JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

ON THE DESIGN AND ANALYSIS OF ENHANCED CLUSTERED CHAIN BASED POWER-AWARE ROUTING WITH NATURAL COMPUTING TECHNIQUE FOR WIRELESS SENSOR NETWORKS

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Abstract : **The energy consumption in a wireless sensor network (WSN) is a crucial issue as WSN is a battery-operated network. Routing is one of the main causes of energy consumption. The routing in a wireless sensor network is a challenging issue to the different characteristics of the network and efficient routing must result in energy saving. Different routing protocols have been given by different authors for efficient routing in the network. Then, this work enhances the CCPAR routing by using a moth dolphin-based algorithm to reduce energy consumption in WSN by using an efficient routing algorithm to route the information to the base station (BS). This work designs a routing algorithm that inherits the behavior of moths and dolphins to route the information towards BS. The routing algorithm depicts the routing**

I. **INTRODUCTION** THIS CHAPTER DISCUSSES THE BASICS OF WIRELESS SENSOR NETWORK (WSN) ALONG WITH VARIOUS APPLICATIONS AND ISSUES. FURTHER, IT DISCUSSES THE ROUTING PROTOCOLS USED IN WSN TO TRANSFER THE DATA FROM SOURCE TO BASE STATION. THIS CHAPTER FOCUSES ON SENSOR NODES, ROUTING OF DATA THROUGH CLUSTERS AS WELL AS THE NATURAL COMPUTING TECHNIQUES AND ITS OBJECTIVES.

WIRELESS SENSOR NETWORK :-

It is group of sensors that may be used for monitoring physical conditions of environment and collects the data through deployed sensors into a single location for use of different applications after analysis and research. The environmental condition may be any type e.g., humidity, temperature, pollution levels, sound, wind etc. In addition, because of the advancement of remote system, a huge number of sensors are started in a specially appointed way to carefully notice and depiction the state of an area. In this manner, remote/wireless sensor systems are accepting further applications in various practices for example, water level observing, war zone reconnaissance and fire alert. Meanwhile, many sorts of sensor convention are considered to make simple the capacity of sensor systems [2]. There are various logics to gather the data from the sensors but as ideal rulNe, data can be amassed by three courses are as: tree-based, group based and chain-based [3] [4]. Routing in WSN is very carefully executed work and it always decide the performance of the network. The technique used for routing need to send the data between sensor nodes and base station. Therefore, base station works as a processing unit and analysis the collected data as per requirement.

ARCHITECTURE OF WSN

As appeared in fig. 1.1, the remote sensor organizes and the traditional framework contains the standard segments like sensor hubs (utilized as source, sink/actuators), portals, internet, and satellite connection etc.

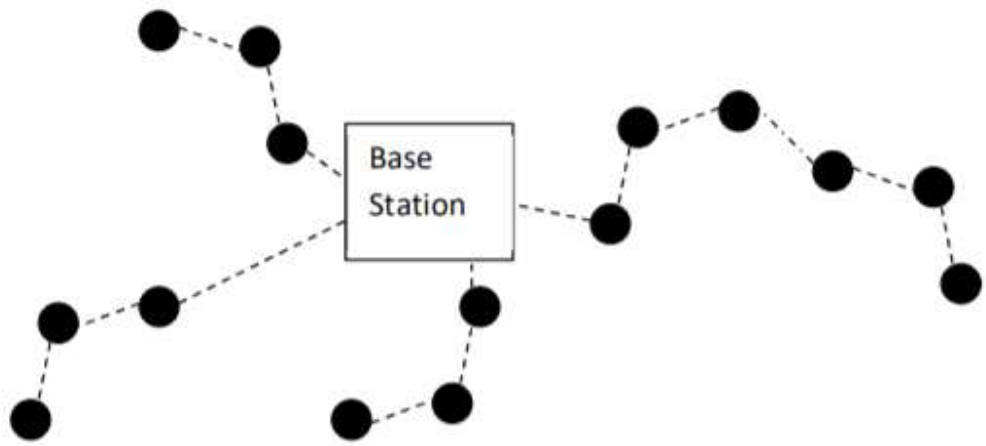


Fig. 1.1: Illustration of sensor network and backbone infrastructure

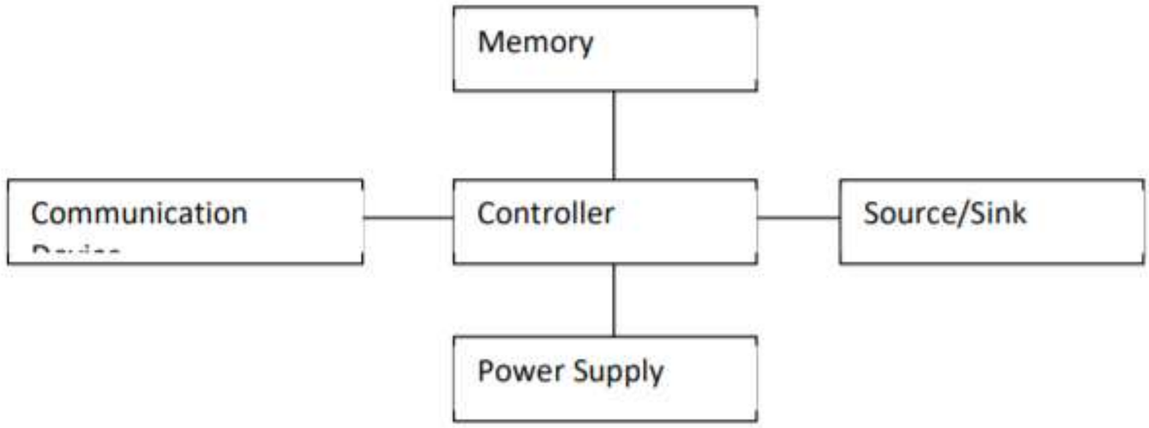


Fig. 1.2: Overview of sensor node hardware components [19].

1.2.1 Sensor Hub / Node

1.2.2 Gateways

1.2.3 OSI Model

1.3 ISSUES IN WSN

The communication networks divided into various classes of networks e.g., cellular networks, adhoc networks, sensor networks and mesh network etc. Most of the networks are infrastructure dependent networks. There are lot of definitions given by the researchers for wireless sensor networks as per observation the WSN is special class of adhoc network that are used to provide infrastructure for wireless communication and used the instruments to observe the natural environment of physical infrastructure and further used that information for decision making and circulate/distribute as per requirement [6,20].

1.3.1 Node Deployment

1.3.2 Energy Considerations

1.3.3 Data Delivery Models

1.3.4 Data Aggregation/Fusion

1.3.5 Collision Avoidance

1.3.6 Location Determination

1.3.7 Data Collection

1.3.8 Fault Tolerance

1.3.9 Scalability

1.3.10 Network Dynamics

1.3.11 Transmission Media

1.3.12 Quality of Service

1.4 CONCEPT OF CLUSTERING IN WSN

Clustering in WSN means to divide all sensors nodes into various groups based on some rules that will be called as virtual groups and there will be different rules/functions can be applicable on the different groups as per needs and application requirements. Every cluster must have a cluster head and all sensor nodes communicate directly or multi hop with the cluster head

1. Sensor Node: Sensor node/node is the center part of WSN. It can be used in a system for various purposes, for example, basic detecting, information stockpiling, steering, and information preparing etc.

2. Cluster-heads (CHs): These are the association pioneer of a group. It's used for storing and filtering the information and then forwards the aggregated information on the destination. 9

3. Base Station: The base station which act as administrator, or which can take the decision at the upper level and aggregate the data. It gives the correspondence interface between the sensor organize and the end-client.

4. End User: Information in a sensor system can be utilized for an extensive variety of uses. [9] Therefore, a specific application may make utilization of the system information over the web, utilizing a PDA or even a personal computer. In a questioned sensor arrange (where the required information is accumulated from an inquiry sent through the system). This inquiry is produced by the end client [26, 27 and 28].

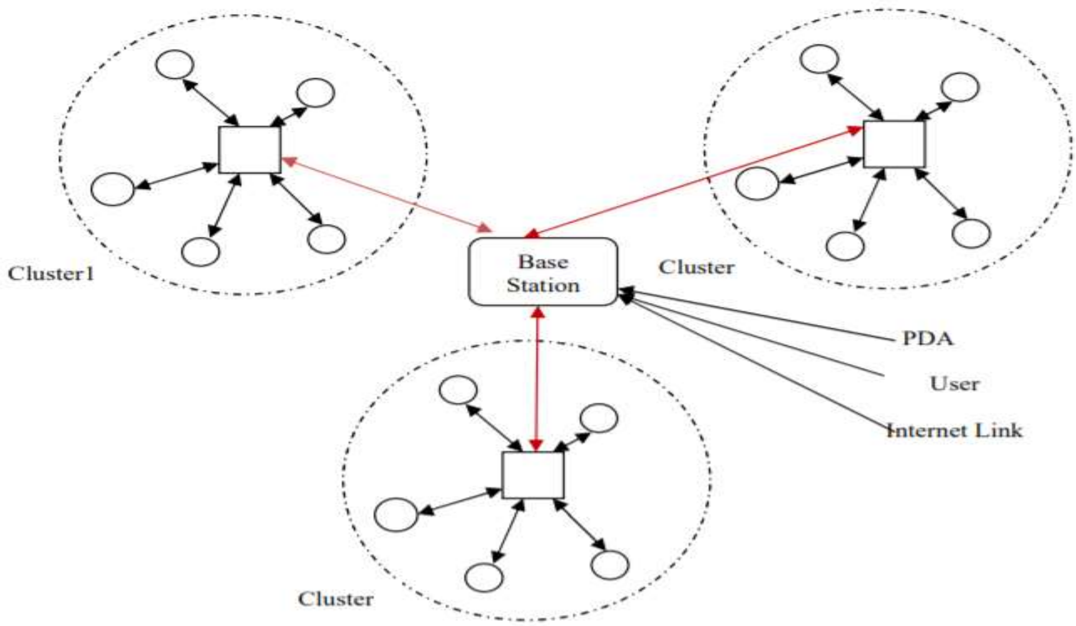


Fig. 1.3: General Sensor Network Architecture [26].

1.5 CLUSTER

The cluster is group of nodes with logics that simplify the complexity of large network and improve the performance in different networks [30]. 1.5.1 Types of Clusters 1) Well-Isolated Bunches: A bunch is an arrangement of focuses with the end goal that any point in a group is closer (or more comparable) to each other point in the group than to any point not in the cluster [31]. 2) Center-Based Groups: A group is an arrangement of articles with the end goal that a question in a bunch is nearer (more comparative) to the "middle" of a group, than to the focal point of some other bunch. The focal point of a bunch is frequently a centroid, the normal of the considerable number of focuses on the group or a medoid, the most "illustrative" purpose of a cluster [31]. 3)

1.6 CLUSTERING

Clustering is characterized as the gathering of comparable items or the way toward finding a characteristic relationship among some articles or information [32]. It implies partitioning sensor hubs in virtual gathering as per a few tenets (called bunch) and after that, sensor hubs having a place in a gathering can execute distinctive capacities from other nodes. It is utilized in WSN to transmit prepared information to base station limiting the quantity of hubs that participate in long separation correspondence prompting bringing down of aggregate vitality utilization of the framework. It is a division of information into gatherings of comparable items. Each gathering, called bunch, comprises of articles that are comparative amongst themselves and not at all like 11 objects of different gatherings

1.6.1 Classification of Clustering

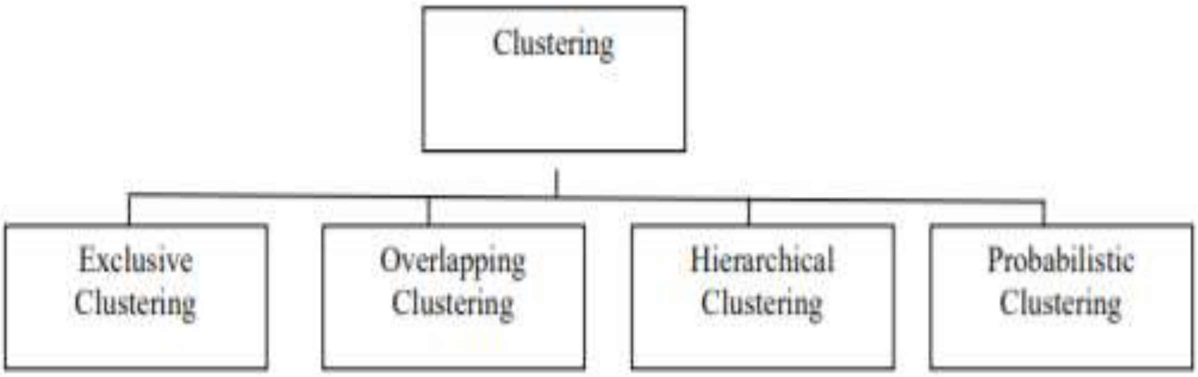


Fig. 1.4: Classification of clustering algorithm [32]

1.7 ROUTING PROTOCOL:-

The routing is a set of rules which is used to select the optimum path to transfer the data within the networks or between the networks. Routing generally a simple process to transfer the data from source to destination in the basis of routing protocols or tables which may specified by the administrator. As per need of application and networks implementations the two types of routing are used mainly. First, Non-dynamic routing (static routing), this type of routing is used most of the time in small networks and predetermined routes are mentioned by the administrator e.g. public switched telephone network (PSTN).

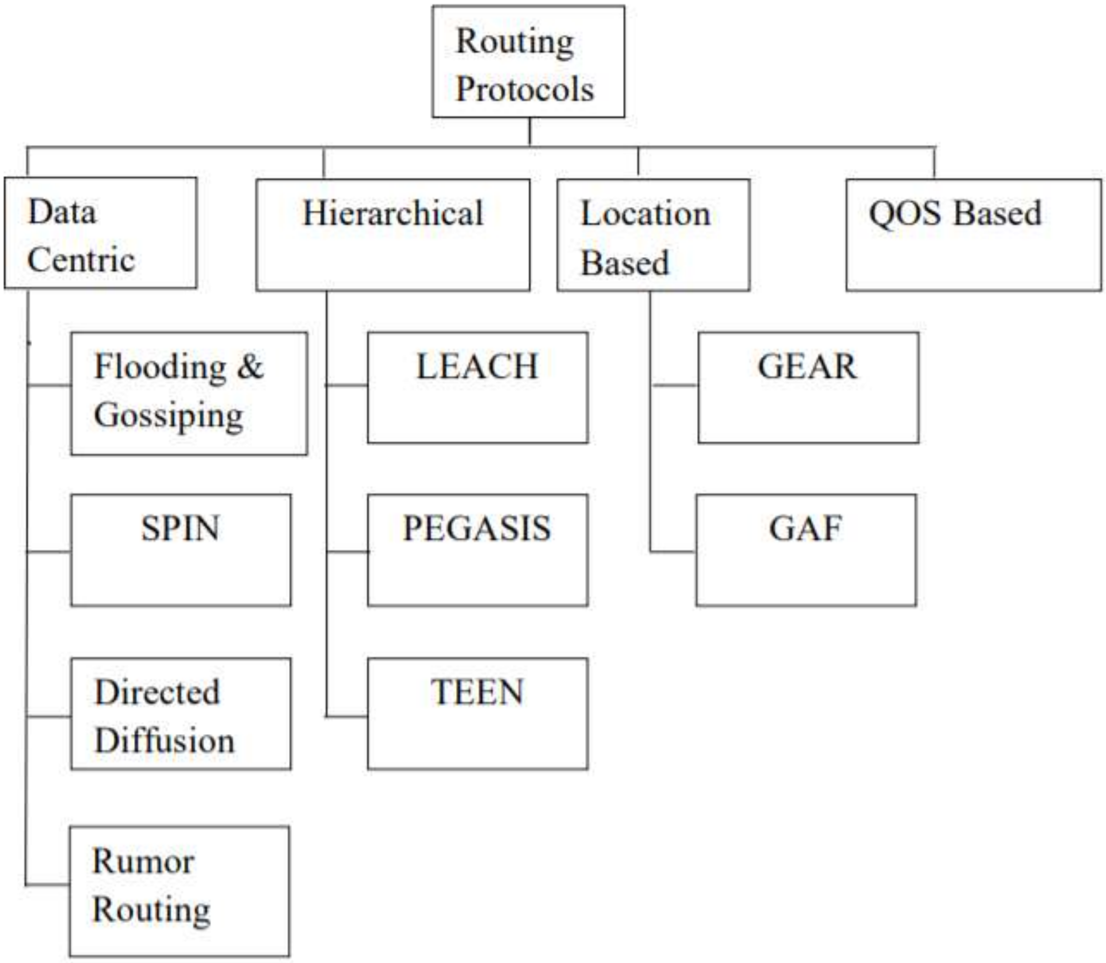


Fig. 1.5: Various Routing Protocols [35]

Here, the sensor nodes receive the interest packets using the unicast model.

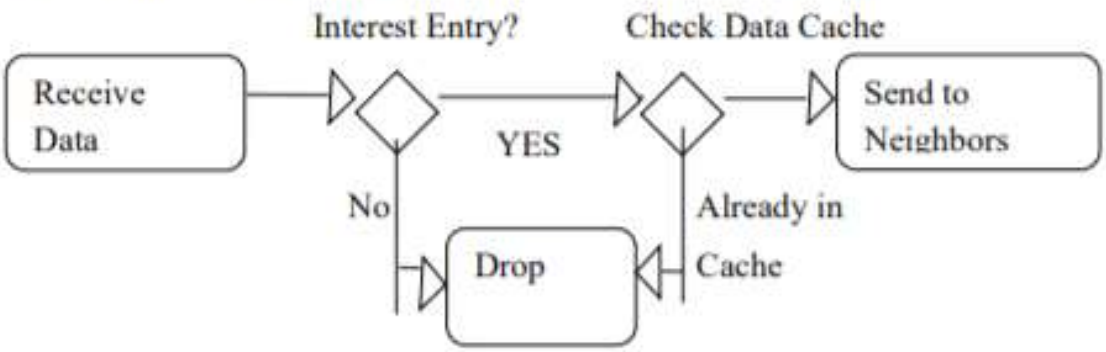


Fig. 1.7: Data Return [38]

1.7.1.2 Rumor Routing

1.7.1.3 Hierarchical Routing Protocols

1.7.2.1 LEACH (Low-Energy Adaptive Clustering Hierarchy)

1.7.2.1 Architecture of leach protocol

1.7.2.1 PEGASIS (Power-Efficient Gathering in Sensor Information Systems)

1.7.2.2 TEEN (Threshold Sensitive Energy Efficient Sensor Network Protocol)

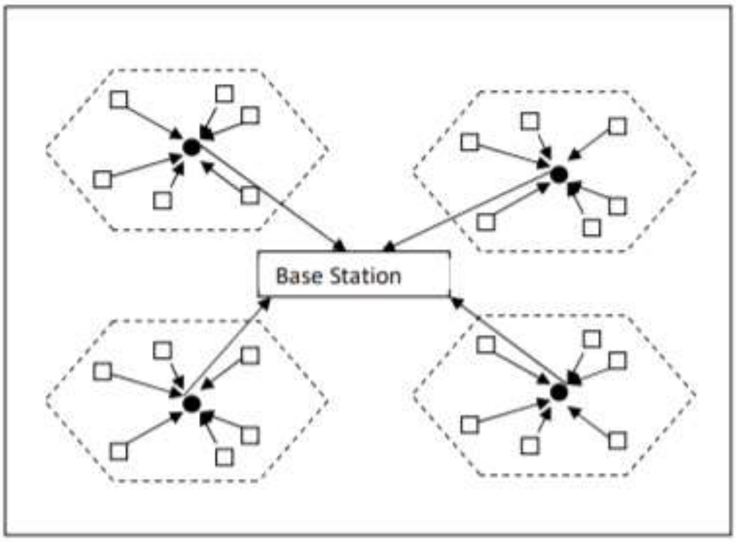


Fig. 1.8: LEACH protocol architecture [47]

1.7.3 Location-Based Routing (Geographic Protocol) Local Based Algorithms:

In this routing algorithms the position of nodes is used. These type of algorithms works on close area means in the specified region that is defined virtually. It works on local information and executes in one node mainly.

1.7.3.1 GEAR (Geographic and Energy Aware Routing)

1.7.3.2 GAF and HGAF

1.7.3.3 QoS-based Routing

1.8 NATURAL COMPUTING

Natural Computing is problem solving technique that inspired by the law of nature. This technique inspires that the natural rules, principals, mechanisms may also be used for 23 solving the technical problems with effective ways [51]. Natural inspired science/rules or nature law have complex structure and motion of work, but all have some basic rules means every think is executed in the basis of rules and regulations. The same thinks are incorporated by the researchers into the algorithms and tried to refine the existing algorithms for solving the problem in WSN. Some one of them were also succeed and it is very interesting area of research now a days [52].

1.8.1 Genetic Algorithm (GA)

1.8.2 Ant Colony Optimization (ACO)

1.8.3 Particle Swarm Optimization (PSO)

1.8.4 Moth Flame Optimization Algorithms (MFOA)

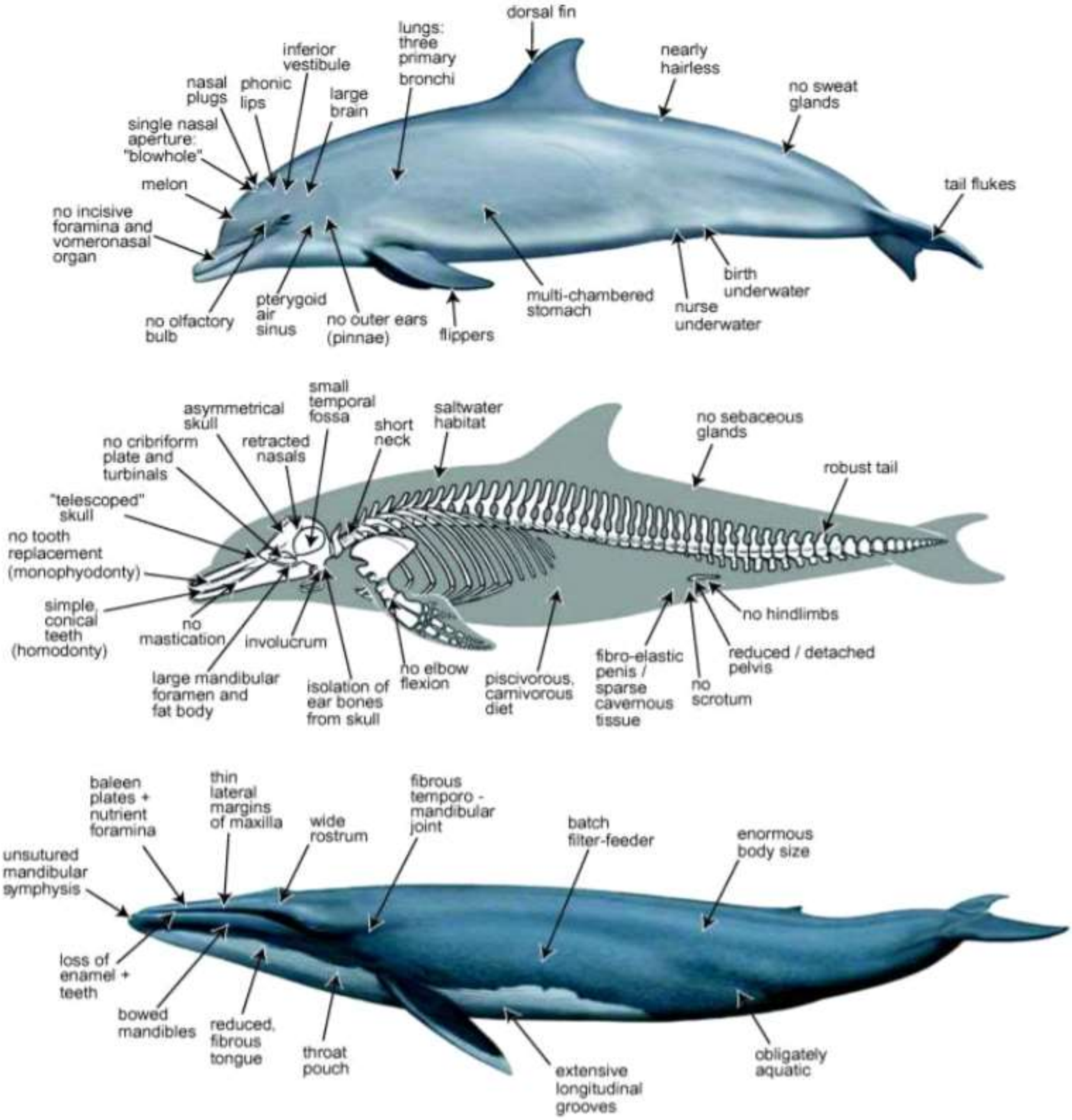
3.1 NATURAL COMPUTING

Natural computing is a field of research that is inspired by law of nature and can be used to inspire the human design computing. It appears with its three principal regions of examination, that information from different fields of research is important (1) for a superior comprehension of life, (2) for the review and reproduction of characteristic frameworks and forms, and (3) for the proposition of novel registering ideal models. Physicists, scientific experts, engineers, researcher, PC (computer scientist) researchers, among others, all need to act together or possibly share thoughts and information with a specific end goal to make normal registering practical. The computational methodologies are used to solve the multidisciplinary complex problem with their advance computing skills. Its greater part depends on exceedingly streamlined variants of the instruments and procedures. The purposes behind such improvements and deliberations are complex. Likewise, it can be profitable to highlight the insignificant components. It is also important to empower some specific fields/portions of a framework which may be recreated for exploring some reputed properties. These reputed/eminent properties lead to algorithms which are inspired from 46 the natural computing techniques and that can also be used in heuristic search. So, nature inspired techniques can be used for optimization [52].

3.2 DOLPHIN

Dolphins, like human being, have expansive brains. Dolphins live in obviously complex social gatherings and speak with a broad collection of acoustic signs [132,133]. Without a doubt, dolphins have a famous status in mainstream culture as a higher type of insight, yet how advanced and dialect like dolphin correspondence truly is, and how keen they are all in all, remain fervently. The logical contention goes back to the mid-1960s when John Lilly [134] recommended that dolphin’s trade keen data, utilize human-like conversational tenets to do as such, and even endeavor to set up between species correspondence with people. Albeit a couple of researchers today would completely acknowledge such claims, later reviews recommend that, as with human dialect, social learning is fundamentally required in the improvement of dolphin correspondence [135] that dolphin can mimic each other's calls [136] and that, together with different cetaceans, they have socially transmitted lingos [137,138]. These adaptable open capacities may support dolphins' clear limit with regards to complex types of social association, a thought upheld by another investigation of their mark shrieks [139].

On my thesis I also did this work



The body structure details of dolphin are shown in figure 3.1. Dolphin brains are composed uniquely in contrast to human brains. However, the exceedingly elaborated brains of numerous dolphins and different odontocetes are likewise altogether bigger than the human mind. The cerebrum to-body measure proportion is utilized for looking at and evaluating a creature's general knowledge or discernment. The encephalization quotient (EQ) is an estimation of the relative mind measure, which is characterized as the proportion of the genuine to the anticipated cerebrum mass of a creature of a given size and is ascertained utilizing the condition:

3.4.1 Algorithm

1. Initialize each Moth

   For i=1:n

   For j=1:Dimension

   $P_{i,j}$= random position between given bounds

   End

   F_i = Objective Function(P_i)

   End

2. [Flame_F index]=sort(F)
3. Flame=P(index)
4. Initiate Iteration say i=1
5. While $i \leq Max\_iter$

F_{Pi}= Objective Function(P_i)

$$P_i = \vee_{j=1}^{Dimension} |Flame_j - P_i| * e^{bt} * cos(2\pi t) + Flame_j$$

$P_{Best_i=}Flame(1)$

$P_{worst_i=}Flame(n)$

$$P_i' = P_i + r_1(P_{Best_i} - |P_i|) - r_2(P_{Worst_i} - |P_i|)$$

F_i'= Objective Function(P_i')

$P1_i$=QuickSort(P_i',P_i)

$F1_i$= QuickSort(F_i',F_i)

P=QuickSort($P1_i$,P_i)

F= QuickSort($F1_i$,F_i)

Update b and t

Update number of flames $n = ceil\left(n - i * \frac{n-1}{Max\_iter}\right)$

$i = i + 1$End while

6. Exit

The above algorithm follows the flame for the optimization along with the position updation, based on worst and best position. This algorithm must converge towards the global optima due to the use of exploration as well as exploitation search. The initialization process uses the exploration search. While the position updation uses the exploration as well as the exploitation along with the convergence. The performance of the MDOA is analyzed on different unimodal and multimodal functions envisaged in table 3.1 and table 3.2 serially. The MODA performance is better on multimodal function than other existing techniques shown in table 3.4. This is due to the use of exploration and exploitation phenomena in the searching. The test function of the unimodal and multimodal along with their convergence curve are shown in figure 3.2 to 3.21 for respective functions.

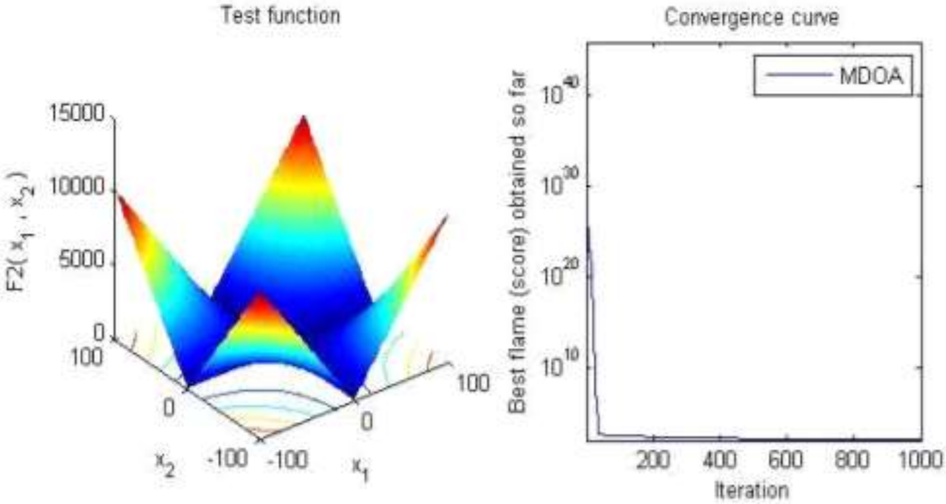


Fig. 3.3: Unimodal Test Function and Convergence Curve of MDOA on F2

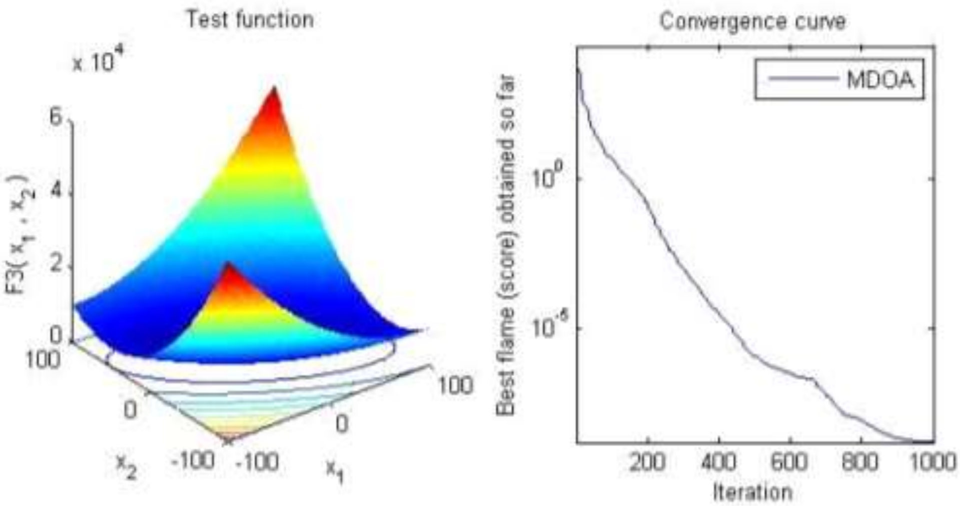


Fig. 3.4: Unimodal Test Function and Convergence Curve of MDOA on F3

CONCLUSION

This chapter defined MDOA algorithm by using the communication behavior of the dolphin. The MDOA algorithm along with the exiting MFOA algorithm has been analyzed on different benchmark functions in this chapter. The evaluated performance among different natural computing techniques ensures that the MDOA should perform better than in MFOA in a different application. Therefore, the MDOA is used to extend the CCPAR algorithm for routing in WSN. On this basis, a new routing protocol, i.e., EC-MDRA is proposed that will be the extension of existing CCPAR routing protocol which improves the performance of routing protocol.

RESULT AND DISCUSSION

The chapter describes CCPAR (Clustered Chain based Power Aware Routing) routing protocol. Then, it shows the implementation of CCPAR routing by using the MFOA algorithm i.e., EC-MFRA algorithm. Moreover, the chapter shows the implementation of EC-MDRA algorithm by using the MDOA algorithm. With the help of MATLAB simulator CCPAR, EC-MFRA and EC-MDRA have been analyzed on different network scenarios and different scaled networks by using various parameters.

4.1 CLUSTERED CHAIN BASED POWER AWARE ROUTING (CCPAR)

The modification in any existing techniques always inspired from application demands, existing drawbacks as well as scope of improvements. In LEACH system cluster head transmit direct to the base station and it's a main drawback because cluster head have a large distance from the base station. It consumes a lot of energy due to large distance covered by the data packet. Various modifications of LEACH have been discussed in [143] while data preservation during transmission has been taken care of by Xiao and Xie et al. [144] [145]. The swarm intelligence-based transmission of data is done by Rosset et al. [146]. While the CCPAR [147] transmits the data in an efficient manner without any change in data. The CCPAR system reduces the energy consumption by introducing a chain system between the cluster heads. In this routing protocol, the base station has complete information about the coordinates of the nodes within the given network. So, in the first step the base station divides the complete area into uniform clusters while covering the whole region. Then, the BS selects the cluster head of each cluster according to the energy level of the nodes within the specific cluster [147].

Table 4.3 Comparison of Throughput (in Kbps) on scaled network

Number of Nodes	CCPAR	ACO-MNCC	Frog	EC-MFRA	EC-MDRA
10	0.0048	0.005475	0.007275	0.014775	0.01635
20	0.0064	0.0073	0.0097	0.0197	0.0218
50	0.00768	0.00876	0.01164	0.02364	0.02616
100	0.01024	0.01168	0.01552	0.03152	0.03488
200	0.012928	0.014746	0.019594	0.039794	0.044036
500	0.016077	0.018338	0.024366	0.049486	0.054762
1000	0.01913	0.02182	0.028993	0.058883	0.06516

The graphical analysis of table 4.4 is shown in fig. 4.6. ; Here, the analysis has been done on different scaled networks with number of nodes ranging from 10 to 1000.

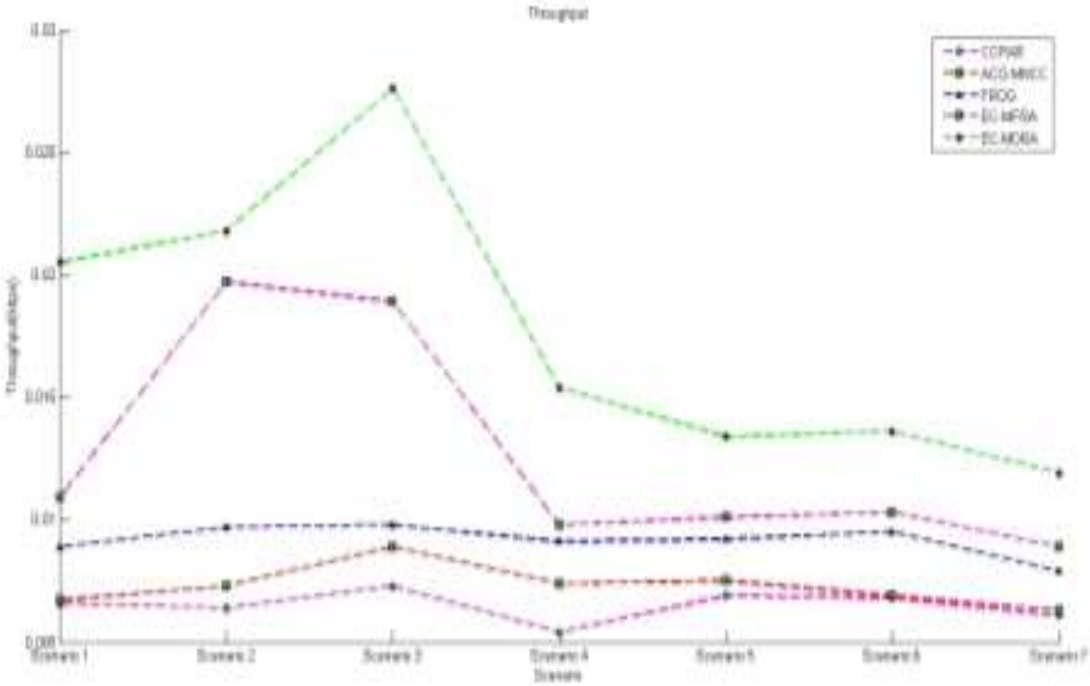


Fig. 4.4: Comparison of Throughput over Different Scaled Networks

Table 4.5 Comparison between Time consumed (in ms) on different scenario

Network	CCPAR	ACO-MNCC	Frog	EC-MFRA	EC-MDRA
Scenario1	151.51	148.80	92.21	52.73	48.88
Scenario 2	156.18	137.07	89.91	49.98	45.92
Scenario 3	137.56	112.96	88.29	42.21	36.22
Scenario 4	185.32	134.38	90.12	74.67	65.03
Scenario 5	144.40	132.59	92.12	80.21	74.63
Scenario 6	146.40	144.58	88.21	79.98	73.71
Scenario 7	162.75	158.07	99.32	91.21	83.98

CONCLUSION AND FUTURE SCOPE

Wireless sensor network is limited constraint network due to battery operated sensor nodes. The replacement of battery or sensor node is a challenging and costly task. The battery consumption in the WSN can be reduced by efficient routing of data in the network. Clustered Chain Based Power Aware Routing (CCPAR) reduces the energy consumption by introducing a chain system between the cluster heads. In this routing protocol, the base station has complete information about the coordinates of the nodes within the given network. So, in the first step the base station divides the complete area into uniform clusters while covering whole region. Then, the BS selects the cluster head of each cluster according to the energy level of the nodes within the specific cluster. The cluster head closest to base station is known as chain leader. The cluster head farthest from the base station will transmit its data to its closest neighbor cluster head. The process goes on until data is reached to the chain leader. The chain leader transmits the data to the base station. Natural computing is a field of research that is inspired by law of nature and can be used to inspire the human design computing. It appears with its three principal regions of examination, that information from different fields of research is important (1) for a superior comprehension of life, (2) for the review and reproduction of characteristic frameworks and forms, and (3) for the proposition of novel registering ideal models. Physicists, scientific experts, engineers, researcher, PC (computer scientist) researchers, among others, all need to act together or possibly share thoughts and information with a specific end goal to make normal registering practical. The

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