Mobile agent PSO-GA based Energy Efficient Routing Protocol in WSN

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Abstract - WSNs (Wireless Sensor Networks) would arrange tiny & self-organizing nodes that could obtain the process and data transmission over the medium of wireless. Saving the energy as well as the effective energy utilization are the considerable issues for WSN. Previously, few cluster based protocols of routing would care the cluster heads relationship & sensor nodes but have not considered the great difference costs among them. There might be a chance that nodes are left out in some existing clustering protocols without being a member of any of the clusters which are called residual nodes. These residual nodes might lessen the network lifetime. We would present a latest configuration that involves an effective clustering mechanism with IN-MA (Intra Mobile Agents) in this work. Also a PSO-GA relied the location assessment algorithm has been initiated to discover out the best position for the sink depended on the structure of network. This IN-MA would gather the data from the members & carry towards CHs. An optimal position for sink has been assessed by algorithm of PSO-GA. This experiment effects would show that our recommended structure will produce the better outcomes that are compared along with earlier mechanisms. The suggested system performance, decrease the energy consumption of the routing & would extend the duration of network.

Keywords: *Wireless sensor networks, Ant colony optimization, Routing algorithms, Energy consumption, Mobile agent based data aggregation, LTAWSN, Network lifetime, MMA-PSOGA, DMADA.*

I. INTRODUCTION

Typically, WSN comprises of tens to hundreds or thousands of comparatively tiny nodes, and every equipped along with a device which is sensing. The majority of sensor networks make utilization of wireless communication, as well as the nodes that have been powered with battery frequently. And the restricted resources, limited capabilities of communication & limited consumption of power which would demand whose effectiveness are high on the criteria list of design [1]. An outcome of the advances in wireless communication as well as the technologies of electronic, the wireless sensors are becoming cheaper, smaller and also more powerful. Because of rapid microprocessor improvement, transceiver & sensor, also there has been a great applications foreground regarding WSNs. Regularly, we would utilize these networks in rough & in accessible environments like volcanoes, forests, battle fields & so on generally there is low probability for changing or recharging the dead or defective nodes. Thus, the primary difference among WSNs & other classic wireless networks is that WSNs are hypersensitive as well as vulnerable to energy [2].

The limit energy is the primary challenge affecting the performance of WSNs. So, how to make utilization of the WSNs limit energy for maximizing the WSNs life would become the all-significant routing design difficulty [3]. Many of the routing algorithms for sensor networks would need the location details for sensor nodes. In order to compute the distance among 2 specific nodes so that consumption of energy could be assessed [4] in many cases location details is required. Hence, details of location could be used in routing the data in effective way of energy.

ACO (Ant Colony Optimization) family algorithms have applied successfully for solving few routing issues in WSN [5]. Over the last 2 decades, ACO has come out as the most important method of Meta heuristic for the clarification of combinatorial optimization challenges [4].

A LTAWSN (life time aware routing algorithm for wireless sensor networks) has been applied successfully to resolve the problems of energy level in WSN [6]. The algorithm's objective is for maximizing the network lifetime by carefully explaining the cost of link as a node function that remain the energy & necessary transmission energy utilizing that specific link.

We suggested an efficient routing algorithm of energy for WSN relied on energy efficient optimization algorithm along with efficient constraints in this paper. The algorithm's key objective is to optimal location of SINK node and maximizes the lifetime of network by decreasing the distance among the SINK node & the nodes of sensor and avoiding congestion at the surrounding nodes of the SINK node. We call the recommended algorithm as MMA-PSOGA (modified mobile agent based particle swarm optimization genetic algorithm) and match up to it with LTAWSN (Life time aware routing algorithm for wireless sensor networks) that has been obtainable in [18], DMADA (Dynamic mobile agent based data aggregation approach) that presented in [19], and perceive that suggested algorithm decrease the energy consumption in comparison of these algorithms that are routing.

II. LITERATURE SURVEY

The authors in [7] have suggested a routing algorithm for WSNs utilizing ACO that provide a similarity of 2 algorithms of ant colony-based routing, considering the current quantity of energy utilization in diverse situations and reporting the common metrics to route WSNs.

The authors recommended an energy aware ACO in [8] WSNs for the routing that whenever ant selects the subsequent node, not only the sink node distance, yet also the residual energy of subsequent node as well as the average energy path have been taken into consideration. This algorithm has been evaluated along with ACA traditional algorithm & would get other enhancements in balancing the nodes' utilization of energy &would extend the network's life.

The authors in [10] have suggested a reasonable comparison of LEACH as well as the ant colony that has been applied on LEACH on the death base of initial node in the WSNs & also has been given that whenever the algorithm of ant colony has been applied on accessible protocol of LEACH, the lifetime of network has been advanced.

The evaluation table in [11] first has been constructed as well as referred for generating various probable paths of routing. Then the ACO would explore these paths for reducing the nodes' power utilization.

Every node in [12] would compute the quantity of its own level of energy & then would sum up the rest of the network's energy level. Along with the support of this node comparison would decide either to be the head of cluster or not for that particular round. These nodes along with advanced energy are prone to turn out to be the cluster heads. Such method's negative aspect is that it would need an additional communication of nodes along with the base station in turn requires further energy.

The authors in [13] have suggested an EEABR (energy-efficient ant based routing algorithm) for flat & architectures of location alertness. In this suggestion, the ants look for less power consumption path in the meantime decreasing the ants' dimension at the time of the communication amongst these nodes. Authors have suggested well-known ACLR algorithm which is a location & flat awareness algorithm. This would fuse the residual energy as well as local & worldwide nodes of location details, for explaining the possibility to choose the later node for the ants.

The authors in [14] recommended an algorithm of ACO & apply it to control of energy as well as the congestion control on route of WSN. The pheromone & the node's energy are united to have an effect on the ration of pheromone consent in the path of optimization in this algorithm that could keep away from the congestion of network & quick energy consume of individual node and it could extend the whole lifecycle of network.

The authors in [15] have recommended a PRACO (predication mode routing algorithm based on ACO) for attaining the energy-aware data-gathering routing arrangement in WSNs. This particular algorithm would verify the factor of load in heuristic aspect & would suggest a pheromone of novel updating rule. The artificial ants in this algorithm could anticipate the local networks' energy state & the consequent actions could be adaptively taken for developing the efficient energy in the construction that has been routing.

The authors in [16] suggested a latest efficient energy routing algorithm for WSNs comprising the clustering & routing stages. The simulation outcomes have illustrated that this specific algorithm in the comparison of other algorithms would extend the existence of network & decrease the consumption of energy. Conversely, the dynamic scenario in this document as well as the tolerant fault features of the sensor network that had not been taken into consideration.

A GA (Genetic Algorithm) [17] relied method does not needed discovering any node that has been declared for the algorithm for executing; as a substitute it selects any active node as the primary node. Every node has to provide its status to sustain the global details at the PE, so that GA would incur the communication overhead.

III. PROPOSED FRAMEWORK

The suggested work has been separated into 3stages named as, the phase of node selection, the phase of setup and the phase of steady state. Initially in the cluster head phase of selection, all those nodes would get separated into diverse clusters based on the distance. Every node broadcasting the data then would choose the destination for communication of data. A particular ID has been allocated to every SN in this stage. The SNs broadcast their IDs utilizing the protocol of MAC layer once it is completed. Originally, a node would decide to be a CH through making a random number then compare with value of threshold. The next cluster head procedure selection should rely on residual energy as well as the distance. To choose the sink node utilizing the particle swarm optimization along with genetic algorithm in the optimal sink phase position. Here the computation of fitness function & node probability communication helpful to choose the optimal sink position. The mobile agent in this stage has been determined for all the CH nodes. Here depending on GA &PSO algorithms evaluated the chromosomes and would carry out the suggested MMA-PSOGA algorithm for choosing few of the optimal positions. Also compare the resultant chromosomes in terms of distance in steady state phase, RSSI (received signal strength) and nodes of CH information. Here MA (mobile agent) would gather the data from member nodes &would carry to CH. The CH nodes would be sending the data to SINK. Now, we explain our suggested MMA-PSOGA depended on the algorithm along with initialization of particle, derivation of the multi-objective fitness function, algorithm of genetic, and Qos parameters.

The CH election has been recognized by utilizing the function of probability in LEACH. But the 2 parameters are added together with the probability function in this scheme. Those are distance among the energy level as well as the nodes.

Primarily, particular node would decide to be a CH by creating a random number between 0 - 1 & comparing it along with a value of threshold T (n), computed utilizing Equation (1).

$$T(n) = \frac{P}{1-p\left(r\ mob\frac{1}{p}\right)}\ if\ n\ \varepsilon\ G \quad \text{---- (1)}$$

Where p is the required percentage of node to be CH; r is the existing round; G is the set of nodes that have been not cluster heads at the time of previous 1/P rounds.

Where G is the nodes' set those have been involved in the election of CH. Every elected CH broad cast a message of advertisement to the remaining nodes in the network that they are the latest cluster-heads.

This decision would rely on the advertisement's signal strength. The non-cluster nodes of head would explain the proper cluster-heads as they would be a cluster member. All the non-cluster head nodes would decide on the cluster to which they wanted to belong to after receiving this advertisement. After receiving all the messages from the nodes that would like to be involved in the cluster and depending on the several nodes in the cluster, the cluster-head node would create a schedule of TDMA & would allocate every node a timeslot whenever it could get transmitted. This plan is broadcast to all the nodes in the cluster. At the time of the steady phase, the sensor nodes could initiate sensing & data transmission to the cluster-heads. Node of cluster head after receiving all the data that aggregates all the information before sending it to the base-station. After a particular period, which would be concluded as a priority; network would go back to the setup stage again & would enter other round of choosing latest CH. Every cluster would communicate by utilizing different codes of CDMA to decrease interference from nodes belonging to other clusters.

After choosing & computing the possibility, nodes residual energy level and distance could be assessed by utilizing the Equation (2) & (3) respectively.

$$E(resd) = \sum_{i=0}^{n} E(init) - E(cons) \text{---- (2)}$$

Where E (resd) is Residual energy of nodes; E(init) is a primary energy that has been granted to each node; E(cons) has been consumed nodes' energy.

The distance could be evaluated utilizing Euclidean distance formula such as in the Equation (3)

$$\sqrt{(x_j - x_i})^2 + (y_j - y_i)^2 \text{ ---- (3)}$$

After computing all the mentioned values in the Equations (1), (2) and (3), the nodes would be electing the CHs among them. Every elected CH would broadcast an advertisement to non-CHs for forming a cluster. A non-CH would select a CH that could be reached expending the least energy for communication. Though cluster head nodes of election plan would be considering the residual energy as a constraint, but it would ignore the distance factor among the nodes as well as base station. Also many successive rounds where a node has been not a head of cluster have not been directly taken into consideration. The cluster head selection algorithm in this document would consider distance of the nodes, the nodes remaining energy, from the base station as well as the several following rounds in which a node has not been a cluster head as the traits as in eq.2 & 3. Also it would consider an added factor that either the nodes remaining energy is adequate for sending the comprehensive information to the base station or not. It couldn't get chosen as cluster head if the remaining energy of nodes is not enough. This additional trait has been considered for optimizing the procedure of cluster-head selection for ensuring an even energy load distribution over the entire network. Our goal is to attain the efficient energy, not only in the energy consumption terms but in terms of lifetime of network as well.

Finding position for SINK using PSO+GA:

After separating the network into 'n' number of clusters as well as the CH process of selection, an optimal position for the SINK node has been determined by incorporating PSO & GA algorithms. Firstly nodes fitness values have been computed utilizing a fitness function equation (4). Depending on the values of fitness, the final particle for PSO has been populated.

$$fitness(i) = \frac{1}{M}\sum_{j=1}^{M}[\sqrt{(x_j - x_i)^2 + (y_j - y_i)^2}\ ) - d_j \text{- (4)}$$

Where, fitness (i) is the fitness value of particle I; (xi, yi) is the position would coordinate of the particles i, d(j) is the distance. P_{best}, G_{best} Values have been evaluated depending on the fitness values of the nodes at every iteration round. The best of all P_{best} has been compared and G_{best} value is established. Every particles velocity & position for the 'i' th iteration has been updated in accordance with the Equations (5) and (6) respectively.

$$V_i(t+1) = V_i + c_1r_1\left(P_{best} - x_i(t)\right) + c_2r_2(G_{best} - x_i(t)) \text{----(5)}$$

$$x_i(t+1) = x_i(t) + v_i(t+1) \quad \text{--- (6)}$$

After the 'n' number of iterations, the final particles for genetic algorithm have been chosen and the final chromosomes have been populated. A mutation point has been chosen& the values are randomly manipulated.

IV. RESULT AND DISCUSSION

We would present the performance analysis of the suggested algorithm utilizing an extensive experiment now. This sector would provide the simulation setup that has been utilized for the experiments. And, it is concluded by the comparative research of the outcomes that are attained by the algorithm with its contemporaries & statistical analysis of the same.

Parameter	Value
Application Traffic	CBR
Transmission rate	1000 bytes/0.5ms
Radio range	250m
Packet size	1000 bytes
Maximum speed	25m/s
Simulation time	50sec
Number of nodes	44
Area	1500x1000
Routing protocol	AODV
Routing method	LTAWSN, DMADA, MMA-PSO-GA

Table1: Simulation table

We assume that 44 sensor nodes are randomly distributed above1500x1000m^{2}fields by considering the Radio range as 250m in this paper. In the Table1, it shows that the system parameters that have been utilized in our simulations. We would use Application Traffic as CBR (Constant Bit Rate) it could be help for control the traffic in network here, Routing Protocol as AODV and it has been utilized to route the level in network, Routing Methods are LTAWSN, DMADA, in our simulation, & this routing methods are used efficiently to perform the network outcomes. Next the Transmission rate is 1000 bytes/0.5msby considering the Packet size as 1000 bytes& with a Maximum speed 25m/s and the entire Simulation duration is 50 sec. We would also be simulated for available methods such as, DMADA [19] & LTAWSN [18] for the purpose of comparison along with suggested algorithm. The cause behind choosing DMADA as well as LTAWSN algorithms are as follows. The recommended algorithm of MMA-PSOGA would take advantageous of the most popular swarm PSO technique and genetic algorithm. Also MAs have been included to decrease the intra-cluster communication. Yet the available methods primarily consists either techniques of swarm or MAs. Mostly these algorithms failed to address the problem of optimal sink placement as well as congestion in the cluster.

Evaluation results:

We would be simulating the suggested MMA-PSOGA algorithm in this section and compare it with DMADA [19] & LTAWSN [18] algorithms.

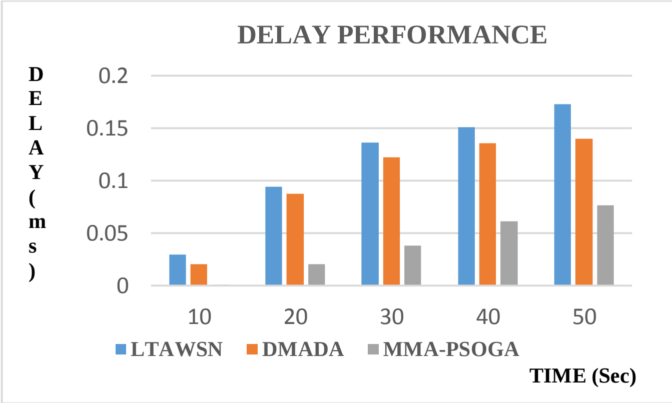

Figure1: Delay time

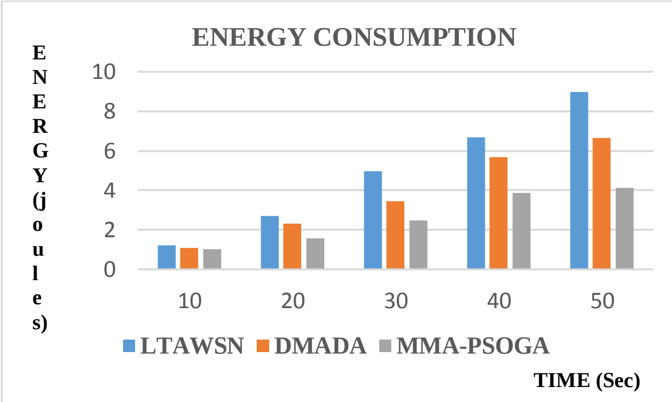

Figure2: Energy consumption

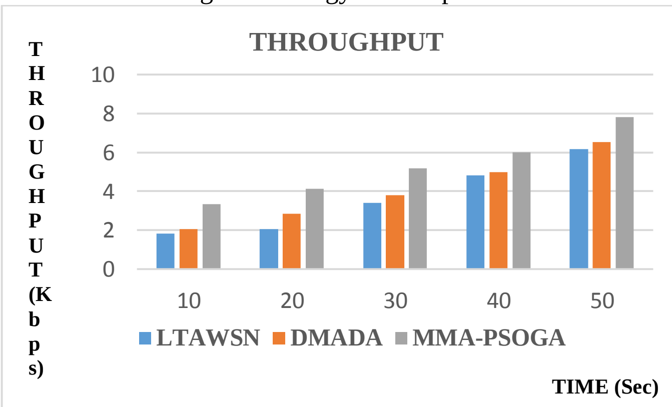

Figure3: Throughput

Figure 1 is showing the analysis of comparison end-to-end delay. This could be perceived that on increasing the duration of simulation in the network the end-to-end delay would be enhanced. The suggested algorithm has lower delay as compared to available method. The cause for this improvement is that our algorithm has the ability to discover the most informative route by traversing comparatively less time consequently MA would take less time to return to the Sink.

Figure 2 would show the comparative energy consumption analysis. We have compared our method with the existing schemes in the subsequent phase of simulation. We would be varying the simulation time from 10 to 50 seconds in our simulation. As the recommended algorithm would choose the optimal position of sink node which would consume comparatively less power for the MA transmission. Hence our algorithm would balance the consumption of energy amongst the nodes of source. Also the accuracy needed has been obtained by visiting restricted number of source nodes, thus our algorithm could approximately save 40 % energy as compared to available methods.

Figure 3 demonstrates throughput against duration of simulation. It is obvious that the MMA-PSOGA throughput, with average 50Kb/s, is higher than other of the DMADA [19] & LTAWSN [18], along with average 25.6Kb/s, & it is nearly stable. This due to, MMA-PSOGA route selection is depended on maximum-minimum signal strength criteria which result in prolonging lifetime of route, & the suggested failure of link mechanism which would expect the failure of link in an earlier duration before data packets dropping. All of these resulting in a high throughput of the recommended MMA-PSOGA.

V. CONCLUSION

The SINK has to be deployed for this at the optimal location &decrease the excess traffic at the nodes is2 conflicting purposes. We have recommended an optimal path design of MMA-PSOGA algorithm for the SINK in WSN along with a trade-off between transmission distance and congestion at surrounding of the SINK in this paper. The algorithm has been provided the support through rigorous simulations and the simulation results demonstrated that the suggested algorithm outperforms DMADA & LTAWSN in terms of various metrics of performance. The statistical importance of the simulation outcomes have been authenticated through tool of NS2, followed by network analysis. Though, we have planned an efficient energy optimal path for SINK node in WSN in this paper. We would be improving the algorithm optimization along with efficient energy for various sink nodes in future.

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