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ED-MFO Optimization Efficient Routing Protocol for Improving Network Stability in WSN

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Abstract: In WSN, reliable and efficient routing protocol is among the main technologies which have attracted various researchers. In WSN, for the routing purpose, the random selection of cluster heads is done. In this CH arbitrary selection in the low energy efficient clustering algorithm, the nodes' residual energy, location of node and density of node are not taken into account. Via theoretical inference as well as mathematical calculation, it has been found that it is NP – hard problem. In order to address this issue, various approaches were proposed. The quantum ABC algorithm was proposed for WSN, which was considered as an efficient technique. This approach has been analyzed and it is founded that it does not lead to major enhancement in the system. Also, the factor those are considered as the fitness factors are only the distance factor. Whereas network stability is dependent on other factors also such as energy, etc. Therefore, for enhancing the existing system for obtaining efficient results, the algorithm based on MFO is introduced in this paper. Moreover, the other fitness factors are also considered i.e. residual energy and communication energy. The proposed approach's performance is assessed by considering different performance parameters. The results has been obtained which demonstrates that proposed approach is efficient than conventional one.

Keywords: Wireless Sensor Network, Energy Efficient Routing Protocols, MFO Algorithm

I. INTRODUCTION

WSN includes a huge amount of spatially disseminated, small, power- operated, entrenched devices which forms a network to considerately gather, process, and transmit data to customers, and it comprise of limited processing and computing competencies [1].

WSN has various applications in distinct areas like, in military activities like surveillance, reconnaissance and target acquisition, and geophysical activities like study of volcano, environmental activities like prevention from forest fire and in the field of medical like monitoring health data or civil engineering such as structural health measurement or artificial retina [2].

As many of WSN include bulk of terminals and many of their properties is not possible to measure simply, the process of selection of various geographical locations of nodes in order to get optimum network –is known as WSN layout problem that can make it complex. It recalls unicast set covering the problems also called as NP.
This is the reason for which meta-heuristics is an option to solve this problem. The most of the research work focused to minimize energy utilization level of the nodes. The amount of nodes can create a problem while covering the network. While displaying network, it suffers from various considerations [3].

The coverage most obey few rules or restrictions and the highly coverage area is given the preference. The reduction of sensor nodes in network is not for a specific purpose but it is just to minimize cost factor. The lifetime of a system depends upon the consumption of energy so energy management is really very critical in the network [4].

Generally, in WSNs, communication among nodes utilizes more amount of energy in contrast to local sensing operations [5].

Due to this, the communication protocol designers consider designing protocols that utilizes less energy and thus enhance the lifespan of network [6].

The routing protocols' classification is represented in below figure.

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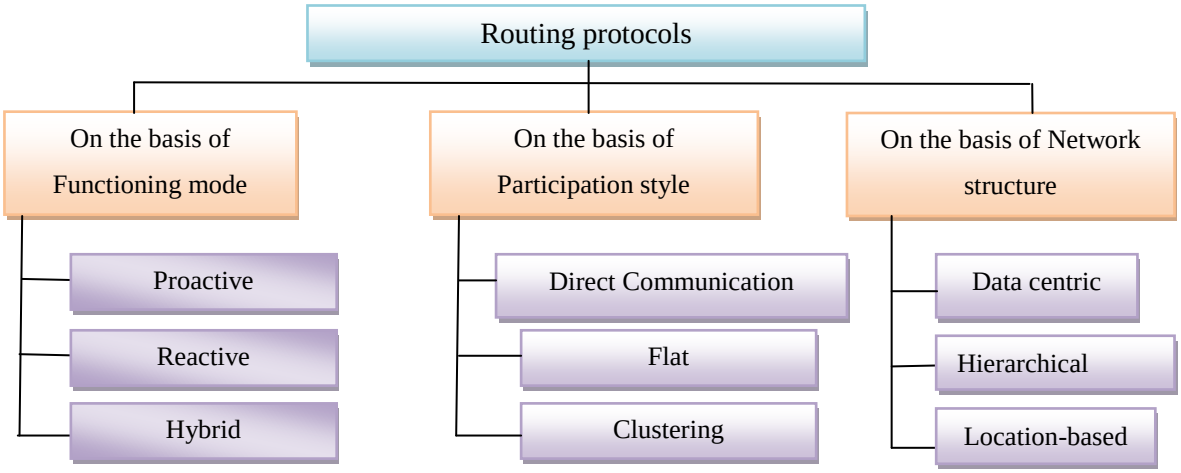

Fig. 1: Classification of routing protocols

Clustering algorithms are more energy efficient than direct routing algorithm so it is another way of saving energy by using clustering algorithms instead of direct routing algorithms. In clustering algorithms the clusters of nodes are created and each of the clusters is assigned with a CH. In this topology, first of all sensor node sends the data to their respective CH and then these Cluster Heads forwards the data to the server of base station.

Clustering technique and algorithms

The clustering algorithms are classified into 3 types which are:

- Partitioning
- Hierarchical [7]
- Density-based

Briefly, the partitioning algorithms endeavours to identify k clusters which optimize a particular, frequently distance-based condition function. The hierarchical algorithms form the database's hierarchical decomposition which is shown as dendrogram. The density-based algorithms identify the dense areas in data space which are alienated from one another via low density noise areas.

II. LITERATURE REVIEW

Numbers of authors have proposed several approaches in order to achieve energy efficient routing. Some of the proposed approaches are discussed below:

In order to prolong lifespan and energy of the nodes, the author in [8] introduced energy effectual clustering technique based on factional calculus and ABC (artificial bee colony) algorithm. In order to control combination of ABC algorithm and fitness function, a hybrid optimization algorithm known as multi-objective fractional ABC artificial bee colony, was developed.

Author in [9], introduced GERP (Grid-based Efficient Routing Protocol) because it includes less packet dropping. In order to decline the packet drop, grid head remains in semi sleep or active mode and incline the life time of the network and save the energy.

In paper [10], an efficient cluster formation approach having modified CH selection criteria based on the multi-objective fitness function was introduced.

In [11], author introduced Hybrid routing protocol for WSN based on section that uses ABC algorithm. Data is sent to sink directly by some nodes whereas with the use of clustering technique, data is transmitted to sink by other nodes.

In order to achieve data latency through investigation of balance of mobile sink by declining mobile path length, inclining data collection and network reliability optimization, the author in [12] introduced large and intensive MWSN. The author also introduced a formula for the representation of MSWN with the proof that it is an NP hard problem.

For addressing the delay-energy trade-off issue, the author in [13] introduced ABC algorithm based novel routing protocol. The route consisting feasibility and possibility from the real node to destination node, was provided by this new routing protocol. For discovery of food source places, modifications in the positions of food sources were done by various artificial bees.

In paper [14], swarm intelligence algorithm was introduced to WSN's clustering algorithm and reliable as well as efficient clustering algorithm based on quantum ABC algorithm was introduced for WSNs. In this paper by taking into account nodes' remaining energy, location of node and node density, and network's energy utilization is balanced.

It is considered as most efficient approach, however, consists of some drawbacks by which it does not provide major enhancement in model.

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III. PRESENT WORK

In the application of WSN, the majority of energy of the sensor nodes is consumed on the wireless communication module. The node energy utilization is the key indicator for the life cycle of WSN. Therefore, lots of researchers have conducted research on how to improve the network consumption and node distribution.

In the conventional system a new variant of ABC algorithm that is QABC algorithm was applied, but it is observed from the results that there is no major improvement in the proposed model. Also the factor those are considered as the fitness factors are only the distance factor. Whereas the network stability is dependent on other factors too as residual energy and energy consumption etc. So there is need to improve the current system by involving energy factors along with any advanced optimization algorithm instead of ABC.

Therefore, in this study, an efficient and reliable routing algorithm on wireless sensor network based on the MFO algorithm is proposed to overcome drawbacks of traditional system. The MFO algorithm is used in proposed work because it is very flexible and robust. It offers very fast convergence at initial stage via changing from investigation to development, which leads to an increase in the efficiency of MFO.

Along with this, the selection approach is to enhance by involving energy factor, the dependent factors for the new approach will be: Residual energy, Communication energy (CH to Sink), Distance of CH and Node, Distance of CH and Sink.

Also, the following aspects are considered for the algorithm evaluation: total energy consumption, amount of survival nodes, Network reliability.

The network setup of the proposed work is represented in following figure:

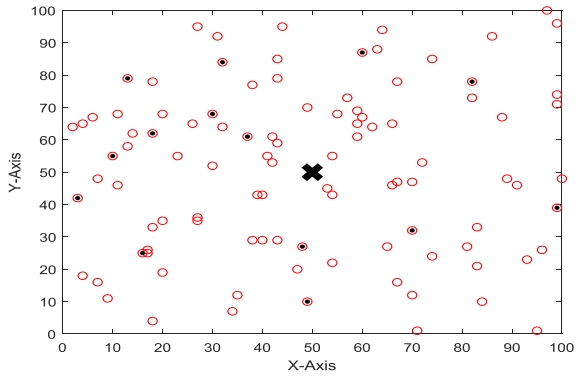

Fig. 2: Proposed Network Model

In fig.2, the graph depicts that the proposed work is comprised of 100 nodes within the area of 100*100 m. The nodes in red depict the sensor nodes in the network. The node marked with cross defines the base station of the network. The nodes with black dot represent the cluster head. The x and y axis in the graph delineates the dimensions of the network with respect to its coverage area.

Also, there are various parameters that are used in the proposed work. These parameters are represented in following table:

Table 1: Simulation experiment parameter settings

Parameter	Value
Network Size	100 m*100 m
Number of nodes	100
Initial energy	0.5 J
Range	10 m
E_{TX}	50 nJ/bit
E_{RX}	50 nJ/bit
packet	4 kb
times	1500 s

In the proposed work, the size of network is 100*100 m^2 and total 100 nodes are been considered in this work and the packet size is of 4kB.

The analysis of the proposed work has been done and the obtained results of simulation are represented in next section.

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IV. RESULTS AND DISCUSSIONS

In order to enhance network energy consumption and node distribution, number of parameters in the proposed approach has been enhanced. Also, MFO algorithm is proposed to prolong network lifespan. In order to assess proposed work's performance, various parameters are been taken into consideration. In this section, the obtained results are represented in the graphical as well as tabular form.

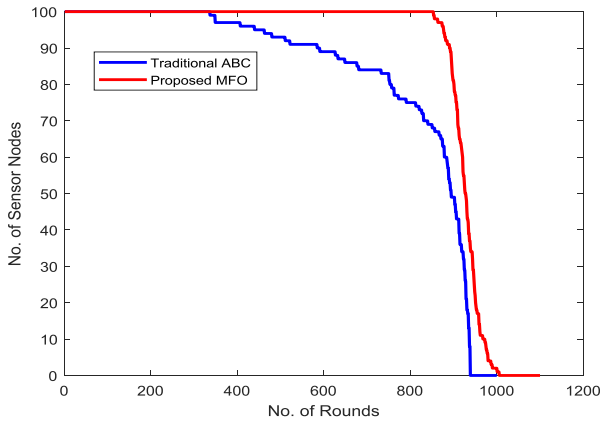

Fig.3: Comparison analysis with respect to number of network nodes alive

The network node lifetime of the traditional QABC approach and proposed MFO approach is exemplified in graph of fig.3. From the obtained graph, it is comprehensible that number of alive nodes in proposed approach is more in contrast to conventional approach, which implies that proposed approach has prolonged lifespan of network. The numbers of alive nodes in traditional and proposed approach with respect to different number of rounds are recorded in table 2.

Table 2: Numbers of alive nodes of traditional and proposed approach at different rounds

Rounds	Network nodes Alive	
	Traditional QABC	Proposed MFO
1	100	100
200	100	100
400	97	100
600	89	100
800	75	97
1000	0	2

From the obtained values, it is observable that in traditional approach, all the nodes are alive during first 200 rounds and after that it gradually started decreasing with increase in number of rounds and all the nodes become dead by reaching at round 1000.On the other hand, in proposed work, all the nodes remain alive during first 600 rounds and after that it started decreasing and by reaching at round 1000, only 2 nodes are alive.

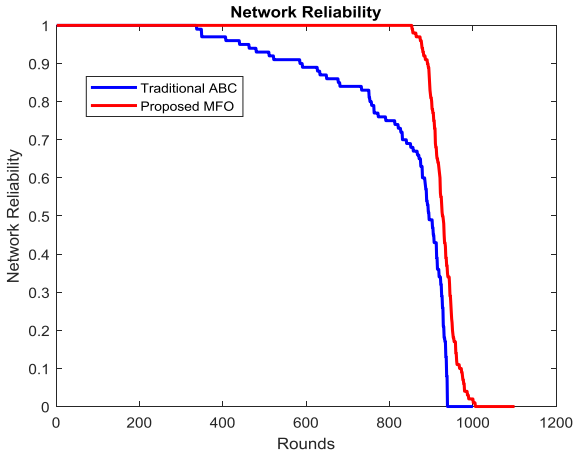

Fig.4: Comparison analysis with respect to network reliability

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In order to be an efficient system, the reliability of network should be high. The comparative analysis of proposed and traditional approach with respect to network reliability is delineated in graph of fig.4. The obtained graph demonstrates that network reliability of the proposed approach is high than traditional one. And high reliability leads to more efficient system. The values of network reliability of both the approaches at different number of rounds are recorded and represented in below table:

Table 3: Network Reliability values of traditional and proposed approach at different rounds

Rounds	Network Reliability	
	Traditional QABC	Proposed MFO
1	1	1
200	1	1
400	0.97	1
600	0.89	1
800	0.75	1
1000	0	0.02

The above table represents the network reliability value of traditional and proposed approach at different number of rounds. It can be concluded from the obtained values that proposed network is more reliable because its reliability remain high i.e. 1 during 800 rounds and get decreased to 0.02 only by reaching at round 1000. Whereas, in traditional approach, the network reliability remain high only during first 200 rounds and then gradually decreases as number of rounds increased and by reaching at round 1000 the reliability becomes zero.

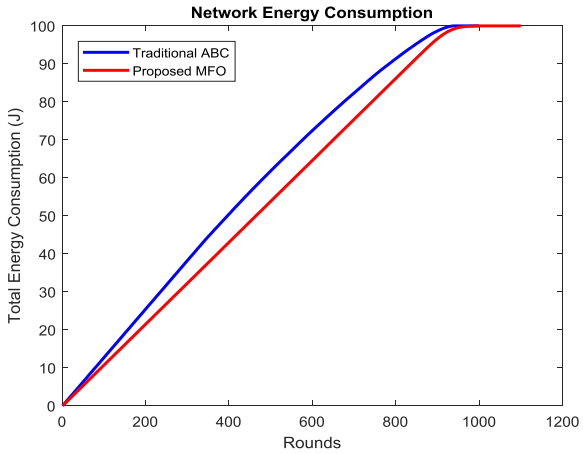

Fig. 5: Comparison analysis with respect to network energy consumption

The graph in fig. 5illustrates the comparative analysis of traditional QABC approach and proposed MFO approach in terms of network energy consumption. In an efficient network, minimum amount of energy should be consumed and from the graph it is demonstrated that proposed network consumes less amount of energy as compared to traditional approach, which implies that proposed approach is more efficient than traditional approach in terms of network energy consumption.

Table 4 is represented below which shows the amount of energy consumption of both approaches (traditional and proposed) at different number of rounds.

Table 4: Energy consumption amount of traditional and proposed approach at different rounds

Rounds	Network Energy Consumption	
	Traditional QABC	Proposed MFO
1	0	1.39E-13
200	25.43370636	21.46191072
400	50.43803938	43.02298065
600	72.44335227	64.59092455
800	91.34571787	86.15689525
1000	100	99.99364194

The values obtained in the above table delineates that traditional approach is less efficient than proposed approach because it consumes more amount of energy. In traditional approach, there is gradual increase in energy consumption

with increase in number of rounds and entire energy has been consumed by reaching at round 1000. In contrary, proposed approach consumes less energy and thus it is proved as more efficient approach.
Thus, from all the obtained results, it is demonstrated that proposed approach is more efficient than traditional approach in terms of different parameters.

V. CONCLUSION AND FUTURE SCOPE

In order to make the WSN's routing and CH selection process more energy efficient and reliable, MFO based algorithm is proposed in this paper. Also, the selection approach is enhanced in the proposed work by involving energy factor i.e. residual energy and communication energy. In order to demonstrate the efficiency of proposed work, the performance evaluation has been performed on the basis of various parameters i.e. total energy consumption, amount of survival nodes and Network reliability. Also, the comparative analysis of proposed MFO approach and traditional QABC approach has been performed. The results has illustrated that proposed approach consumes less amount of energy, is more reliable and also has prolonged lifespan in contrast to traditional approach. Thus, it has been demonstrated that proposed approach is more efficient than traditional approach in terms of all the parameters. Though, in future, the work can be done to enhance the process of cluster formation also. Cluster formation is the initial step in the network and if the grouping of the clusters is improved then it can consequently help to achieve more efficient system.

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