized Energy Efficient Hierarchical Routing Protocol - CEEHRP. This protocol is base station centralized i.e. this protocol utilizes a high-energy base station to set up clusters and routing paths, performing rotation of cluster heads, and carrying out other energy-intensive tasks. The algorithm demonstrates the change of states undergoing in the web and how the energy level of each node changes with time.

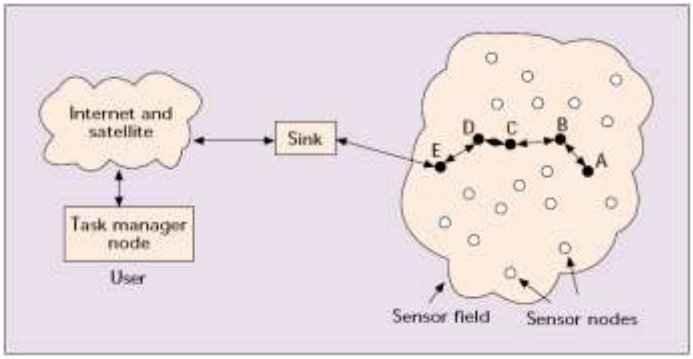

Figure 1: Sensor node scattered in sensor field

In WSN, energy efficiency and lifetime of sensors have a significant impact on applicability and network performance. One of the key characteristics of sensor nodes is that they are energy constrained, if the diameter of the network is large, the power of sensor nodes will be drained very quickly. Furthermore, as the number of sensor nodes increases, collision becomes a significant factor which defeats the purpose of data transmission.Typically sensor nodes rely on finite energy sources like battery. Cluster formations will be simple and distinctive and the cluster head role is supposed to be equally distributed among nodes. Hierarchical routing architecture divides the whole network in to a group of cluster and only cluster head is responsible to forwarding the data to base station directly or via other cluster heads.

2. RELATED WORK

Until now, many researchers performed valuable research in the area of Wireless Sensor Networks by computer simulation and experiments. Most of them are focused on energy consumption, Throughput improvement and life time of the nodes. The research by SumitWadhwa intends to design centralized and energy saver hierarchical routing protocol and compare with BCDCP (Base station Controlled dynamic Clustering Protocol) and SHPER (Scaling Hierarchical Power Efficient Routing). [1]. Stefano[5] proposed a new protocol called Equalized Cluster Head Election Routing Protocol (ECHERP), which pursued energy conservation through balanced clustering. ECHERP models the network as a linear system and, using the Gaussian elimination algorithm, calculates the combinations of nodes that can be chosen as cluster heads in order to extend the network lifetime. The Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is analyzed and implemented on the Tiny OS and Crossbow MICA2 hardware platform by Geofang[6]. Devendra Prasad designed Secure and Energy Efficient Centralized Routing Protocol (SEECH) for hierarchical WSNs. In SEECH, the base station (BS) collects information about the logical structure of the network and residual energy of sensor nodes.[8]

3. THE PROPOSED METHOD

The proposed algorithm is used to remove the problems of the previous algorithms and compare the already existing centralized hierarchical routing protocol. This algorithm extends the system lifetime of the network and betters the consumption of energy. Simulation results indicate the new algorithm has the advantages of reducing energy consuming and prolonging the lifetime of the sensor network. Although energy is dissipated in all of the models of a sensor node, we mainly consider the energy dissipations associated with the communication energy consumption since the core objective of algorithm is to develop an energy-efficient network layer routing protocol to improve network lifetime.

```
S(i).E=S(i).E- 1.2*( (ETX+EDA)*(4000) + Emp*4000*( distance*distance*distance*distance ));
tw=tw+( (ETX+EDA)*(4000) + Emp*4000*( distance*distance*distance*distance ));
t1=t1+( (ETX+EDA)*(4000) + Emp*4000*( distance*distance*distance*distance ));
```

The formulae for energy dissipated by cluster heads are given below-:

```
S(i).E=S(i).E- ( ETX*(4000) + Emp*4000*( min_dis * min_dis * min_dis * min_dis));
tw=tw+( ETX*(4000) + Emp*4000*( min_dis * min_dis * min_dis * min_dis));
t1=t1+( ETX*(4000) + Emp*4000*( min_dis * min_dis * min_dis * min_dis));
```

The transmission and receive energy costs for the transfer of a k-bit data message between two nodes separated by a distance of d meters is given by Eqs. 1 and 2, respectively.

$$E_T(k,d) = E_{Tx}\, k + E_{amp}(d)\, k \quad (1)$$

$$E_R(k) = E_{Rx}\, k \quad (2)$$

Where $E_T(k,d)$ in Eq. 1 denotes the total energy dissipated in the transmitter of the source node, and $E_R(k)$ in Eq. 2 represents the energy cost incurred in the receiver of the destination node. The parameters E_{Tx} and E_{Rx} in Eqs. 1 and 2 are the per bit energy dissipations for transmission and reception, respectively. $E_{amp}(d)$ is the energy required by the transmit amplifier to maintain an acceptable signal-to-noise ratio in order to transfer data messages reliably.

CEEHRP utilizes the base station to control the coordinated sensing task performed by the sensor nodes. In CEEHRP the following assumption are to be considered.

- A fixed base station is positionedaway from the sensor nodes.
- The sensor nodes are energy reserved with a uniform initial energy allocation.
- The nodes are equipped with power control capabilities to vary their transmitted power.
- Each node senses the location at a fixed rate and all sensor nodes are immobile.
- Each node looses energy when it sends or receives data at a rate specified in formulae above.

The terminology used to explain the routing protocol and the elements implemented on it are described here to make easy to follow the detailed description provided in the following sections.

- **REQ** is the message used by base station. Initially, Base station broadcast this message to all the sensor nodes in the field to indicate that all nodes should start their task.
- **REP** is the message broadcasts by all the nodes after receiving REQ message, in order to find their neighbors. This REP message will reach to those nodes only that are within range of that node.
- **REP2** is the message send by a node when it receives REP message. This message contains the node id. After receving the REP2 message, each node makes its neighbor list. Initially a node has empty neighbor list. When a node replies with its ID, then node receiving REP2 message retrives the ID and make entry in its neighbor list.
- **STATUS** is the message send to base station either directly or via gateway. It contains neighbor list, residual energy of the node. After collecting the neighbor information, each node send STATUS message to the base station. Thus the entire information about network nodes is centralised on the base station.
- **ACK** is the acknowlegement send by the base station and those nodes which receives STATUS message. That means when base station receives STATUS message directly it send back an ACK message. Or when a node (Gate Way) have STATUS message, It also sends back an ACK message to acknowldge them that STATUS has been succesfully received.

3.1Methodology

Step 1: Initally enter the number of nodes and number of rounds in the sensor field of the network area.

Step 2: The Base station deploy the nodes in Network area with constant energy E.

Step 3: Base Station sends a REQ message to all the nodes in the sensor field, to find information about every node.

Step 4: After receiving the "REQ" message, each node broadcasts the reply message "REP" and the nodes receiving REP message sends "REP2" message holding its ID. When a node gets reply, it will write down the ID of the node from where the reply has been recognized. In this way each node will have their separate neighbor list.

Step 5: After receiving the information about their neighbors the nodes, for which the base station is inside their range, sends a STATUS message to the base station. This STATUS includes ID, routing table, and Energy of the node. Base station sends an acknowledge (ACK) to all sending nodes.

Step6: After acquiring acknowledgment ACK, the nodes declare itself as cluster head node and broadcast to all its neighboring nodes.

Step7: The node receiving the cluster head node's message will check their status whether it is cluster node or not, if it is not a cluster node then it will become other node of the cluster, from where it has received the cluster node message first.

Step8: Cluster nodes send the STATUS to its other cluster nodes which are near to the base station, or direct to the base station.

Step 9: The nodes which are directly sending the STATUS to Base Station, becomes the Cluster Head for the current round. Steps 6-8 are repeated until single node is active.

Step 10: For second round the nodes directly communication with Base Station and having max. Energy becomes the cluster head.

Step 11: Cluster Head will receive data from nodes that comes in its cluster area.

Step12: After collecting data, Cluster Head sends the aggregated data to the Base Station.
Steps 11-12 are repeated until system is active.

4. RESULTS

The plots shown below demonstrate the working of proposed protocol in simulator implemented in Matlab 7.14. The comparison of the proposed method with other contemporary methods is also shown next.

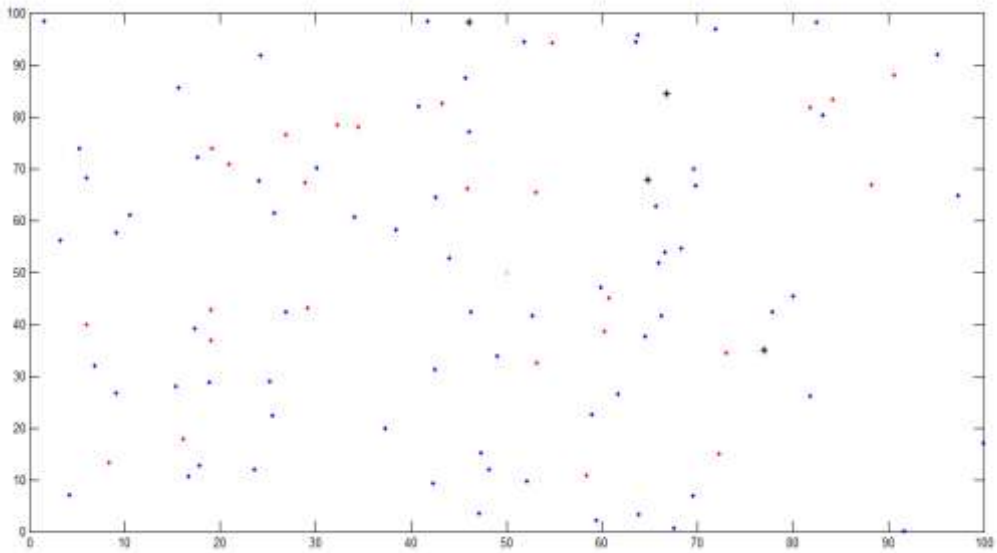

Figure 2 : The network simulator in operation

In the above figure, the network field size is 100 x 100. The blue dots shown in the figure are alive nodes and red dots are dead nodes (energy exhausted). The green dot shown in the middle is the base station. The nodes which have a * embarked on them are the currently chosen cluster heads.

4.1 Effects on performances of routing protocols:

In this experiment, we measure the performance of the proposed technique against contemporary methods using the MATLAB. These graphs represent the no. of nodes alive depends upon the no. of rounds or to calculate the number of nodes are alive. The performance is measured by the number of nodes which are active and measure the system life of the nodes.

4.2 Comparison of Average Energy Dissipation of BCDCP, BECH and CEEHRP:

These plots clearly show that CEEHRP has a much more desirable energy expenditure curve than that of both BCDCP and BECH.

Avg(kk)=aggeregation (rounds)+ energy_received (rounds)+ energy_transmitted (rounds);

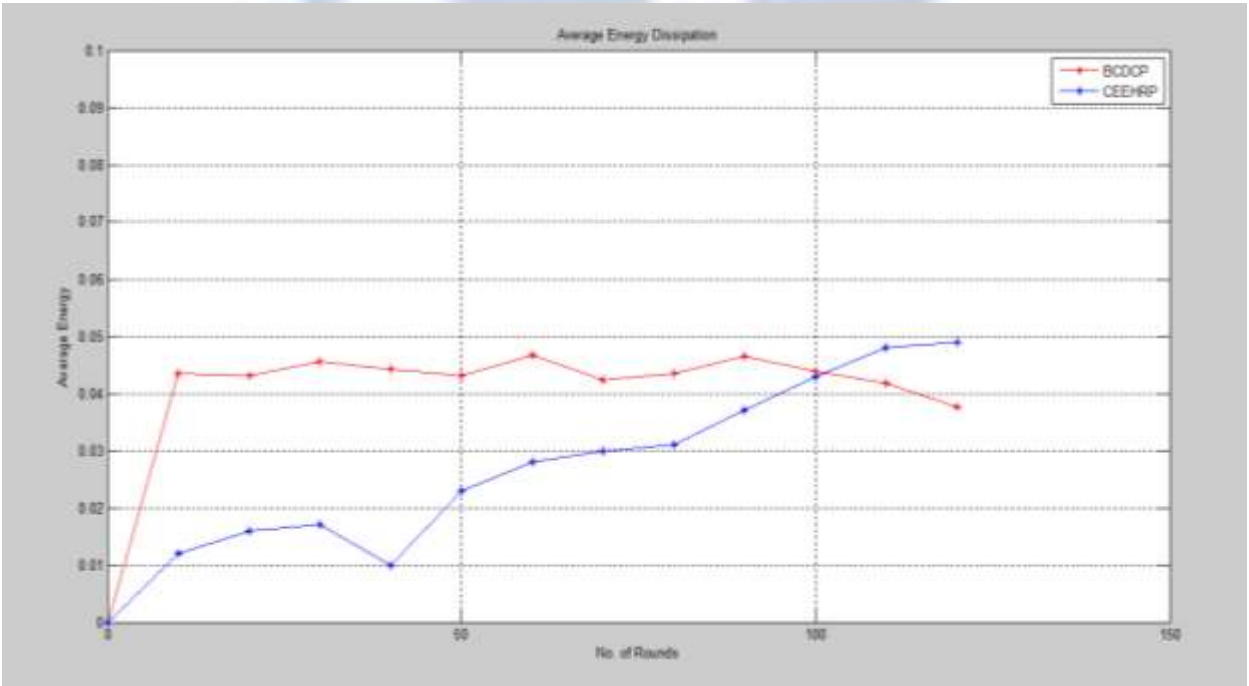

Figure 3: Average energy dissipation of BCDCP & CEEHRP

The above figure shows average energy dissipation of BCDCP & CEEHRP. The average energy is plotted along the y-axis and number of rounds is plotted along the x-axis. The red line shown in the figure is of BCDCP and blue line shown in the figure is of CEEHRP. The graph demonstrates the better working of the proposed algorithm as the average energy consumed by CEEHRP is lesser than BCDCP.

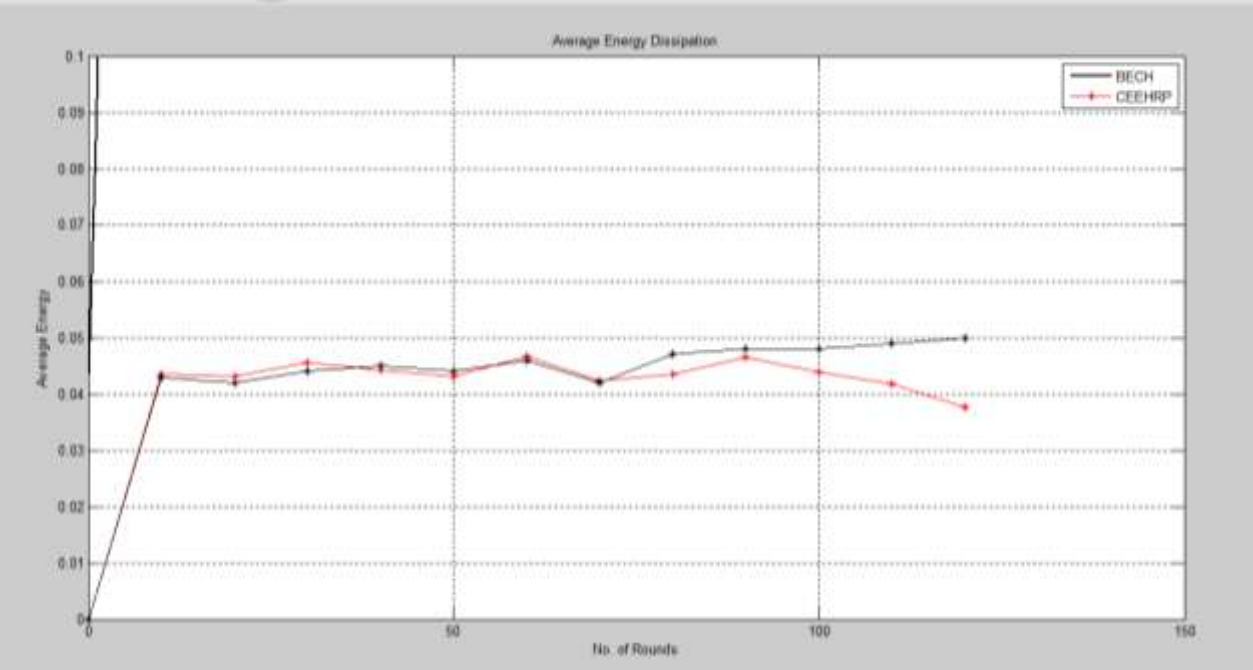

Figure 4: Average energy dissipation of BECH & CEEHRP

The above figure shows the average energy dissipation of BECH & CEEHRP. The graph is plotted between average energy and number of rounds. The average energy is plotted along the y-axis and number of rounds is plotted along the x-axis. The average energy dissipated in CEEHRP is less as compared to BECH.

4.3 System Lifetime

The improvement gained through CEEHRP is further exemplified by the system lifetime using MATLAB graph in Figure 4.7. This plot shows the number of nodes that remain alive over the number of rounds of activity for the 100 m × 100 m network scenario. With CEEHRP, as visible in the graphs shown below, the lifetime of system is better with CEEHRP as compared to BECH & BCDCP. Also, the energy consumption of network is improved with CEEHRP protocol.

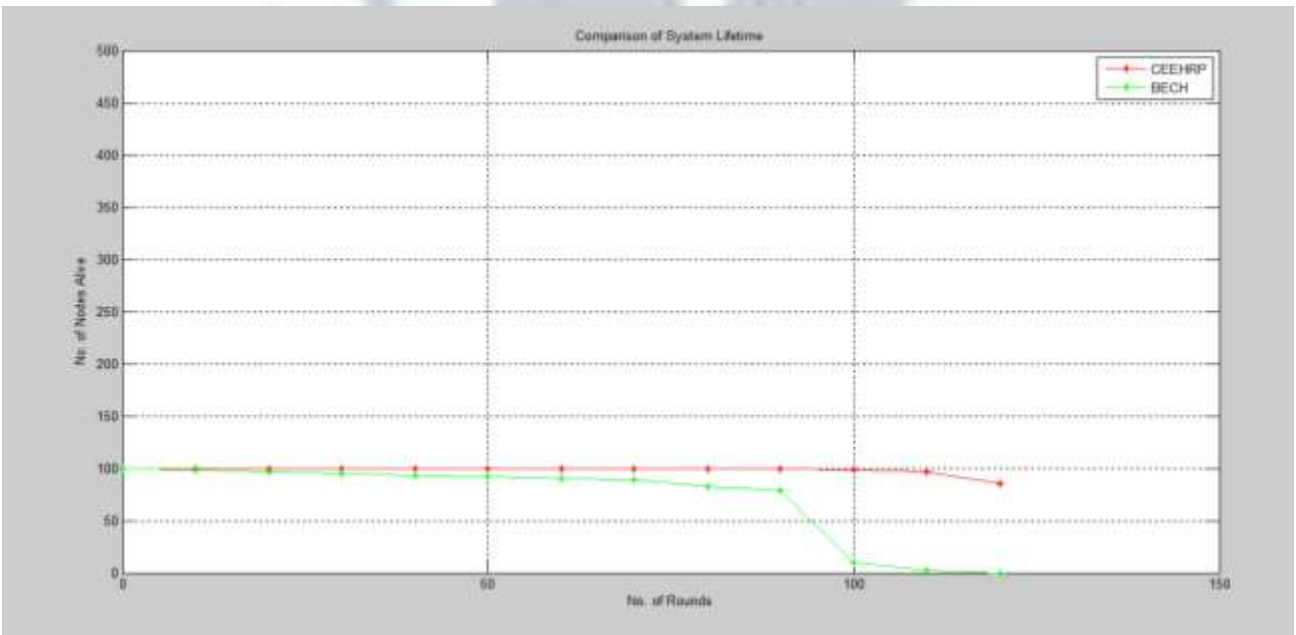

Figure 5: Comparison of system lifetime between CEEHRP & BECH

The above figure shows the comparison of system lifetime between CEEHRP & BECH. The graph is plotted between number of nodes alive which is plotted along y-axis and number of rounds along x-axis. The red line shows above is of CEEHRP and the green line shows above is of BECH. From the above figure, we conclude that number of nodes alive in case of CEEHRP is more as compared to BECH. So the proposed algorithm gives better performance than contemporary algorithms.

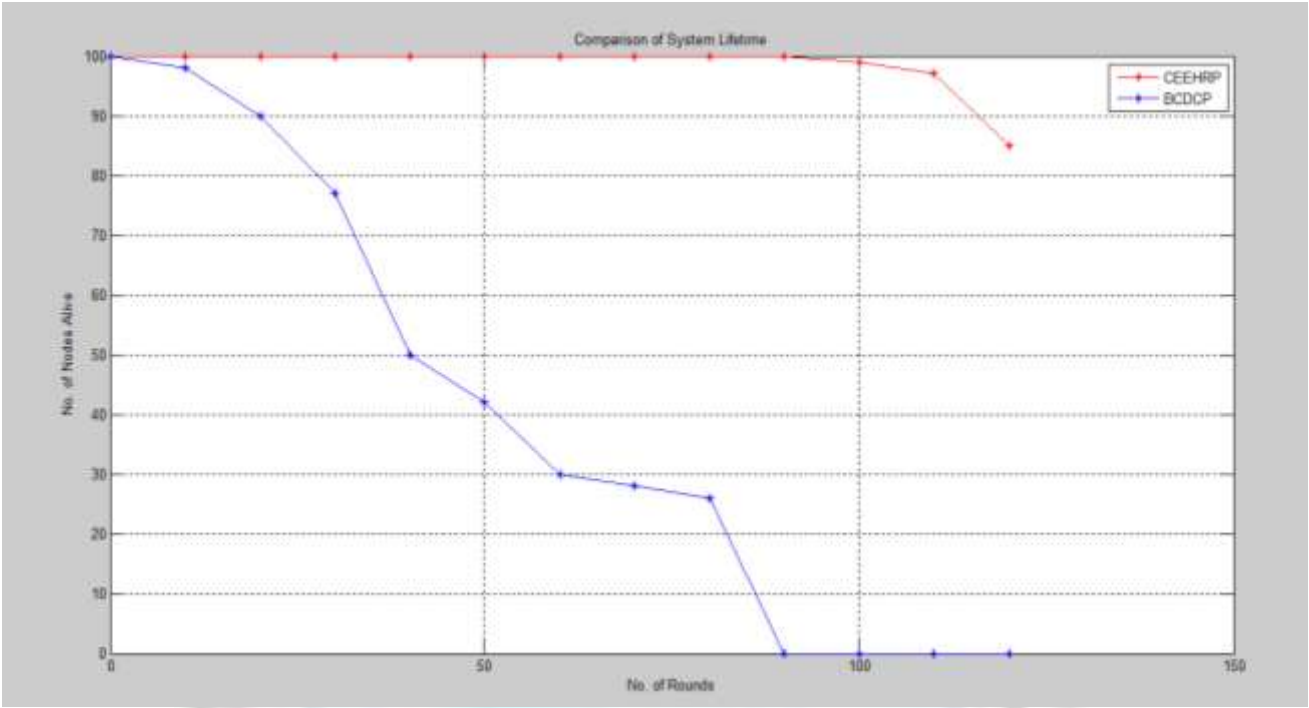

Figure 6: Comparison of system lifetime between CEEHRP & BCDCP

The above figure shows the comparison of system lifetime between CEEHRP and BCDCP. The graph is plotted between number of nodes alive and number of rounds. The number of nodes alive is plotted along y-axis and number of rounds plotted along x-axis. The number of nodes alive in case of CEEHRP is more as compared to BCDCP. So, proposed algorithm has better performance.

NODE 100 RECEIVES REQ MESSAGE FROM BASE STATION
NODE 100 BROADCASTS REP MESSAGE
NODE 1 RETURNS REP2 MESSAGE WITH ID
NODE 11 RETURNS REP2 MESSAGE WITH ID
NODE 16 RETURNS REP2 MESSAGE WITH ID
NODE 100 SENDS STATUS MESSAGE TO BASE STATION ENERGY 0.01796

The above messages are displayed in the simulation as suggested in the proposed protocol. This output demonstrates the election of cluster head and the criteria followed to elect a node as cluster head.

CONCLUSIONS

WSNs differ from traditional wireless communication networks in several of their characteristics. One of them is power awareness, due to the fact that the batteries of sensor nodes have a restricted lifetime and are difficult to be replaced. Therefore, all protocols must be designed in such a way as to minimize energy consumption and preserve the longevity of the network. This new routing protocol named Centralized Energy Efficient Hierarchical Routing Protocol (CEEHRP) which is hierarchical routing based with the whole control to the base station or we can say that base station assisted. In non-centralized hierarchical routing, sensor nodes self -configure them for the formation of cluster head. While self- configuring, the nodes are uninformed about the whole logical structure of the network. But in CEEHRP, the base station first collects information about the logical structure of the network and residual energy of each node. So, with the global information about the network base station does cluster formation better in the sense that it has information about the residual energy of each node. In this research we have demonstrated the working of this protocol through a simulation and it is clearly evident that CEEHRP is better in terms of system life time and energy consumption as compared to BECH and BCDCP. The clustering process has also been defined and demonstrated to provide better efficiency to Cluster heads.

FUTURE SCOPE

The main issue in WSN is energy limited characteristic of the sensor node. So the problem is to have the routing protocol in such a manner that it should be energy efficient in order to increase the life span of the whole WSN. The base station performs computation to form the better cluster in such a way that there is less energy consumption. In this protocol, the election of cluster heads is not randomized but is based on the residual energy of the cluster nodes and the logical structure of the whole network. So the life span of the whole network is increased. So, in future, one can aim at applying security parameters to the base station as well as cluster head of these protocols. System lifetime is basically for how long the system works. But there is no security and authentication while communicating. So this can be another research area where this can be considered. So in future, security parameters can be applied to CEEHRP.

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