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Energy Efficient Routing in Mimo-Leach using Genetic Algorithm

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ABSTRACT

Over the last decade, wireless sensor networks (WSN) have obtained more research awareness for their potential applications in defence, healthcare, environmental monitoring, etc. In WSN, number of routing protocols has been used to minimize the energy consumption and in this paper, three types of existing routing protocols, viz. V-MIMO, MIMO and MIMO-LEACH are discussed that lacks in acceptable decrement in energy consumption. Therefore, in this research paper, the concept of route optimization is proposed with GA to optimize the discovered route by MIMO-LEACH. Optimized MIMO LEACH is used to create an optimized route from source to destination node via cluster heads. In this work, GA is used to select the better cluster head node for route discovers mechanism to reduce the energy. For the computation, parameters such as, energy consumption and delay are used.

Keywords: WSN, MIMO, LEACH, GA, Energy consumption and delay.

INTRODUCTION

WSN (Wireless sensor network) offers number of benefits like flexibility, deplorability, less installation cost, and increased production. WSN is a dispersed network of each light and small node that may sense physical metrics like pressure, relative humidity and temperature [1]. The sensor network has nodes which are consisted of below sub-systems:

i. Sensor subsystem that sense the environment.
ii. Processing subsystem that executes the execution on the sensed data.
iii. Communication subsystem is responsible for message transfer with adjacent sensor nodes.

WSN has memory for the storage of data and programs [2]. Number of sensor nodes is connected with the communication of radio frequency. Varied DoS attacks may influence the network and the affected nodes regularly exchanges the information with the neighbouring nodes and resulted in diminishing of power then the node which is considered as a dead node.

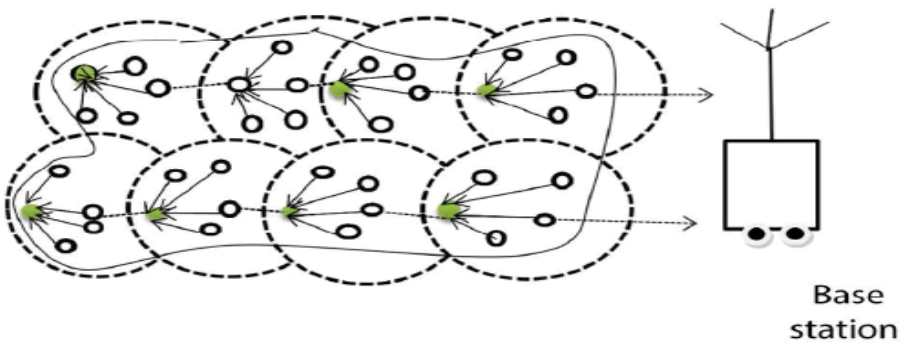

Figure 1: Wireless Sensor Network

WSN has three types of routing protocols, namely, flat routing, hierarchical routing and location based sensor nodes. In flat routing, each node has same role and the sensor nodes collaborates to execute the sensing tasks. Hierarchical routing has higher energy nodes that are used for processing and sending the information whereas in case of low energy nodes which are used for performing the sensing in the target proximity [3]. The production of clusters and providing special mission to the clusters can contribute for enhancement of network lifespan and efficient energy. The routing protocols came in this category are: TEEN, APTEEN, LEACH, PEGASIS and HEED. Location-based Sensor nodes are the one that are usually utilized according to the location. Among the neighbouring nodes, the distance could be analyzed according to the strength of the incoming signals. in location based sensor nodes, the co-ordination of neighbouring nodes can be achieved with the exchanging of information among the neighbours or with the communication by the satellite by utilizing GPS. For the conservation of energy, few location based methods needs that nodes which can go to sleep if there is no action. Some of the examples of location based routing protocols are; SMECN, TBF, GeRaF, GEAR, SPAN and GAF.

Related Terminologies

In this research work, the implementation has been done in four parts, V MIMO (Virtual MIMO), MIMO, Genetic-MIMO, and LEACH-MIMO. The explanation for the same is provided below:

LEACH (Low energy adaptive clustering hierarchy) routing protocol

LEACH protocol is consisted of three steps in cluster routing protocol, cluster head generation, cluster formation and communication between the clusters. So, LEACH protocol lessens the energy consumption with an enhancement of network lifespan [4]. The procedure of LEACH is periodical in which every period has cluster establishment with transmission of data and that period is known as round. For the conservation of energy, the time of stable data transmission is longer as compared to the time needed to the development. The procedure is as below:

In the Set-up clusters phase, the nodes would produce a number generated arbitrarily among zero's and one's. If the arbitrary number is less than then T_n (threshold) then the node would considered as a cluster head in the round. The computation method for T_n is dependent on the below mathematical expression:

$$T_n = \begin{cases} \dfrac{q}{1 - q[rmod\ \left(\frac{1}{q}\right)]}, & N \in H \\ 0, & otherwise \end{cases}$$

As shown in above mathematical expression, q is the cluster node percentage as per the total number of nodes which is the node probability of becoming the cluster heads. R is the number of periods (rounds) ; N is the amount of nodes and G is the nodes that did not came out to be cluster heads in $\frac{1}{q}$ rounds. The nodes which are chosen as cluster heads and then transferred the information towards the neighbour nodes and the left nodes will select that it would link as per the broadcast signal strength by informing the connected cluster head. Then, the cluster heads develops a TDMA (Time-division multiple access), the timing gap being developed for every node in the cluster and transfers the time gap by means of broadcast. Therefore, every node may transfer the data in the time frame whereas in another time gap, the node can enter in the sleep state; therefore, it saves the energy [5].

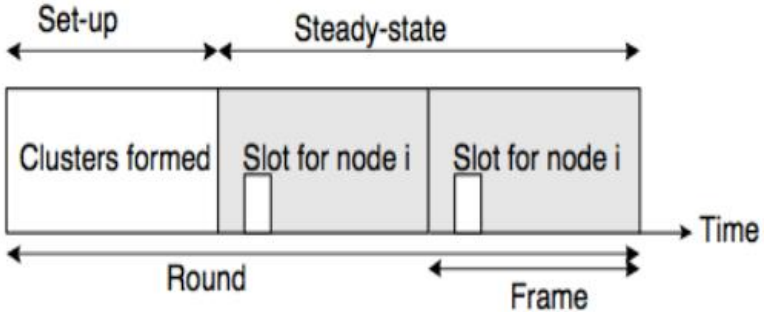

Figure 2: LEACH operations

In stable data transmission phrase, the non-cluster nodes (member nodes) within the cluster can send the examined data to the connected cluster head in the prescribed time frame. The categorization of stable transmission phrase is into

number of frames and the extent of every frame is determined by the amount of nodes within the cluster. Data transferred by every node in time frame is just a division of the frame. At each round end, the cluster and the cluster heads would be re-elected that requires some energy. For reducing the system overhead, the stable stage duration in every round is more than the cluster establishment. The cluster head usually conserves the communication status for receiving the data from the cluster nodes. When the data is being received from the member nodes, then the cluster heads precedes the data like data fusion to lessen the unessential data [6]. At last, the cluster heads sends the fused data to its base node or the cluster head because for non-cluster nodes, the data is send as per the time frame and while at some other time, the wireless communication module is turned off to preserve the energy. In this work, VMIMO has been executed. The principle preferred standpoint of VMIMO is as per the following:

i. It includes quicker Speed inside awesome separations as well.
ii. It can have various concurrent clients.
iii. It has a higher throughput with less number of fading channels.
iv. It has high exactness.

MIMO (Multiple-input multiple-output)

MIMO is a radio communication technology or radio frequency technology that has recently been mentioned and used in many new technologies. MIMO utilizes spatial dimensions to improve wireless system capacity, range and reliability. Therefore, it is an antenna technology for transmission and reception equipment for radio communication. There may be various MIMO configurations [7]. For example, a 2x2 MIMO configuration is two antennas for transmitting signals (from a base station) and two antennas for receiving signals (mobile terminals). Two major MIMO formats are defined below:

Spatial diversity
Spatial diversity used in this narrow sense usually refers to the diversity of transmission and reception. These two methods are used to provide improvements in signal to noise ratio, and they are characterized by increased system reliability relative to various forms of fading.

Spatial multiplexing
It is utilized for providing more data capacity by using varied paths for carrying extra traffics that is increment in the capability of data throughput.

LEACH –MIMO

In this research work, the delineation of the proposed framework has been shown. As appeared in the delineation in this sort of framework we have something many refer to as cluster heads, since the source and goal could be in a portion of the systems so in that system a bunch head would be the middle of the road hub which will help in information exchange [8]. In this figure, we are thinking about that the source and goal are on various systems, so we have two heads. At the point when source needs to transmit the information he will initially send the data to the group leader of his system the bunch head will then discover the cluster head of the system in which the goal lies, once the head is discovered the information is exchanged to him, and after that the information is given to the goal by the cluster head. This procedure may look long yet is exceptionally effective. Here in this framework likewise we have 1000B of every a solitary parcel, and it takes roughly 0.01sec to send a bundle. Accordingly in one moment we can send 100 packets and 100000B [9].

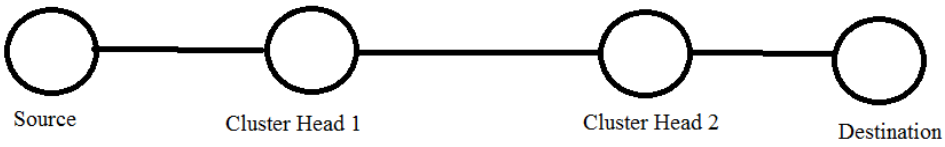

Figure 3: Data transfer in LEACH MIMO

GA (Genetic algorithm)

Genetic Algorithm (GA) is a random search and optimization technique that has been applied to a wide range of research. The basic operational flow of GA includes creating initial populations, assessing fitness, selection, crossover, mutation, updating the best chromosomes, and examining termination conditions and checking of termination condition as depicted in below algorithm [10]:

Begin
Create an initial_population

Calculate the fitness_function of every individual
While (not halting criteria) do

Select parents from the population
Execute crossover to create offsprings
Execute mutation
Calculate fitness of every individual
Swap the parents by subsequent offspring in novel generation

End
End

GA begins with a set of randomly generated possible solutions called populations. Each individual solution in the population is called a chromosome or an individual. Each chromosome can be represented as a simple string or array of genes containing a portion of the solution [11]. The value of a gene is called an allele. The length of the chromosomes in the population should be the same. A fitness function is provided to assign fitness values to each individual. This feature is based on how close the individual is to the best solution. The higher the fitness value, the closer the solution for the best solution. Two randomly selected chromosomes (called parents) can exchange genetic information in a process called recombination or crossover. This produces two new chromosomes called children or offspring. If parents share a particular pattern in their chromosomes, the same pattern will be transferred to the offspring. In order to obtain a good solution, mutations are often applied to randomly selected chromosomes after the crossover process. When the population converges too fast, the mutation helps to recover any missing genetic values. Once the process of crossover and mutation occurs in the population completes, select the next generation of chromosomes [12].

GA-MIMO

GAs are a quick, suboptimal, low- complexity nature technique for taking care of improvement issues, for example, the boost of a booking metric, and can deal with discretionary capacities and QoS requirements. We initially analyze a framework that transmits utilizing limit accomplishing dirty paper coding (DPC).Genetic calculations (GAs) are a fast, however problematic, alternative of playing out an utility (for this situation planning) metric streamlining [13].

GAs is known for accomplishing great answers for improvement issues rapidly. GAs for planning evacuates the majority of the multifaceted nature from the client determination process and moves it to the utility capacity estimation [14].

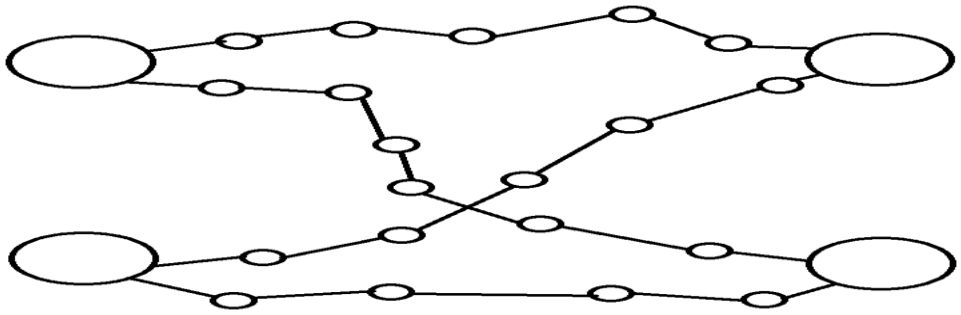

Figure 4: Data transfer in Genetic MIMO

RESULTS AND DISCUSSION

This section explains the results obtained after the simulation of the proposed work. Parameters, such as energy consumption, delay are computed to depict the efficiency of the proposed work. The computation is on the basis of number of nodes and the results are obtained for MLEACH, LEACH and GA and are shown in tabular and graphical form:

Table 1: Energy Consumed during communication (Energy in mJ)

Nodes number	MLEACH	LEACH	G A
20	20	22	18
50	38	32	30
100	65	58	54
200	85	75	62
400	110	98	90
500	135	130	115

In the above table, we can see that the LEACH Algorithm has a medium precision rate for numerous info nodes given comparatively for the data sources the Multi-Hop LEACH has exceptionally low accuracy and ultimately, the Genetic calculation has the most noteworthy exactness of the actualized calculation. The Graph is demonstrated as follows. The average value for energy consumption of MLEACH is 75.5, LEACH is 69.16 and for GA, it is 61.5.

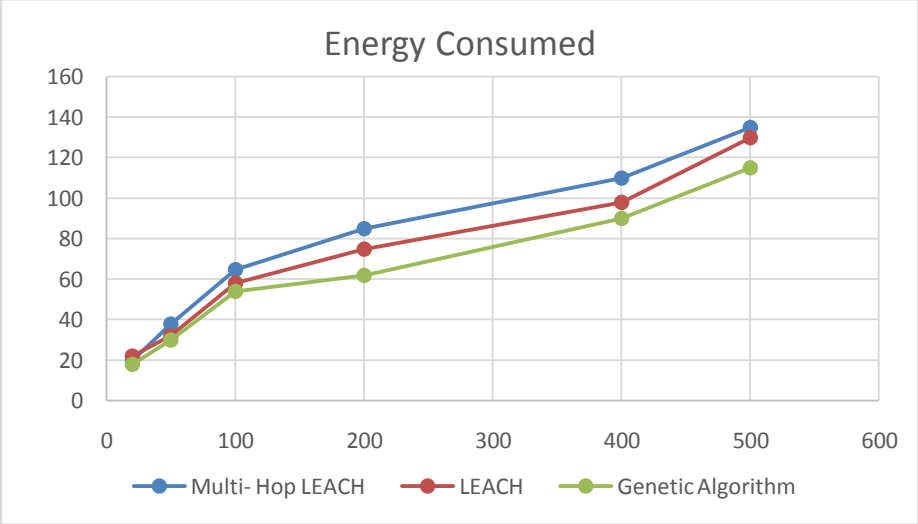

Figure 5: Energy Consumed during Communication

Table 2: Delay required for communication (delay in ms)

No. of Nodes	M LEACH	LEACH	GA
20	86.56	55.63	62.54
50	91.12	59.91	63.86
100	93.26	62.36	68.21
200	95.56	64.97	69.51
400	96.23	66.32	71.28
500	86.56	55.63	62.54

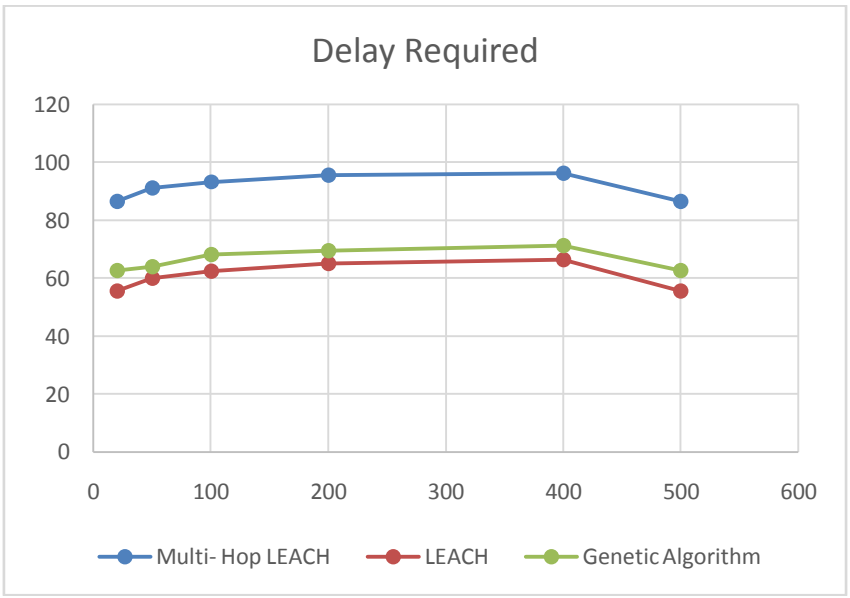

Figure 6: Delay during Communication

In the above table, we can observe that the multi- hop algorithm has the most astounding postponement among the three calculations executed. Furthermore, the LEACH Algorithm is among the slightest deferred taking an algorithm and in conclusion the estimations of the Genetic calculation are of mid reaches. The average value for delay of MLEACH is 91.54, LEACH is 60.80 and for GA, it is 66.32

CONCLUSION

According to our concern proclamation each wireless network system relies upon the vitality utilization and the lifetime of the network system, thus, to expand this we have actualized few strategies. In this research, we have looked at three methods in particular Multi-Hop, LEACH, and Genetic Algorithm. Among the three, the most proficient to execute is the Genetic Algorithm, as in the GA method the Energy of the WSN is less expended that is it has the most noteworthy lifetime and the deferral or the handling time is neither high nor low. It has a medium handling time. Along these lines GA is the best algorithm to execute among them. The average value for energy consumption of MLEACH is 75.5, LEACH is 69.16 and for GA, it is 61.5. The average value for delay of MLEACH is 91.54, LEACH is 60.80 and for GA, it is 66.32

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