Efficient Routing in Wireless Sensor Network by using Water Cycle Algorithm to Evaluating the Performance of Density Grid Based Clustering

Shradha Yadav, Shalley Bakshi, Manpreet Kaur

Abstract: Wireless communication has an exceptional network known as a wireless sensor network, which consists of many dedicated sensors. They have characteristics of sensing capacity and have the capability to complete a common task. To increase the performance of the network an energy efficient algorithm is needed which enhances the network lifetime and make the system more energy efficient. In this paper, the density grid based clustering is enhanced using the water cycle algorithm. The water cycle algorithm is a nature-inspired optimization algorithm that is used to increase the performance of the network which effects the lifetime of the network. The simulation is done in the Matlab r2015a environment. The proposed methodology has increased the performance of the network when compared with the existing algorithm ABC (artificial bee colony) and its better improvement is shown in parameters like network lifetime, computation time and clusterformed.

Keywords: WCA, WSN, optimization

I. INTRODUCTION

WSN consists of multiple sensor that are spatially dispersed and assigned to monitor the action in the environment. WSN calculates the conditions in the environment related to temperature, pollution levels, and humidity. The base station gets data when these sensors cooperate and connect with each other and pass their data. Nowadays advanced networks are present having properties of bidirectional and control the activity of sensors. Over the past few years, there is a rapid growth in WSN because of its low power usage battery, wireless communication, its sensor technology and widely used of analog circuit and of its small size of equipment used. They are widely used in applications that contain the operation related to monitoring and detection in the real environment. The network consists of a large number of sensor or hubs of sensor which are closely deployed to perform multifunction activity including sensing and monitoring, processing and communication capabilities, including the events which are happening in the environment. These nodes have various equipment along with sensors, processors, receiver, and transmitter, power source. The architecture of the sensor node is given in Fig.1. These sensor nodes collectively perform the function of sending the sensed data through radio wave to base station or also known as sink mode.

Fig.1 Architecture of sensor node in WSN

The main focuses of the sensor networks are to increase the network lifetime while performing the operation of data communication and reduce connectivity degradation by using multiple routing techniques. Due to their ability of sensing, monitoring and detection they are used in a wide range of applications in different fields including health care services, environment (monitoring of any particular habitat, volcanic activity, earthquake), military (enemy detection, monitoring the borders). Nodes that are present in the network are resource constraints because of limited battery supply, their small size processors, so there is a need for an efficient routing protocol to increase their efficiency. These protocols have the ability to discover the routes which make communication faster and efficient. Multiple clustering is developing nowadays which improves the efficiency of the network. These clustering techniques are integrated with different optimization algorithm which helps in increasing the network lifetime and make network more efficient.
A Density grid based clustering

By the combination of grid based clustering and density based clustering, the formation of density grid based clustering takes place. In this type of clustering network topology is more stabilized, more fault tolerance ability, maximum network lifetime, and increases the network connectivity. It works on dynamic networks. The processing time calculated in density grid based clustering is quite fast.

II. LITERATURE SURVEY

2017 Baljinder Singh proposed a methodology on the density grid based clustering using ABC and show the behavior of bees and how they work and pass information[1].2016 Utpal Kumar Paul proposed a novel grid based energy efficient routing algorithm for wireless sensor networks. In which topology is divided into grid shaped on the basis of static cluster protocol, the selection of cluster head is done. It gives every node an opportunity to become a cluster head [2].2015 ManalAbdullah etal proposed a new clustering technique for density grid based clustering in WSN. According to this method, the network topology is divided into grids and their classification is done on the basis of highly dense and empty grids respectively to the number of the nodes which are present. Excluding empty grids, there grids combine to form a cluster, two neighboring low dense grids form an outlier of a cluster. For the selection of cluster head, cluster nodes are classified into an advance node that has less distance to the base station when compare the distance of other nodes to the base station. Afterward, the cluster head will be selected on the basis of the highest energy. According to this method, the most suitable grid size which has best results increases the lifetime of the nodes in the network area [3]. 2014 D Kumar proposed two clustering protocols MEEDCP multi-hop vitality efficiency grouping convention and single hop vitality efficiency bunching protocol SKEEP [4]. 2014 Stefanos et al explains the equalized cluster head selection routing protocol. For the selection of cluster head in the network using the Gaussian elimination algorithm. For the transmission of data from source to base station the routing which is used is multi-hop routing [5]. 2012 J Peng et al proposed an algorithm that has its origin from LEACH and nodes adaptive schedule was designed for better latency, energy efficiency network [6]. 2011 Ashok et al. Explain a protocol that is location-based, which works on cluster head selection, routing of data and make network energy efficient which promotes network lifetime. With the use of clustering in the region of where the operation of sensing is required it helps in cluster formation which is based on the size of the cluster and less number of transmissions and receiving of operations is required. For ensuring that in the node, energy dissipation is balanced by cluster head rotation. Init this method, the rotation of the cluster head becomes more efficient if parameters like distance, energy density are given importance rather than focusing on residual energy[7]. 2010 Nan et al. In this paper ADAM (adaptive data aggregation mechanism) is adopted to achieve the highest optimal aggregation, cluster head verifies every packet received from its surrounding nodes on the basis of character it contains. It transforms the data into shorter blocks. To reduce the level of redundancy in the internode, ADAM has an efficient compression ratio and increases the lifetime of the networks [8]. 2010 Liu Xiaolong proposed a bacterial foraging swarm optimization technique [9]. 2009 Xiarong et al. Works on the basis of the location of a node, its efficiency in communication and its network connection it uses static cluster formation. The selection of cluster head is insuchawaythat the lifetime of cluster head increases so optimal scheduling. The work of the cluster head is uses of minimal energy routing technique and collection of data aggregation which is periodical in nature. By using the above method the network lifetime increases along with effective utilization of energy in a manner that is balanced in nature [10]. 2009 Gao et al proposed a protocol known as reclustering LEACH protocol is based on the cluster and its node density which is inside the cluster and a mechanism that is based on cluster-based data fusion. The limitation created by the single hop LEACH protocol is overcome in this protocol. To increase, the network lifetime and its energy efficiency multi-hop algorithm are used for cluster head selection [11]. 2009 Dongkyun et al works on cluster head detection scheme for every node in the network. The protocol main attention is on the passive scheme of DAD with the goal in which increase the accuracy of detection of address conflicts. Increase the detection of success ratio and decrease the time required to find these conflicts. Some more information are including location, its sequence number, neighbor knowledge. An increase in accuracy and less time to find conflict addresses and but IP address allocation schemes are also given importance [12]. 2008 Jamping et al works on the algorithm which is known as time-based cluster head selection to increase the execution of LEACH (TB LEACH). The selection of the cluster head is based on a random number that is assigned to every node in a random time interval. When a comparison is done the number of cluster formation is less in the TB LEACH is when compared to LEACH. The TB LEACH decreases the formation of a number of clusters and also works on simplification for the process of selection of cluster head[13]. 2007 Baek et al works on with the help of stochastic geometric and queueing models how to improve the spatial balance of energy burdens and with the help of using the proactive multipath increase the tradeoff between the energy costs of spreading traffic. Then the comparison is done with the help of routing which is known as smartshortpathrouting which has more initial energy [14]. 2006 Uk – Pu Han works on routing protocol which is cluster-based which adds a small slot in a frame; it also provides the facilities of exchange of residual energy messages among cluster head, nodes and base station. The energy status is gathered by the cluster head of the network nodes which they belong and send them to the sink or base station. After that this operation is received by every node.
With the help of respective cluster heads they had. For the beginning of the second round, everyone is ready [15]. 2004 Younis et al explains in the ad hoc sensor network an approach which is used is novel distributed clustering. In this method, the consideration of infrastructure and node capability is not there. The simple assumption of multiple power level nodes is present in the network. The selection for the procedure of the cluster head is done on the basis of the nodes residual energy, its proximity from its neighbor. It also does data aggregation and it works only for two-level hierarchy[16].

**GAPS IN THE LITERATURE SURVEY**

Wireless communication is based on data transfer and its processing ability. The receiving of data at the base station sometimes causes flooding of information. To solve the above problem data accumulation method should be used but this method has not been given much attention.

The effect of data loss during the flooding of data is not given much attention by researchers.

With the goal of less data loss and more lifetime, fewer computation times a new technique is used which solves the problem of enhancing the network lifetime and decreases the computation time.

**III. PROPOSED ALGORITHM**

The proposed algorithm is used to improve the network lifetime as well as enhancing the density grid based clustering by using the routing water cycle optimization algorithm. The simulation is done in the Matlab environment (Matlab r2015a). The flowchart of the proposed methodology is shown in Fig. 2.

The proposed methodology is done in three phases

A. Initialization phase

B. Procedure for the selection of cluster head phase

C. Routing phase
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A. Initialization phase

WSN is deployed in the given area where data or information is collected and send to the base station or sink. Grid (density grid based) topology is used in the network. Each grid in a network represents a cluster.

B. Procedure for the selection of cluster head phase

Intraclustercentrality is calculated to find out which node in the cluster on the terms of the number of its connection it makes with other nodes, how fast they convey information in the network. The node with high centrality becomes a cluster head (CH) in a cluster. The work of the cluster head is the collection of information from its node which is present in its cluster and transfer of this information. There is a restriction of transferring information within the node themselves. They can only communicate or send their information to their cluster head which is respectively present in their clusters.

C. Routing process

The routing phase plays an important role in the proposed methodology because it helps in finding the best route for transferring the data to the base station or sink. It helps in increasing the performance of the network by decreasing the usage of battery used by the sensors and improving the network lifetime.

The water cycle algorithm is used for routing the data to the base station or main location. The water cycle imitates the flow of streams and rivers towards the sea or ocean and was inspired by observing the process of the water cycle. In the initial phase of the water cycle, the initial population of the design variable (number of streams) is randomly generated after raining process. The best variable or the best stream is selected on the basis of the minimum cost function which is chosen as the sea. The stream which has a value close to the best variable is chosen as rivers, the remaining variable is considered as streams which flow into the river. If the velocity of the river decides the absorption of water from the stream. Hence the volume of water entering the river, seavaries from stream to stream. The river whose location mostly downhill flows into the sea. All rivers and sea have a specific number of streams which flow into them. The interchange of positions is done between river and stream when compared with its solution given by stream is more optimal when compared with its connecting river. Asimilar interchange can be done for rivers and a sea. For the exploration phase in the water cycle, the operator used is evaporation. It causes water to evaporate from the sea, rivers, and streams. It is basically used for local optima to avoid the situation of premature convergence. Finally, the calculation of distance is done whether stream, a river which has a short distance to the sea. After evaporation, condensation of water vapor occurs and raining process repeats and new streams which are formed to specify their new locations, a uniform random search is used. The steps involved in the water cycle algorithm (optimization) are as follows:

- Generate the initial population.
- Calculate the fitness function.
- Find the best solution and update the fitness value.
- Check the objective function.
- Check if optimized then analysis the time and dead node.
- Otherwise check the counter is greater than zero or not. If the counter value is less than zero, then ignore the node during routing.
- Else again initialize the value at WCA.

IV. PERFORMANCE ANALYSIS

This paper has implemented the proposed algorithm in the Matlab r2015a software. In part A the existing Artificial Bee Colony (ABC) technique is discussed and in part B the proposed (improved) water cycle algorithm (WCA) is integrated to enhance density grid based clustering is discussed.

Part A

The existing technique artificial bee colony is discussed and the various parameters are shown in the graph. The value obtained by the graph on three parameters which are cluster formation, network lifetime, computation time is represented in table 1.

### Table 1

| Technique     | Cluster formation | Network lifetime | Computation time |
|---------------|-------------------|------------------|------------------|
| ABC           |                   |                  |                  |

The exiting technique artificial bee colony is used for optimization. This technique is based on honey bee foraging behavior and was developed by Dervis Karabogain 2005. The model of ABC consists of

1. Employed bees
2. Onlooker bees
3. Scouting bees

This technique is a population-based algorithm. The food source location corresponds to a possible solution for the optimization problem and the food source (amount, quality) represents the associated solution. But the disadvantage of the ABC technique is that it performs only local optimization. To overcome this problem, water cycle optimization algorithm is used in proposed work and it performs local and global optimization both.

Table 1 shows the existing technique (ABC) is on parameters cluster formation, network lifetime, computation time. Computation time defined as the length of time required to
perform a computation process. Network lifetime defines an operational time of the network in which it is able to perform the dedicated task.

### TABLE 1 VALUE GIVEN BY EXITING ABC TECHNIQUE

| No. of nodes | Value by ABC (ARTIFICIAL BEE COLONY) | Cluster formed | Network lifetime | Computation time |
|--------------|--------------------------------------|----------------|------------------|-----------------|
|              |                                      |                |                  |                 |
| 100          | 211                                  | 336            | 0.3697           |                 |
| 150          | 210                                  | 337            | 0.5227           |                 |
| 200          | 211                                  | 342            | 0.7011           |                 |
| 250          | 198                                  | 338            | 0.8614           |                 |
| 300          | 189                                  | 337            | 1.0389           |                 |

The graph is given by Artificial Bee Colony (ABC) existing technique

**Fig.2 Cluster formed**

**Fig.3 Network lifetime**

**Fig.4 computation time**

**Part B**

In B part of the section, the proposed routing (water cycle algorithm) is integrated to enhance the density grid based clustering. This optimization algorithm is used in the network for routing the data. The graph obtained by the proposed algorithm (WCA) shows significant improvement in the value which was given by the ABC technique. The physical and wireless parameters of the proposed methodology are given below in Table 2.
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TABLE 2 SETTLING PHYSICAL AND WIRELESS PARAMETERS

| Operation                          | Energy dissipation               |
|-----------------------------------|----------------------------------|
| Shape of network                  | Grid/ Square                     |
| Area of Implementation            | $10^4$ m$^2$                     |
| Number of Nodes                   | 100-300                          |
| Transmitter/ Receiver             | $E_{elec}=E_{tx}=50$ nJ/Bit      |
| Data Aggregation                  | $E_{sa}=10P/Bit/\mu m^4$         |
| Transmit Amplifier                | $E_{mp}=0.0013$ P/Bit m$^4$      |

The water cycle algorithm is the best algorithm when compared with other routing algorithms. It is a nature-inspired algorithm which is based on the concept of rivers and streams flow in the sea. This algorithm is able to compute the maximum and minimum value of the function. It works on user-defined fixed variable and it addresses a large number of the optimization problem. It performs local and global optimization. ABC supports only local optimization. The result given by the water cycle algorithm is shown in table 3.

TABLE 3 VALUES GIVEN BY PROPOSED WATER CYCLE ALGORITHM

| No. of nodes | Value by WCA (water cycle algorithm) |
|--------------|--------------------------------------|
| Cluster formed | Network lifetime | Computation time |
| 100          | 278          | 340          | 0.2342       |
| 150          | 234          | 339          | 0.4532       |
| 200          | 267          | 350          | 0.6544       |
| 250          | 200          | 345          | 0.7000       |
| 300          | 190          | 347          | 0.8979       |

The graph shown by the water cycle algorithm proposed an algorithm
From the graph given by WCA on cluster formation, network lifetime, computation time, it is clear that the proposed algorithm has improved the result by 12.83% in cluster formation, 2% in network lifetime, 18.8% in computation time when compared with existing ABC technique [1]. The simulation done is best on the environment having 300 nodes.

V. CONCLUSION

The concentration of research work is on developing an efficient routing that optimizes the route from cluster head to the base station which affects the parameters like computation time, network lifetime, cluster formation and which improves system stability and lifetime. The proposed strategy is composed and executed in the Matlab software. The water cycle algorithm is used to perform local and global optimization. This work can be further extended to implementing in such an application where throughput, energy conservation is important.

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