Reverse Game Theory Approach for Aggregator Nodes Selection with Ant Colony Optimization Based Routing in Wireless Sensor Network

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***Abstract*— The self –configurable, randomly distributed, adhoc technology based wireless sensor networks can be invaluable in various domestic and military applications for collecting, processing and propagating wide range of complex environmental data. Hierarchical routing has been adopted, where clusters of nodes are formulated based on geographical location of nodes and associate node to aggregator node and other aggregator node to sink or aggregator node to aggregator node to sink routing mechanism is followed. The model work "Low Energy Adaptive Clustering Hierarchical (LEACH)", is the leading work in this direction, whereas it is a complete probabilistic model, which does not achieve the tradeoff between power and QoS parameter optimization. We proposed RGT-AGN-ACO-R (Reverse Game Theory based Aggregator Node Selection and Ant Colony Optimization based Routing), In order to maximize life time of the network. The proposed protocol has been simulated, and the life time assessment, power inconsistency, residual power against number of rounds is evaluated and is compared with LEACH. Simulation results shows a remarkable enhancement as compare to LEACH**

Keywords-component; Wireless sensor networks, routing, ant colony optimization

I. INTRODUCTION

The evidential fact of existence of projects like WINS and Smart Dust projects [1] , aspire to integrate sensing, computing and wireless communication capabilities into small form factor to enable low cost production of tiny nodes in large numbers. There are various other applications has been conceptualized such as environmental monitoring, structural health monitoring(SHM), health monitoring, vehicle tracking system, military surveillance and earthquake observation etc, in both civilian and military discipline [2]. The typical wireless sensor network (WSN), works on adhoc technology, due to which every participating nodes acts as a router to forward packets from other nodes, apart from sensing its own surroundings and communicating its own data to other nodes. In this way, at every node further processing and computing task overhead leads to excessive consumption of energy [3].

A WSN routing task which consists of stable or limited mobile nodes and a base station is considered as the problem. To achieve an efficient and robust routing operation, major features of typical WSNs are taken into consideration. First, failures in communication nodes are more probable in WSNs than classical networks, as nodes are often located in unattended places and they use a limited power supply. Therefore the network should not be affected by a node's failure and should be in an adaptive structure to maintain the routing operation. This is performed by sustaining different paths alive in a routing task. A node transferring data to the base sends it in divided parts (as data packages) using different paths. When a failure occurs in a path, the associated data package cannot arrive at the base. To achieve guaranteed delivery, acknowledgement signals are used. In the case of an absent acknowledgement for a data package, the source node resends that package to a different path. By performing acknowledgement-associated data transfers and sustaining different paths alive, routing becomes more robust. It is obvious that some paths in this type of network would be shorter, allowing for lower energy costs. Transmission on these paths should be more frequent to reduce the total cost of energy consumed using these paths. In other words, more data packages should be transferred along shorter paths to achieve a lower energy consumption. Second, nodes in WSNs present stringent energy constraints. They consume much more energy when they are in communication. The proposed technique utilized both energy levels along with length of the routes. This is performed by choosing nodes having more energy in a routing task. Thus, the average network lifetime would be increased. Third, due to limited bandwidth of WSN, it is very essential not to consider routing with massive information over the communication channel. This is also a means of preserving more energy. Fourth, some node mobility should be allowed in some specific WSN applications. In our approach, nodes are considered to be normally stable. However, probable changes in node locations do not preclude network operation safety. Instead, it causes some setup stage to organize paths well. However, transfer of data packages is still performed in this stage as quality grows over time by exploring new paths. To summarize the operation of the routing scheme, a node having information for the base station initializes the routing task by transferring data in packages to different neighbor nodes. Each node then chooses other neighbor nodes and so on. Thus, paths towards the base are formed and each routing operation supplies some information about optimum paths for the consequent routing tasks. While performing this operation, some agents (artificial ants) are used to achieve efficient routing. This operation is explained in the following section of the paper. Section 2 discusses about the related work followed problem formulation in Section 3. The proposed model is discussed in Section 4 and research methodology in Section 5. Section 6 discusses about implementation strategy followed by result discussion on Section 7. Finally, the summarization of the work is discussed in conclusion in Section 8

II. Related Work

Before coming to the proposed system, it is very prime stage to understand the quantity of the work being done in focus on conservation of power using game theory as well as ANT colony Optimization in order to understand the uniqueness in the proposed system. Here are brief details of the survey being conducted in focus of the proposed system.

A. Related Work in Game Theory: Valli [4] has proposed a power control solution considering Multivariate Interpolation Decoding RS (MIDRS) Code in Virtual MIMO (VMIMO) WSN using game theoretic approach. The game is formulated as a utility maximizing distributed power control game while considering the pricing function. The system uses space time block code that enables to accomplish maximized power conservation as well as enhances the network lifetime. Sengupta [5] has proposed a distributed protocol for optimal energy management and showed that the system is energy stable only of the sensor nodes obeys with specific threshold of transmit power. Valli [6] proposes a power control solution for wireless sensor network (WSN) considering Error control coding in the analytical setting of a game theoretic approach. Kanthe [7] has proposed a non-cooperative game theoretic approach for the power control problem in the sensor networks. The work shows that the Nash Equilibrium exists when it is assume for minimum and maximum threshold for channel condition and power level. Closas et. al [8] has introduced a distributed algorithm that is designed by applying game theory concepts to design a non-cooperative game, network connectivity that is guaranteed based on asymptotic results of network connectivity. Tan and Zhang [9] have discussed a scheme of cost sharing game model in order to perform clustering in sensor network. Prospective cluster heads will divide cost of general affairs in clustering mechanism that minimizes the burden of single cluster head and partially accomplishes load balancing through cluster head alliance. Kazemeyni [10] has illustrated an enhanced group membership procedure for wireless sensor network in order to select the best obtainable group by the sensor. Valli [11] has introduced a model that evaluates a game theoretic model along with pricing for energy control considering the residual energy of the nodes. The work has also considered a homogeneous sensor network with square grid, triangular and hexagonal deployment schema. Behzadan e.t. al [12] has proposed a distributed energy balanced algorithm for data gathering and Routing to construct energy balanced routing trees in a network that contains heterogenous nodes. Crosby and Pissinou [13] introduce the concept of multi-class wireless sensor networks where each class is governed by a different authority.

B. Related Work in ANT Colony Optimization: Wang et. al [14] proposes an energy efficient organization method based on collaborative sensing and adaptive target estimation. Ant colony optimization (ACO) was introduced to optimize the routing scheme. Prasan and Murugappan [15] has introduced an implementation of Ant Colony Optimization in the underwater WSN where the underwater wireless Sensor networks are constituted by sensors and autonomous underwater vehicles. Begum et. al [16] has introduced a different method where the minimum working sensor node is chosen by modified Ant Colony protocol. The purpose of their work is to resolve the coverage issue of all targets which have been considerably enhanced in comparison with the fundamental Ant colony protocol. Camilo et. al [17] presents a new Wireless Sensor Network routing protocol, which is based on the Ant Colony Optimization metaheuristic. Wang et. al [18] investigates the energy efficiency problem and proposes an energy-efficient organization method with time series forecasting. this paper proposes an energy efficient organization method based on collaborative sensing and adaptive target estimation. Sun [19] has introduced a novel energy efficient routing optimization approach using improved Ant Colony Optimization (EERIA) to maintain network lifetime at a maximum, while discovering the shortest paths from the source nodes to the sink node using an improved ant colony based optimization. Saleem et. al [20] has proposed a cross layer design based self optimized (ACO) routing protocol for WSN that is based on link quality, energy and velocity parameters HU and Chen [21] has illustrated a novel routing algorithm based on Ant Colony Algorithm with Position and Resistance strategy performed on NS2. Mohamed [22] present a protocol based on an ant colony to calculate dynamic routes and a cooperation mechanism which allows better quality of service (QoS) management problem in WSNs. Hiba Al-Zurba [23] propose an ant colony-based routing algorithm for multimedia WSNs. This algorithm optimizes energy consumption, link quality and link reliability.

Therefore, after reviewing 10 papers from game theoretical approach and 10 papers from ANT colony optimization technique, it can be seen that although a bunch of work has been proposed for highlighting the issue of unwanted power drainage during data aggregation technique as well as routing, it is very difficult to consider the reliability of the result accomplished. Reviewing the papers also witnessed the performance parameters mainly as jitter, energy, distance, bit error rate, utility, and residual energy. However, the researcher feels that there is a strong need of introducing more parameters for improvising the prior research work conducted.

III. Problem Formulation

Data collection is the main purpose of wireless sensor nodes. The sensors sporadically sense the data from the surrounding environment processes it and transmits it to the sink. The frequency of reporting the data and the quantity of sensors that reports the data packet actually depends on the specific application. Data gathering involves systematically collecting the sensed data from multiple sensors and transmitting the data to the sink for further processing. But the data originated from sensor nodes are often superfluous and also the quantity of data sourced may be very massive for the sink to process it.

Some design issues in data aggregation are:

- Sensor networks are inherently unreliable and certain information may be unavailable or expensive to obtain; like the amount of sensor nodes located in the network and the quantity of sensor nodes that are responding. It is very difficult to accomplish complete and up-to date information of the neighboring sensor nodes to collect updated information.
- Making some of the sensor nodes to transmit the data directly to the sink or to have less transmission of data to the sink for minimizing energy.
- Eliminate transmission of redundant data using meta- data negotiations as in SPIN protocol.
- Improving clustering techniques for data aggregation to conserve energy of the sensors.
- Improving In-Network aggregation techniques to improve energy efficiency. In-Network aggregation means sending partially aggregated values rather than raw values, thereby reducing power consumption.

Main research focus in data aggregation is geared towards conserving energy. Other research issues include improving security in data transmission and aggregation, handling tradeoffs in data aggregation i.e. tradeoffs between different objectives such as energy consumption, latency and data accuracy, improving quality of service of the data aggregation protocols in terms of bandwidth and end to end delay. In wireless sensor networks, conservation of energy is treated as a chief performance decisive factor to furnish maximum network lifetime. When considering conservation of power, routing protocols should also be designed effectively in order to achieve fault tolerance in wireless communications. The optimization of network parameters for a routing procedure to offer maximum network life span might be considered as a combinatorial optimization problem. Many researchers have recently analyzed the collective behavior of biological species such as ants, dolphins, elephant, and bacteria as similarity furnishing a normal model for combinatorial optimization problems. Ant colony optimization (ACO) techniques replicating the actions of ant colony have been successfully functional in many optimization problems. Therefore, it can be seen that Wireless Sensor Networks have created wide range of challenges that still needs to be addressed.

IV. PROPOSED MODEL

The prime target of the proposed model is to design a novel framework for power efficient data aggregation technique in Wireless Sensor Network. The model also targets to build a robust selection of aggregator node (AN) using the technique of Reverse Game Theory as well as it designs the best optimized power efficient routing strategy using Ant Colony Optimization. The schema of the proposed model is as below.

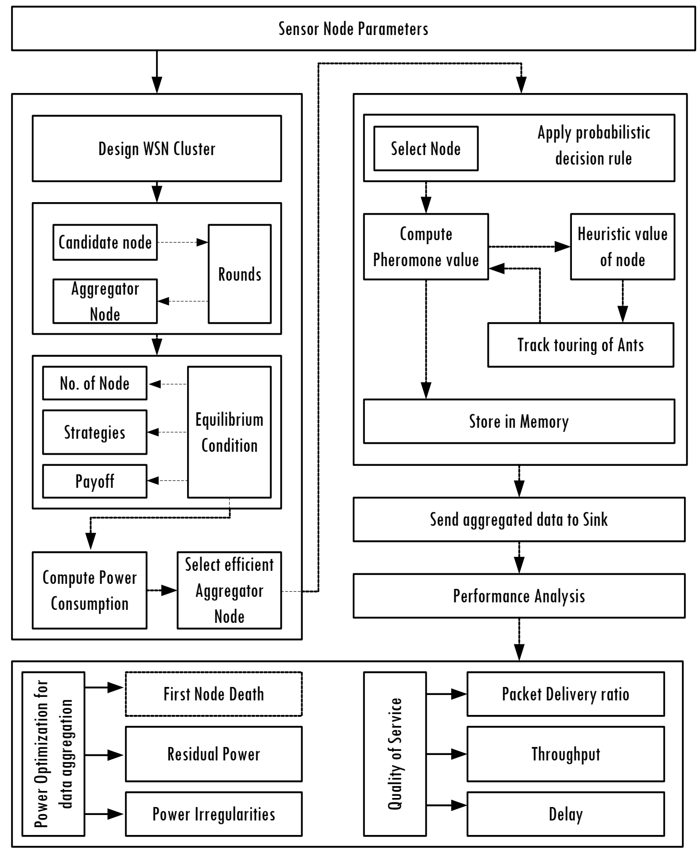

Figure 1 Schema of Proposed Model

V. RESEARCH METHODOLOGY

In order to understand the methodology adopted, we classify the work into two sequential phases e.g. Selection of Aggregator Node (AN) and Strategy for Routing Schema.

A. Selection of Aggregator Node:

Performing clustering and selection of the AN is one the prime preliminary step in the proposed work. This mechanism is performed using reverse game theory. The concept is mapped as the game conducted by the sensor nodes in WSN where each candidate nodes elect themselves as aggregator node whose prime responsibility will be to aggregate the data from other candidate nodes from the home cluster and forward them to sink finally. The Reverse game theory formulates the game concept in WSN as ANRGT=[N, S, P] where N is set of players (nodes), S is set of available strategies, and P is set of payoff of the nodes. Considering having pure strategy, the categories for strategy will be executed based on dual choices: a sensor node judges to either announce themselves as AN or not. Let A be the strategy “announce myself as AN” and NA as “Do Not Announce Myself as AN.” Therefore the strategy map will be formulated as S={A, NA}. Similarly, the design of the payoff is done in such a way that if the node select itself as AN, then if no other candidate node becomes AN either, its payoff will be considered as zero as the node will be unable to transmit its data to the sink. In case any one of the neighbor node announces itself as AN, then its payoff will be considered as v. This factor is therefore considered as gain in successfully transmitting the data towards the sink. Ultimately, if the node announces itself as AN, its payoff for successfully transmitting the data v will be diminished by an quantity equivalent to the cost c of becoming AN. Therefore, in that circumstance, the ultimate payoff will be (v-c).

Table 1 Consideration of payoff for the proposed model

	Announce	Do Not Announce
Announce	(v-c, v-c)	(v-c, v)
Do not Announce	(v, v-c)	(0,0)

The proposed equilibrium condition is represented as payoff in Table 1.

It is quite obvious from the above consideration that the proposed model is based on symmetrical game concept as the payoff value if based on the strategies of the sensor nodes and not on that node that is considered for analysis. Therefore, the strategy (A, A) cannot be considered as Nash Equilibrium as each node has better feasibility to alter its strategy to NA where the payoff will be v>(v-c). Similarly, the strategy (NA, NA) cannot be considered as Nash equilibrium either as here any sensor node might chose to deviate and announce itself as AN as it will lead to a positive payoff. However, the strategy (A, NA) can be considered as Nash Equilibrium as if the 1st node selects A and second node selects NA than node of these nodes will have any incentive to alter its selected strategies. Similarly, (NA, A) can also be considered as Nash Equilibrium. As no common strategies for the sensor node exists that results in equilibrium stage there is no symmetrical Nash equilibrium in this concept.

Therefore, we now present reverse game theory model in order to achieve equilibrium stage as well as to reduce the power consumption in the process of selection of AN. Assuming N number of sensor node, let $S=\{s_1, s_2, \ldots s_N\}$ be the adopted strategies of the sensor nodes. If no sensor nodes "Announces" than the entire node's payoff will be considered as Zero. If at least one node (say n_1) selects A than the payoff of all other nodes except n1 will be v, while node's n_1's initial gain '*v*' will be minimized by the cost of declaring itself. Therefore the revised payoff $R_{payoff}(S)$ of any random node will be generalized as:

$$R_{payoff}(S)\begin{Bmatrix} 0 \quad s_j = NA, \forall j \in N \\ (v-c) \quad s_i = A \\ v \quad s_i = NA, \exists j \in N, | s_j = A \end{Bmatrix} \qquad (1)$$

The power consumed when a sensor node '*i*' transmits a packet of '*k*' bits to its aggregator node AN_i that is located at a distance d_{iANi} is computed by the following equation:

$$P_{i,ANi}=k.(p_{elec}+p_{amp2}.d_{iANi}^{2}) \qquad (2)$$

Similarly, the receiver utilizes power when receiving a data packet of k bits as represented as:

$$P_{rx}=k.p_{elec} \qquad (3)$$

In the above equations, pelec is the power consumed in transmitted whereas pamp is power consumed by the transmitter's amplifier for accomplishing the necessary signal level at the receiver for precise decoding. The parameter p_{amp2} is 1st variation of the parameter corresponding to a square law distance attenuation. Similarly, the power consumed by the AN while communicating between AN and sink is represented by,

$$P_{AN,sink}=k.\ (p_{elec}+p_{amp4}.\ d_{AN,sink}^{4}) \qquad (4)$$

Where p_{amp4} is the 2nd variant parameter corresponding to the attenuation proportional to the fourth power of the distance. When the sensor node transmit data to AN, the consumed power P_{iANi} depends on their distance d_{iAN} for a fixed size of the data packet. Since AN may vary with time and due to the random distances between the sensor and the AN, it is feasible to compute an expected value of power consumption.

The other parameter that needs to be estimated is the cost '*c*' for the AN due to aggregation of the collected data and transmitting them to the sink. There are a number of methods that sink can be reached: The AN can send the data directly to the sink, it could use intermediate nodes to reach it, or another clustering hierarchy could be used. Regardless of the method used, the parameter *c* will depend on the size of data, the number of packets received and the distance between the node and the node that will receive them, either this is the sink itself or another node in the network. Hence, with this policy of reverse game theory, the proposed model assures the robust selection of AN from each cluster in each rounds.

B. Strategy for Routing Schema:

This is the second phase of the proposed model where an efficient and optimized routing technique is accomplished using the concept of ANT colony optimization. The source node S is assumed to launch ants that will move through the neighbor iterative nodes nin, and reach an ultimate destination sink node n_{sink}. The execution of ants will be performed only when the sensor node has data packet to be sent to the destination sink node. The selection of next node n is done using probabilistic decision rule as below:

$$P_k(n,s) = \begin{cases} \dfrac{[\tau(n,s)]^{\alpha}.[\eta(n,s)]^{\beta}}{\sum_{n \in N_s}[\tau(n,s)]^{\alpha}.[\eta(n,s)]^{\beta}} & k \notin tabu^r \end{cases} \qquad (5)$$

The value of $P_k(n,s)$ will be zero otherwise. In the above equation τ(n,s) is the pheromone value, η(n,s) is the value of the heuristic associated to power, N_s is receiver node. For the sensor node n, tabur is the list of identities of received data previously, α and β are parameters that manages the relative weight of the pheromone trail (that links to arcs) and heuristic value. Each *arc(n,s)* has a trail value τ(n,s)ϵ [0, 1]. As the destination d is a steady sink, the final node of the route is the same for each ant travel. However, the heuristic value of the node n is represented as below:

$$\eta(n,s) = \frac{(I-e_r)^{-1}}{\sum_{n\in R_s}(I-e_n)^{-1}} \quad (6)$$

In the above equation I is the initial power and e_r is current power of the receiver node n. This enables decision making according to neighbor nodes' energy levels, meaning that if a node has a lower energy source then it has lower probability to be chosen. Nodes inform their neighbors about their energy levels when they sense any change in their energy levels. Once the touring of the ant is over, every ant furnishes the quantity of pheromone $\Delta\tau^k(t)$ (as shown in below equation),

$$\Delta\tau^k(t)=1/ J_w^k(t) \quad (7)$$

where $J_w^k(t)$ is the length of the tour $w_k(t)$ that is conducted by an ant 'k' at iteration t. Therefore, $J_w^k(t)$ represents the cumulative nodes visited by ant 'k' of tour w at iteration t. The quantity of the pheromone at each connection (*l(n,s)*) of the sensor node is shown in below equation.

$$\tau(n,s)(t)= \tau(n,s)(t)+ \Delta\tau(n,s)(t) \quad (8)$$

for all value of $l(n,s)\epsilon\ wk(t)$, k=1,….m

The values of the pheromone are stored in memory of sensor node where each node has information about the quantity of the pheromone on the routes to their neighbor nodes. The value of pheromone trail $\Delta\tau^k$ is appended to the routes already covered by an ant 'k'. Increasing pheromone amounts on the paths according to lengths of tours, $J_w(t)$, would continuously cause an increasing positive feedback. In order to control the operation, a negative feedback, the operation of pheromone evaporation after the tour is also accomplished in equation (9). A control coefficient $\rho\epsilon$ (0,1) is used to determine the weight of evaporation for each tour [24]

$$\tau_{ij}(t)=(1-\rho)\tau_{ij}(t) \quad (9)$$

VI. IMPLEMENTATION STRATEGY

The simulation of the proposed technique is performed on 32 bit Windows OS with 1.84 GHz in dual core processor considering Matlab as programming environment. In order to prove the efficiency of the proposed methodology, the comparison of the proposed technique is done with frequently used LEACH protocol. Different scenarios of the sensor nodes are considered with random distribution of the nodes in defined simulation area. We have resulted into an expression of the equilibrium probability a sensor node that will self-announced as aggregator node. This means that no sensor has any incentive to deviate from this probability. So, the remaining problem is only the calculation of the total number of sensor nodes that is the total number of nodes participating in the clustering game. Following the assumption made for the LEACH protocol, the proposed RGT-ACO technique will assume that every sensor may hear the transmission from every other sensor. This is of course not very realistic, however it will permit us evaluate this simple method with respect to LEACH, which is a very popular clustering mechanism for sensor networks. It could also be considered as the first level of a clustering procedure with many levels of hierarchy. If it is needed to be very strict, the system will have to examine if a node has an incentive not to announce its existence to its neighbors. Since a node is interested in using another node to send its packets on behalf of it and thus conserve energy, if it does not announce its existence then it will be unable to pass its data to a aggregator node and so it will have to send the data to sink by himself, which is undesirable. Therefore, all nodes will make their existence known to all others and since we assumed that there is no sensor out of range of any other, all nodes will compute the same number of players participating in the clustering game. The nodes that have served as aggregator node have no reason to deviate since any probability greater than 0 would result in lower payoff, as there is a positive probability that it is self-announced as AN again and thus utilize more power. By playing the game in rounds, the framework define a repeated clustering game. In order to analyze this repeated game, an appropriate definition of the utilities of the nodes is used and a discount factor to model the patience of the nodes in receiving their payoffs. Due to the this technique that bounds the number of the stages of the repeated game and assuming that the sensors are too impatient, the perform analysis is highly valid and reliable.

VII. RESULTS DISCUSSION

For the purpose of evaluation, we follow two performance metric e.g.

A. Performance metric-1: Power Optimization

This set of the simulation result will assist to understand the efficiency of the proposed model with respect to approach towards minimization of power consumption. It will include the following sub-metrics:

i) Round vs alive nodes: This metric is related to the instant of time representing FND (First Node Death). The experiment is performed for data aggregation phenomenon using the proposed concept of RGT-ACO as well as in LEACH protocol. Figure 2 shows the number of the active nodes with respect to the operation performed on network in 700 rounds for various scenarios. The simulation results shows that the proposed RGT-ACO technique highly enhanced the life time of the sensor node during the process of data aggregation.

ii) Round vs Residual Power: This metric is related to the aftermath of the proposed technique in order to conserve residual power. With lesser vertical curves, the result can ensure better clearness of the equilibrium stage of power consumption. Figure 3 shows the simulation results where it can be seen that proposed RGT-ACO technique has better residual power in cumulative network as compared to LEACH protocol.

iii) Round vs Power Irregularities: This metric is used for evaluating the fairness of the utilization of power for all sensor nodes in each 700 rounds. The minimized type of residual power in every rounds is the prime cause of the fairer power utilization. On the contrary, maximized irregularities in power utilization results in better network load on every nodes. Figure 4 shows the simulation results where it can be seen that proposed RGT-ACO technique has more straight lines that represents minimized power irregularities thereby showing better power in equilibrium stage.

B. Performance metric-2: Quality of Service

This set of simulation results will highlight the improvement with respect to quality of service resulting from proposed RGT-ACO adopted routing technique.

i) Packet Delivery Ratio Vs Rounds: This category of metric will highlight the effect of newly implemented RGT-ACO technique on packet delivery ratio. A smart and efficient network with robust routing protocol is always characterized by better packet delivery ratio. Implementation of Reverse Game Theory assist in smart selection of aggregator node while responsibility of an efficient routing from aggregator nodes to sink lies in Ant Colony Optimization scheme applied. Figure 5 shows the simulation results where it can be seen that proposed RGT-ACO scheme has better packet delivery ratio in comparison to LEACH protocol.

ii) Throughput vs rounds: This metric is required to understand the basic throughput of the data aggregation scheme using RGT-ACO technique. One of the interesting part of this result is the initial starting point of the throughput is same for both RGT-ACO and LEACH technique, but when the experiment is performed for 700 rounds, it can be seen in Figure 6 that proposed RGT-ACO scheme outperforms LEACH protocol.

iii) Delay Vs Rounds: This is the final metric for evaluating delay of data packets in the receiver point of view. An efficient network always ensure minimized delay with less communication overheads. Figure 7 shows the simulation results where it can be seen that delay (second) minimized for proposed RGT-ACO technique in consecutive 700 rounds as compared to frequently used LEACH protocol.

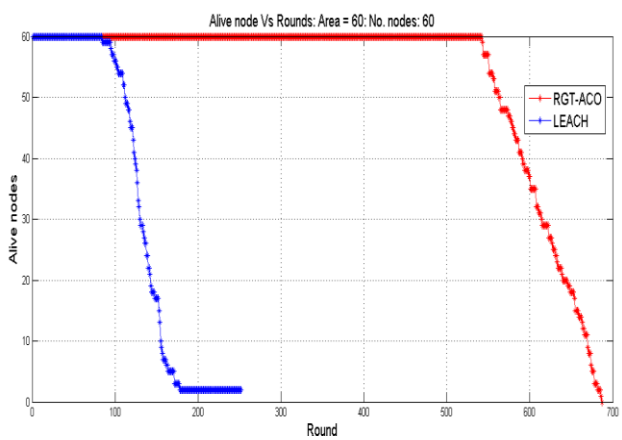

Figure 2 Simulation Results showing Alive nodes vs Rounds

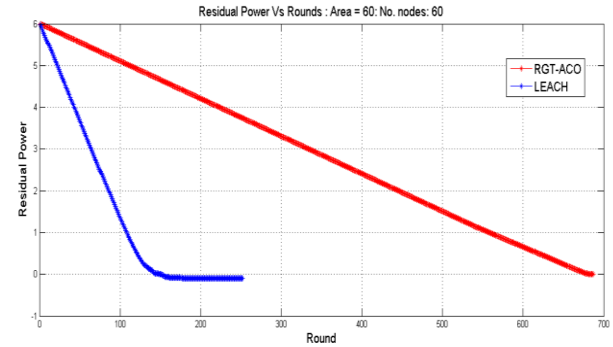

Figure 3 Simulation Results showing Residual power vs Rounds

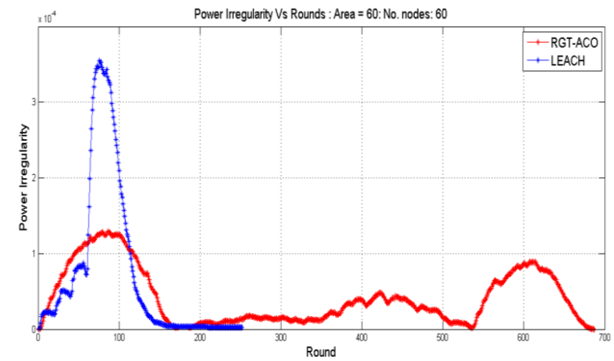

Figure 4 Simulation Results showing Power irregularity vs Rounds

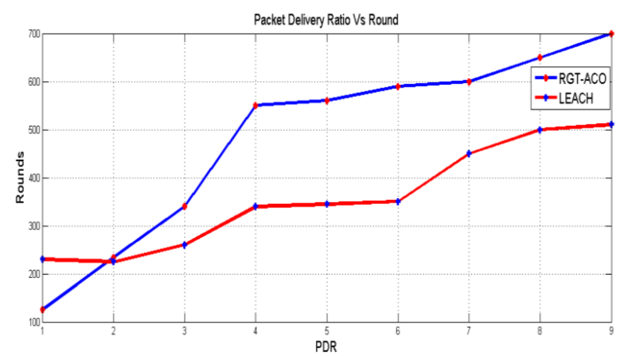

Figure 5 Simulation Results showing Packet Delivery Ratio Vs Round

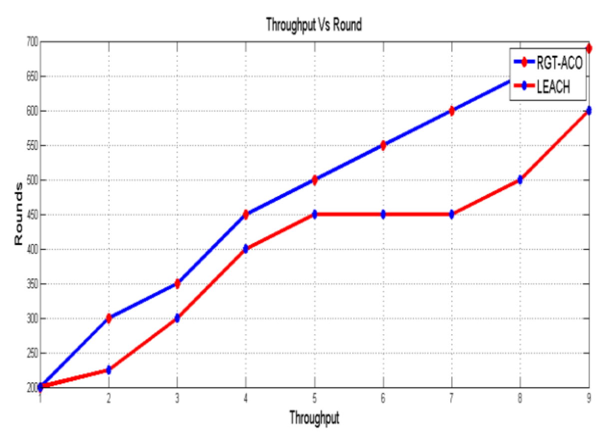

Figure 6 Simulation Results showing Throughput vs Round

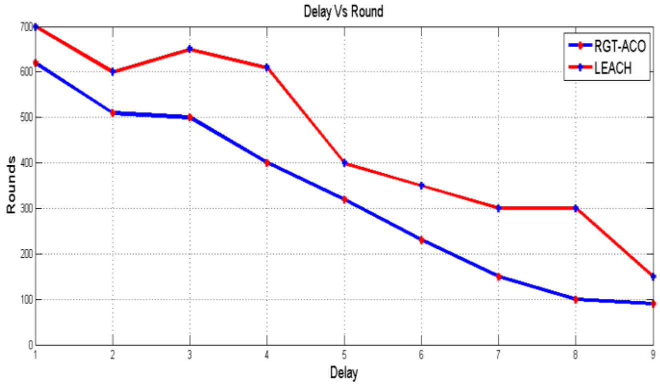

Figure 7 Simulation Results showing Delay vs Round

VIII. 8. CONCLUSION

The proposed system has introduced a novel technique of power efficient data aggregation technique in order to address the power drainage during communication in wireless sensor network. The paper has extensively studied 10 papers each for game theoretical approach exclusively used for data aggregation technique in focus on energy conservation as well as Ant colony optimization for an exploring an efficient routing techniques of the past. Reviewing the current issue of energy during data aggregation, the proposed system is classified sequentially intro two phases viz. the 1st phase is related to energy aware data aggregation technique using reverse game theory and 2nd phase is associated to data dissemination and efficient routing scheme using Ant colony Optimization. Designed on Matlab environment, the proposed system is compared with frequently used LEACH protocol in order to benchmark it. Simulation results shows better power optimization and highly enhanced quality of service compared to LEACH protocol.

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