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An Improved Pegasis Protocol for Energy Efficient Wireless Sensor Network by Ant Colony Optimization

Daniel Benedict Ndawi
M.Tech (CST-CN),
Department of Computer Science & Systems Engineering,
Andhra University, Vishakapatnam.

Abstract:
Wireless sensor networks have grown rapidly with the innovation in Information Technology. Sensor nodes are distributed and deployed over the area for gathering requisite information. Sensor nodes possess a negative characteristic of limited energy which pulls back the network from exploiting its peak capabilities. Hence, it is necessary to gather and transfer the information in an optimized way which reduces the energy dissipation. Ant Colony Optimization (ACO) is being widely used in optimizing the network routing protocols. Ant Based Routing can play a significant role in the enhancement of network life time of the sensor network ,to insure reliable network communication and to increase the efficiency of the network operation, a routing protocol should be well design, in this paper an improved power efficient gathering in sensor information system(AI-pegasis) is the chain based protocol has been proposed that relies upon ACO algorithm for routing of data packet in network and attempt has been made to reduce the power consumption during chain formation and data delay transmission routing from leader node to the base station, to minimize the efforts wasted in transferring the redundant data sent by the sensors which lie in the close proximity of each other in a densely deployed network. The ACO techniques used, (AI-pegasis) algorithm was studied by simulation for various network scenarios. The results depict the lead of AI-pegasis algorithm as more energy efficient protocol than traditional pegasis protocol by indicating higher energy efficiency by least number of nodes involved in every round of the chain formation, which result to prolonged network lifetime, enhanced stability period of the entire network, and to provide fault tolerance of the network.

Index Terms— ***Ant Colony Optimization, Energy efficiency, Wireless sensor network***

INTRODUCTION

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure-less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analyzed. A sink or base station acts like an interface between users and the network. [9]One can retrieve required information from the network by injecting queries and gathering results from the sink. Typically a wireless sensor network contains hundreds of thousands of sensor nodes. The sensor nodes can communicate among themselves using radio signals. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components. The individual nodes in a wireless sensor network (WSN) are inherently resource constrained: they have limited processing speed, storage capacity, and communication bandwidth. After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them. Then the onboard sensors start collecting information of interest. Wireless sensor devices also respond to queries sent from a "control site" to perform specific instructions or provide sensing samples. The working mode of the sensor nodes may be either continuous or event driven. Global Positioning System (GPS) and local positioning algorithms can be used to obtain location and positioning information. Wireless sensor devices can be equipped with actuators to "act" upon certain conditions. These networks are sometimes more specifically referred as Wireless Sensor and Actuator Networks as described in Wireless sensor networks (WSNs) enable new applications and require nonconventional paradigms for protocol design due to several constraints. Owing to the requirement for low device complexity together with low energy consumption (i.e. long Network lifetime), a proper balance between communication and signal/data processing capabilities must be found. This motivates a huge effort in research activities, standardization process, and industrial investments on this field since the last decade. At present time, most of the research on WSNs has concentrated on the design of energy and computationally efficient algorithms and protocols, and the application domain has been restricted to simple data-oriented monitoring and reporting applications. New network architectures with heterogeneous devices and the recent advancement in this technology eliminate the current limitations and expand the spectrum of possible applications for WSNs considerably and all these are changing very rapidly.

Applications of wireless sensor network

Wireless sensor networks have gained considerable popularity due to their flexibility in solving problems in different application domains and have the potential to change our lives in many different ways. WSNs have been successfully applied in various application domains, such as:

- **Military applications:** Wireless sensor networks be likely an integral part of military command, control, communications, computing, intelligence, battlefield surveillance, reconnaissance and targeting systems.
- **Area monitoring:** In area monitoring, the sensor nodes are deployed over a region where some phenomenon is to be monitored. When the sensors detect the event being monitored (heat, pressure etc.), the event is reported to one of the base stations, which then takes appropriate action.
- **Transportation:** Real-time traffic information is being collected by WSNs to later feed transportation models and alert drivers of congestion and traffic problems.
- **Health applications:** Some of the health applications for sensor networks are supporting interfaces for the disabled, integrated patient monitoring, diagnostics, and drug administration in hospitals, tele-monitoring of human physiological data, and tracking & monitoring doctors or patients inside a hospital.
- **Environmental sensing:** The term Environmental Sensor Networks has developed to cover many applications of WSNs to earth science research. This includes sensing volcanoes, oceans, glaciers, forests etc. Some other major areas are Air pollution monitoring, Forest fires detection, Greenhouse monitoring, Landslide detection
- **Structural monitoring:** Wireless sensors can be utilized to monitor the movement within buildings and infrastructure such as bridges, flyovers, embankments, tunnels etc. enabling Engineering practices to monitor assets remotely without the need for costly site visits.
- **Industrial monitoring:** Wireless sensor networks have been developed for machinery condition-based maintenance (CBM) as they offer significant cost savings and enable new functionalities. In wired systems, the installation of enough sensors is often limited by the cost of wiring.

- **Agricultural sector**: using a wireless network frees the farmer from the maintenance of wiring in a difficult environment. Irrigation automation enables.
- The basic method to transfer information from a sensor node to base station is called flooding, the optimization of network parameters for WSN routing process to provide maximum service life of the network can be regarded as a combinatorial optimization problem,

In this paper an approach An Improved pegasis by Ant Colony Optimization (AI-pegasis) has been proposed for the optimal path chain construction during routing, to optimize routing mechanism by avoid unnecessary energy consumption during node chain construction by avoiding entire nodes on the network to get participate on every round, hence to minimize the wastage of energy and to overcome other flaws found in traditional PEGASIS, and the result to prolong the network life time of the WSN. This paper is organized as follows. In Sect. 2, we summarize the studies related to pegasis protocol. In Sect. 3, explain about ACO, radio model and my proposed algorithm scheme is implemented. In Sect. 4, the simulation model and results discussion is explain in detail. And Sect. 5, it cover the conclusion of this paper and infers some limitations and future work.

RELATED WORKS

Though PEGASIS protocol has its advantages over LEACH protocol, it still had certain deficiencies. The below described protocols are various versions of PEGASIS that are designed to overcome those deficiencies. Each protocol takes into consideration unique factors and proposes its different version.

Energy Efficient PEGASIS Based (EEPB) is an enhanced PEGASIS algorithm [6] in WSN. As in PEGASIS greedy algorithm is used to form the data chain, it can result in communication distance between two sensors being too long. Thus the sensors consume more energy in transmitting the data and die early. In the chaining process, a node will consider the average distance of which the chain is formed. This distance is known as thresh distance. If the distance from the closest node to the upstream node is longer than thresh distance, the closest node is the “far node”. If the closest node joins the chain, it will become “long chain”. EB-PEGASIS avoids this phenomena using distance threshold. It not only saves energy on threshold, but also balances the energy consumption of all sensor nodes.

Comparative Study of PEGASIS Protocols in Wireless Sensor Network.

The PEGASIS-ANT protocol uses ANT colony algorithm rather than greedy algorithm to construct the data chain. This helps to achieve global optimization. It forms the chain that makes the path more even-distributed and reduces the transmission distance. It also balances the energy consumption between the nodes. In each round of transmission, on the basis of current energy of each node the leader is selected that Directly communicates with the BS. This algorithm has prolonged network lifetime.

H-PEGASIS [3] is an extended version of PEGASIS protocol. It was introduced with the objective of decreasing the delay of transmission packets to the BS. It proposes a solution to data gathering problems by considering energy X delay metrics. In order to reduce delay, simultaneous data messages are transmitted. To avoid collisions, signal coding is implemented e.g. CDMA to avoid signal interference, only spatially separated nodes are allowed transmit data at the same time. With CDMA capable nodes, the chain forms the tree like hierarchy and each selected node transmit the data to the node of upper hierarchy. This ensures parallel data transmission and reduces the delay significantly. PEGASIS with double Cluster Head (PDCH) balances load of every node and increase network lifetime. Generally PEGASIS protocol uses one CH that communicates with the BS. Here instead of one double CH are used in a single chain and is given a hierarchical structure so that long chaining is

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avoided. PDCH outperforms PEGASIS by eliminating dynamic cluster formation, reducing the distance between nodes, reducing the number of messages sent to and from other nodes and using only one transmission to BS per round. As the energy load is distributed among the nodes, the network lifetime increases and so does the quality of network. Improved Energy Efficient PEGASIS Based (IEEPB) protocol, overcomes the deficiencies of EEPB. When EEPB builds a chain, the threshold adopted is uncertain
And complex to determine. This results in the formation of “long chain”. Also, when EEPB selects the leader, it ignores the node energy and the distance between the BS and node that optimizes the selection of leader. Based on this, IEEPB compares the distance between two nodes twice and finds the shortest path to link two adjacent nodes. The chain construction is simplified such that formation of “long chain” is avoided. Also while selecting the leader, IEEPB considers the node’s energy, distance between the BS and the node, normalizes these two factors and assigns different weight co-efficient to them. Finally the node with the minimum weight becomes the leader. IEEPB has higher energy efficiency and hence longer network lifetime.

Authors in [8] have given a optimization technique for WSN which aid in optimal utilization of sensor node resources so as to balance energy consumption in the whole network. Taking inspiration from the colony ants, they proposed sensor ant to use routing mechanism which optimize the power of the node contributing in the routes to forward the data in the network. The quality function depends on mult-creteria metrics such as minimum residual energy or battery power, hop number, and average energy of both route and network .the traffic load is uniformly distributed in the network life time thus resulting in reduced energy usage, prolong network life time and reduce the packet loss. The result of this scheme proves to be better than energy efficiency Ant- based routing (EEABR) in terms of energy consumption and efficiency.

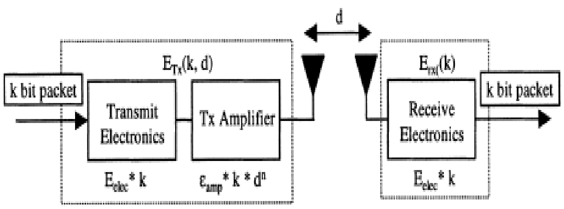
In [4], an Ant colony optimization based heuristic approach is proposed to minimize the energy conception for sensor network.in this work three algorithm based on ACO namely Ant System, Ant colony system and improved AS, are presented for the wireless sensor network .in ACS, local pheromone updating is done in the courses of tour bulding.after each construction step, all ants used to update the local pheromone value,. In AS and ASW the mechanism for choosing next node is same but the pheromone updating is process is different. The resulting of these protocols are evaluated and found that ACS total energy is lesser than AS and ASW, the energy consumption standard deviation of ACS is more stable and lower than AS and ASW techniques.so the application of ACDO to WSN is promising for routing and aims in prolonging the network life.

Radio model

There has been a considerable amount of research in the field of radio and electronics in the last decade. In the proposed approach simple first order radio model proposed by Heinzelman et al [5]. Has been used, because it suits our purpose for the matter presented and is easier to simulate .The model consists of transmitting and receiving electronics and a transmitting amplifier as shown in Figure 1. Using the model described above, we find that to achieve a suitable SNR for transmission, the energy expended by the system is represented mathematically as

$$ETX(k, d) = \begin{cases} Eelec * k + \epsilon amp * k * d2 \text{ if } d < d0 \\ Eelec * k + \epsilon amp * k * d4 \text{ if } d \geq d0, \end{cases}$$

$$ERX(k) = Eelec * k,$$



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Heinzelman first order radio model

Where ETX(k, d) is the energy dissipated per bit to run the transmitter circuit, ERX(k) is the energy expended per bit to run the receiver circuit, k is the number of bits in the message, ∈amp is a constant dependent on the transmitter electronics, and d is the distance of the node from the base station. The free space model and the multipath fading channel model are used in the construction of the radio model. When the distance between the transmitter and receiver is less than threshold value d0, the algorithm adopts the free space model (d 2 power loss).Otherwise, the algorithm adopts the multipath fading channel model (d 4 power loss).

PROPOSED WORK

Power-efficient gathering in sensor information systems (PEGASIS) and its extension, hierarchical PEGASIS, are a family of routing and information-gathering protocols for WSNs [7]. The main objectives of PEGASIS are two. First, the protocol aims at extending the lifetime of a network by achieving a high level of energy efficiency and uniform energy consumption across all network nodes. Second, the protocol strives to reduce the delay that data incur on their way to the sink. The network model considered by PEGASIS assumes a homogeneous set of nodes deployed across a geographical area. Nodes are assumed to have global knowledge about other sensors' positions. Furthermore, they have the ability to control their power to cover arbitrary ranges. The nodes may also be equipped with CDMA capable

Radio transceivers. The nodes' responsibility is to gather and deliver data to a sink, typically a wireless base station. The goal is to develop a routing structure and an aggregation scheme to reduce energy consumption and deliver the aggregated data to the base station with minimal delay while balancing energy consumption among the sensor nodes. Contrary to other protocols, which rely on a tree structure or a cluster based hierarchical organization of the network for data gathering and dissemination? PEGASIS is the chain Based hierarchical routing protocol in which all the wireless sensor nodes are structured or placed in form of a chain using the algorithm called greedy algorithm. This chain based routing approach distributes the energy load equally among the wireless sensor nodes in the wireless sensor network and the main key idea behind the PEGASIS is to form a chain among the wireless sensor nodes so that each and every node will transmit to and receive from a close or a nearby neighbor. The aggregated data passes from node to node and then directly get fused to the designated or labeled leader and finally forwarded to the base station. And For constructing the chain, we assume that each sensor node have global knowledge of the wireless sensor network. Nodes take turns (rounds for communication) in transmitting data to the Base Station so that the average energy exhausted by each node per round can be higher due to the entire involvement of nodes in during chain construction. PEGASIS considers all the wireless sensor nodes in order to balance the network but Still there are various flaws in this chain based routing approach. Some of flaws are like unacceptable data delay time due to a single long chain and wastage of the network energy due to redundant transmission path across the entire network zone and based to the greedy algorithm the randomly selection of the leader node does not consider the distance of leader node from the sink node. So to minimize the wastage of energy, fault tolerance and to overcome other flaws found in PEGASIS, a new approach is proposed in this paper with the help of ant colony optimization technique.

ACO

The ant colony optimization algorithm (ACO) is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs. This algorithm is a member of the ant colony algorithms family, in swarm intelligence methods, and it constitutes some metaheuristic optimizations [1]. Initially proposed by Marco Dorigo in 1992 in his PhD thesis, the first algorithm was aiming to search for an optimal path in a graph, based on the behavior of an ants seeking path between their

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colony and a source of food. The original idea has since diversified to solve a wider class of numerical problems, and as a result, several problems have emerged, drawing on various aspects of the behavior of ants.

A combinatorial optimization problem [2] is a problem defined over a set C = c_1... c_n of basic components. A subset S of components represents a solution of the problem; F ⊆2C is the subset of feasible solutions, thus a solution S is feasible if and only if S ∈ F. A cost function z is defined over the solution domain, z: C ∈ R, the objective being to find a minimum cost feasible solution S*, i.e., to find S*: S* ∈F and z(S*) ≤ z(S), ∀S∈F. Given this, the functioning of an ACO algorithm can be summarized as follows:-
A set of computational concurrent and asynchronous agents (a colony of ants) moves through states of the problem corresponding to partial solutions of the problem to solve. They move by applying a stochastic local decision policy based on two parameters, called trails and attractiveness. By moving, each ant incrementally constructs a solution to the problem. When an ant completes a solution, or during the construction phase, the ant evaluates the solution and modifies the trail value on the components used in its solution. This pheromone information will direct the search of the future ants. Furthermore, an ACO algorithm includes two more mechanisms:

Trail evaporation and, optionally, daemon actions. Trail evaporation decreases all trail values over time, in order to avoid unlimited accumulation of trails over some component. Daemon actions can be used to implement centralized actions which cannot be performed by single ants, such as the invocation of a local optimization procedure, or the update of global information to be used to decide whether to bias the search process from a non-local perspective. More specifically, an ant is a simple computational agent, which iteratively constructs a solution for the instance to solve. Partial problem solutions are seen as states. At the core of the ACO algorithm lies a loop, where at each iteration, each ant moves (performs a step) from a state ι to another one corresponding to a more complete partial solution. That is, at each step σ, each ant k computes a set Akσ(ι) of feasible expansions to its current state, and moves to one of these in probability. The probability distribution is specified as follows. For ant k, the probability pιψk of moving from state ι to state ψ depends on the combination of two values:

- The attractiveness ηιψ of the move, as computed by some heuristic indicating the a priori desirability of that move;
- The trail level τιψ of the move, indicating how proficient it has been in the past to make that particular move: it represents therefore an a posteriori indication of the desirability of that move. Trails are updated usually when all ants have completed their solution, increasing or decreasing the level of trails corresponding to the moves that were part of "good" or "bad" solution respectively.

Proposed Solution

The proposed routing algorithm and its working are explain in this section as stated earlier the algorithm designed in an attempt to have a routing protocol in wireless sensor network which will burn the energy of the sensor nodes gracefully and Hence increase the life time of the network. The protocol is designed to route the data packet through the path that have shortest distance to the base station. It is well known that swarm intelligence is specifically ACO is a probabilistic technique for solving computation problem which can be reduce to find the good path and more accurate in routing purpose as compare to other optimization algorithnim.in this work the proposed work need to overcome the drawback of traditional pegasis, where by the main objective it to optimize routing mechanism and avoid unnecessary energy consumption during node chain construction and overcome the fault tolerance of the network. In my scheme, this proposed aim at building a system that would ensure that the total energy consumption on

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during chain contraction is less due to the less number of nodes involved on the chain formation in the entire network during communication. In my propose I don't follow a scheme similar to PEGASIS where it form an open chain starting from the farthest node in domain from the base station, which is been selected by greedy algorithm, A greedy algorithm is an algorithm that follows the problem solving heuristic of making the locally optimal choice at each stage with the hope of finding a global optimum. In many problems, a greedy strategy does not in general produce an optimal solution, but nonetheless a greedy heuristic may yield locally optimal solutions that approximate a global optimal solution in a reasonable time, instead the chain will be started from the node which is much closer to event occurrence as the source node and constructing the chain towards the selected leader node base on its high residue value energy , Where I assume that global knowledge of the network is available as has been done in PEGASIS.

The Protocol Works In the Three Phases

The proposed protocol works into three stapes or phase, where by only phase one is initiate by base station, the rest is based on event occurrence.

Setup Phase

The 'N' nodes in the network and are denoted by numbers starting from 1 to N. The nodes are at first distributed randomly in the play field, The destination node/sink node initiate session by broadcasting hello packet to all node in the domain, the hello packet contains details of base station such as the coordinate values(x,y) to declare its base station location and distance between each node in the network, all nodes which are in the range and alive will receive the hello packet, so the coordinate of the sender(sink node) will entered to the routing entry corresponding to that node. And each node will memorize the coordinates of the sink/BS.

Leader Node Selection Phase

After the event detection, the node which is more closed to the particular event become source node and partial leader node at a time, Then the source node will broadcast the interest packet to all nodes which are not beyond its position from the base station, the interest packet request every received node to declare its node id, location and residue energy value, those alive node will respond back the packet to the source node, and un alive node will be noted as the dead node. Then the source node will be compare the its residue energy value with the rest, and the node with high residue will be selected as the leader node at a time, as it shown in figure 3.4, nj is the heuristic value that represented the energy of nodes and it is calculated on the basis of the residue energy of the node .this heuristic value helps in direction making according to the energy levels of neighbour nodes, implying that if a node has a lower energy ,then it has lower probability to be chosen. The heuristic value is calculated as given as follows.

$$n_j = \frac{E_{0-E_{residual}}}{\sum_{k \in N} Ek}$$

Where E_0 is the initial energy and E residue is the residue energy of the node, Then the node with high energy level will become leader node in the chain, which transmit the information data to the base station .For the implementation of my scheme I have formed the chain using the ant colony optimization (ACO).Chain formation using ACO as well as its advantages over the greedy approach is described in problem Statement. The leader node is done at every round of communication within the path. The leader elected in a particular cycle receives the fused data packets of the nodes in the network from its neighbors, fuses it with its own data packet and finally the data packet is transmitted to the base station. But there is one very important aspect where my approach differs from traditional PEGASIS. In PEGASIS the nodes are successively selected as leaders before event detection. For example if there are 'N' nodes then each node will become a leader once every 'N' data gathering cycles This results in uneven energy dissipation of the nodes

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as it does not take into account the varying distances of the nodes from the base station. This results in some nodes dying much earlier than others because of their larger distances from the base station. The variation in the inter-nodal distances among the nodes is not of great concern as these distances are generally much smaller compared to the distances from the base station. To prevent a degradation of network performance my scheme allows the individual nodes to become leaders' variable number of times depending on their residue energy of the node during the chain formation of the shortest distance from the base station.

Chain Construction Phase

In ant colony optimization, each ant attempts to find the optimal path. In their journey from source node to destination node, ants move from node i to a neighboring node j with a transition probability p_{ij}, defined as: Where p_{ij} [k**]** is the probability of ant k to move from node i to node j**,** τij is the pheromone value deposited on the link (i , j), η_{ij} is a heuristic value assigned to the link, and (α, β) are weights used to control the importance given to the pheromone and the heuristic values, respectively.

$$P_{ij} = \frac{(\tau_{ij})(n_j)^{\beta}}{\sum_{k\in N}(\tau_{ij})(n_j)^{\beta}}$$

In artificial ant the pheromone strength is similar to the radio frequency strength of the node, Here, n_{ij} [k] is the list of neighbors of node i visited by ant k .The pheromone value τ_{ij} on a given link depends on the likelihood that the ants pass by the link while constructing the solutions. The heuristic value η_{ij} , on the other hand, depends on the calculated cost of the link. The initial pheromone value is usually set to be equal for all links. The heuristic value of the link (i ,j) is the inverse of the link cost,τ_{ij} Is the pheromone value between the source node and the adjacent node .it is given as

$$\tau_{ij} = \frac{1}{d_{ij}}$$

Where d_{ij} is the distance between source node i and the base node. Each node selects the next adjacent node with the sensed information towards the leader node, in the propose solution the pheromone value is regarded as the distance of adjacent nodes. radio frequency strength of the real life node which depends on how closed between adjacent nodes. When a node dies the chain is reconstructed by bypassing the dead node. It must be noted that the i^{th} node may occupy any random j^{th} position in the chain. The data gathering process begins once the leader selected and the source becoming the starting point for the chain formation. In every data gathering cycle each node in the network forms a data packet of its own. For every data gathering cycle a leader is elected among all the nodes within the shortest path to base station, during a data gathering cycle each node in the network receives a data packet from its neighboring node fuses it with its own data packet and transmits it to its other neighbor in the selected path, until it reach the leader node which will transmit to the base station and complete the cycle.

Proposed Work Algorithm

The algorithm of proposed work done in this thesis mention below in steps

Step 1: [Deployment] nodes are randomly deployed in domain together with base station

Step 2: [initialization] after deployment of the nodes in the field the base station is initialize the configuration phase by sending the hello packet to all nodes in the domain to declare its location coordinates and base station ID.

Step 3: [event detection] Whenever event occurred ,the source node broadcast the token packet to all nodes which are not beyond the source from the base station, the interest packet request the node id, location and the residue energy value.

Step 4: [reception of token packet] all alive nodes receive the packet and non-alive node noted as the dead node, and then each node sends back the respond to the source node.

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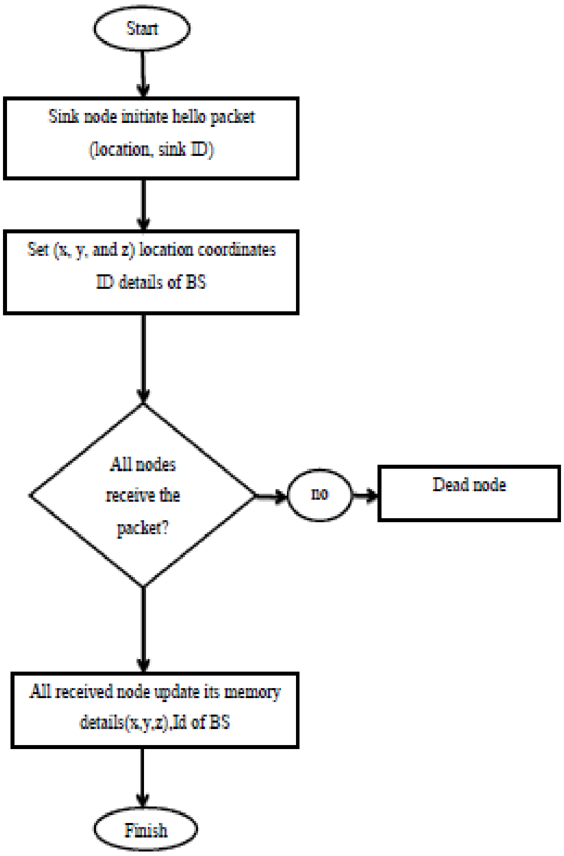
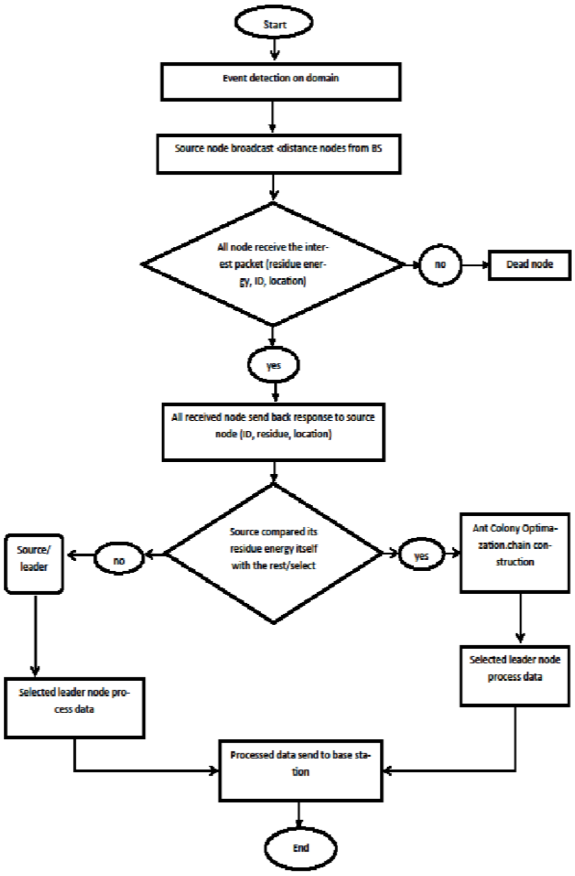
Step 5: [source node compare residue values] the source node calculates by comparing the residue energy value of every arrived packet.
Step 6: [leader node selection] the node with the high residue energy value is selected to become the leader node at particular round.
Step 7: [ant colony Optimization]By the help of ant colony optimization for finding optimal path, source node initialize the routing communication between its neighbor nodes towards the direction of the leader node base on the closet distance of the adjacent nodes, until the data reach to the leader node.
Step 8: [process data and sending] Leader node process the receive data from the chain and transmit it direct to the base station.
Step 9: Evaluating performance and observing the number of node involve during the chain formation through simulation result obtain.



Setup Phase



Chain Construction Phase

SIMULATION AND DISCUSSION

Simulation are conducted using omnet++ network simulator frame work with more than 50 nodes deployed on the network field, the wireless channel is used because the nodes deployed on the network are communicating based on the wirelessly based on the distance and the transmission range, simulation show that the An improved pegasis perform better considering the metric of through put, number of node participate on the chain formation as well as increasing the life time of the entire network.

Network Scenario Assumption and Parameter

Proposed protocol is simulated in wireless sensor network in a field with dimensions 120m X 70m. The

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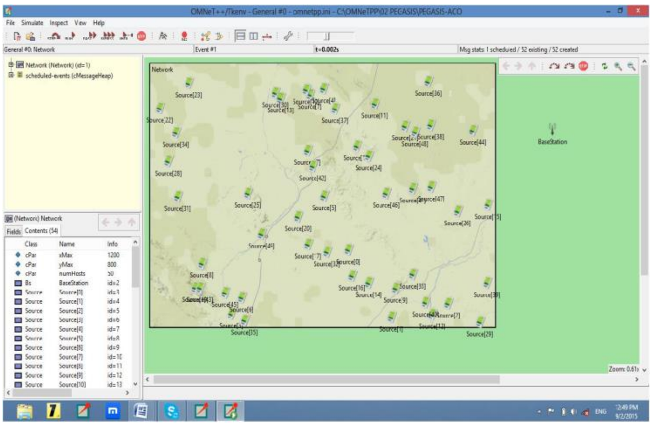
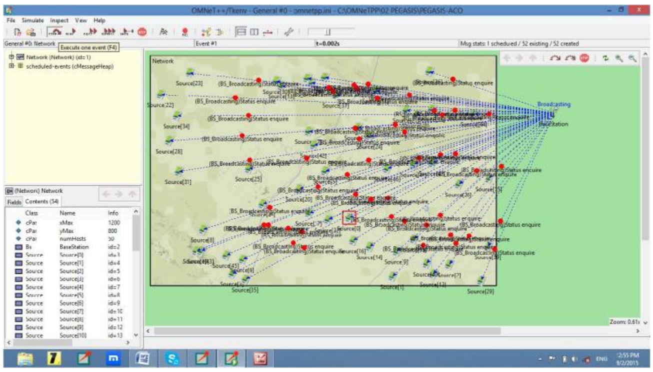
total number of sensors is 50. All the nodes are randomly (uniformly) distributed over the field (much of the WSN literature assumes that the sensors will be randomly deployed). This means that the horizontal and vertical coordinates of each sensor are randomly selected between 0 and the maximum value of the dimension. The Base station is located at near to the top right corner of the sensing field. Real and artificial Ant behavior mechanism is applied is simulation.

- Sensor nodes are unaware with their location, until the initial configuration initiated by the sink node. And there is only one sink node in the field which deployed randomly.
- Based on the number of event occurrence, number of chain can be formulating as well as leader nodes (multiple leader node occurrences).
- A node is consider to be dead when it is not capable to receive or send the data to the nearest node
- It is considered that the probability of signal collision and interference in the wireless channel is ignorable and the radio transmitter, radio amplifier, data fusion and long chain formation unit are the main energy consumer of the sensor nodes.
- Transmission power varies depend upon the distance between sender and receiver as well as for the (leader node) and the base station

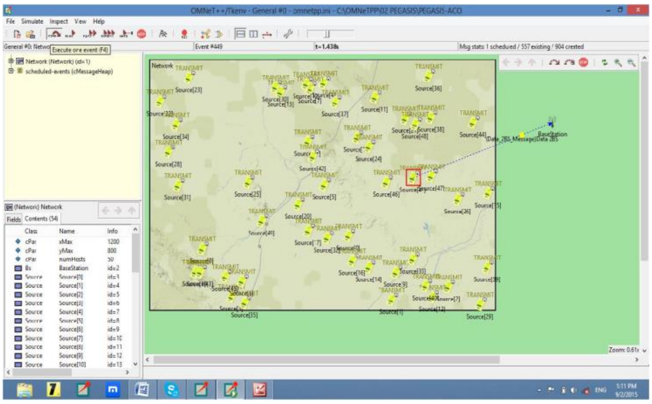
Parameter Values Used In Simulations



Node deployed in domain



Base Station Initialize by Sending Hello Packet



Notation	Description	Value
N	Number of the sensors	50
Eo	Initial Energy	1.0J
ETX/ERX	Electronics energy	50nJ/bit
ϵ_{fs} ϵ_{amp}	Amplified transmitting energy using free space	10pJ/bit/m2
	Amplified transmitting energy using multipath	0.0013pJ/bit/m4
	energy using free space	
LData	Data packet size	500 bytes
LBroad	Broadcast packet size	25 bytes
α, β	weighted factor	0.7,0.2

Leader Node Sending Data to the Base Station.

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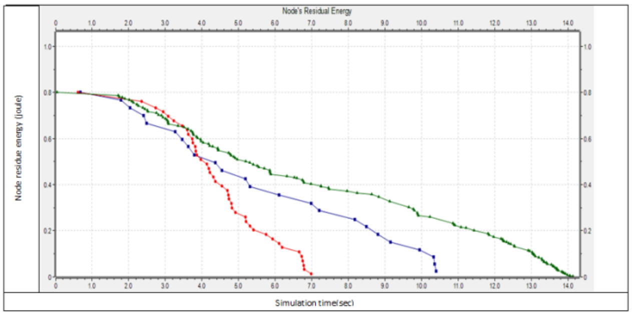
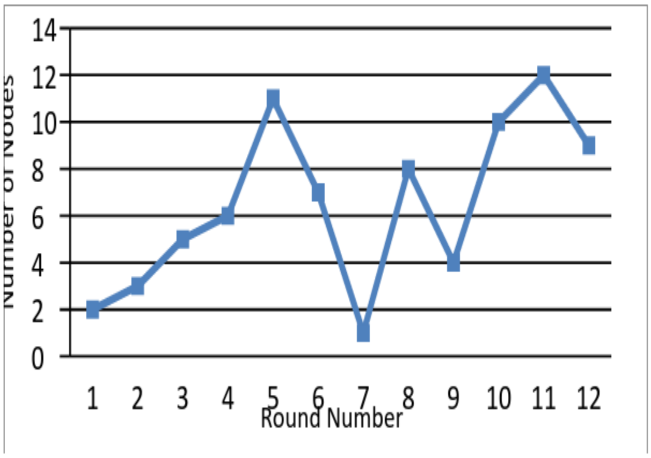


Node residue energy.

Life time network, Depend much on its nodes energy, the graph shows the residue energy values of three nodes in the network after undergo some communication round, the residue energy keep decreasing gradually, hence the new proposed simulation result shown, it balance the entire energy of network by utilize high residue energy first as leader node and keep maintaining the other node with less residue energy value as participant nodes in different round of chain formation. Hence the result shown on how the residue energy last longer, This increase the routing efficient of data since the leader node should route the data to the far base station which require having enough power in order for the packet to reach base station.

Shortest chain scenario

In the figure 8, on simulation result shows the number of node participate on chain formation in every round in network domain, in round 11 the number of nodes involve the simulation shows 12 node including the leader node. A created optimal path chain is towards the direction of the base station, which performed by the help of Ant Colony Optimization, hence the simulation result shown the solution archive its energy saving by minimizing routing distance by selecting optimal path to the selected leader node as well as from leader node to base station. This will result to low cost of transmission and high throughput of the network.



Number of nodes involve in chain formation.

The simulator prove that the proposed protocol is more energy efficient than traditional pegasis by showing the few number of nodes participated in every round cycle, In traditional pegasis in every round the fastest node initiated by starting creating a chain towards the leader node and make all node in the domain to participate on chain formation in every round, which is more energy consumer compare to proposed one, as I was discuss in statement of problem.

Leader node multiple selection

Leader node multiple selection, Due to the mechanism of selecting leader node after event detection, the chance for the node to be selected as leader node in proposed solution is more than once as its shows in simulation result base on the parameters condition, the graph shown a node with ID's 6 can appear as leader node in 28 times and other node can appear once time, as per proposed protocol, the major condition for the node to become leader node is amount of residue energy, hence some node can sustain as the leader in many round while other (dead node) in zero time within the interval time.

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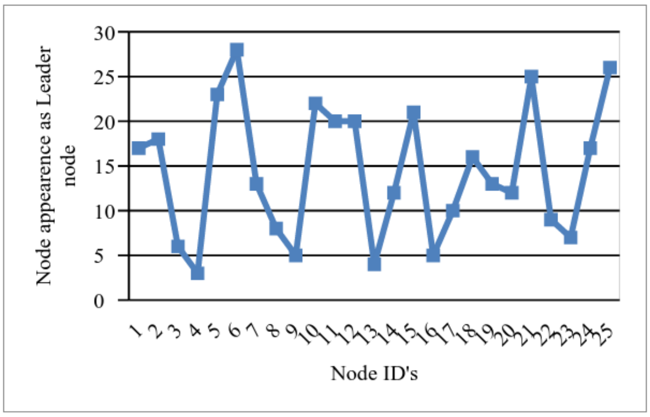

Fig 9: leader node multiple selection

CONCLUSION AND FUTURE WORK

The sensor nodes in WSNs have got only limited source of energy and computing, the main constrain of this network is amount of energy consumption ,the lifetime of the network depend on its node's energy level ,in pegasis protocol energy Consumption during chain construction and node to node communication is so high and resulting to the shorten life time of the network, this is due to randomly selection of the leader node which is been done by the greedy algorithm, resulting to the long chain formation which consume more energy of network in every round, thus the overall life time of the network gets reduces, hence (AI- pegasis) protocol the application of Ant Colony metaheuristic approach to identify the optimal path between a sensor node and base station, consider in this paper to ensure that near energy utilization occurs thereby increase the life time of the network as validated in simulation result ,the ant colony optimization help to enhance the performance of our scheme by forming and selecting the optimal path in every round of the chain construction , by not letting every node to participate on the chain formation in network, instead only few node which can make the shortest path from the source node to the base station, this protocol improve the existence pegasis protocol where by the chain construction in the network started from the farthest node in the network field to the leader node, which has been proved to consumer more energy of the network compared to proposed protocol, by showing simulation result only few node involve on chain construction instead of all nodes as it has been done in traditional pegasis protocol. This new protocol consumes less energy, reduce the delay time of transmission and prevent fault tolerance in the network, therefore the proposed protocol prolong the network life time and improve energy efficient of entire network.

Limitations

The main intention of this new protocol is to provide the energy efficient algorithm of the sensor network in the domain, by balancing energy value of the all nodes around the entire network, this was achieved by considering the higher energy value node to become the leader node in every cycle, so that to allow other participating node in chain contraction to consume less energy, due to the far distance of the base station in order for the leader node to transmit data to the base station should have enough energy.

In this (AI pegasis) its concentrate and concern only to find the leader node which has higher residue value, and not the wastage energy of the source node, whereby during leader node selection the source node broadcast the token packet to all the node which are not beyond its distance from the base station, and the received nodes tend to reply back to the source node, the sending and receiving packet to and from its tend to Consume more energy of the source node and the chance for the congestion occurrence is high, hence it resulted to depletion of energy to the source node.

Future Enhancements

The future work is to modify the routing protocol to be more dynamic by considering sink mobility and to ensure successful delivery of data, hence all node in the domain should be periodical updated on the location of base station/sink node on every round of data transmission. The next improvement can be possible to consider not only the high residue energy of the node to qualify and get selected as a leader node at a moment, but the protocol should calculate the

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reasonable routing energy consumption of the leader node between the node which has less residue energy value but mostly closet to the base station which can transmit data easily with less energy by considering the radio model theory.

Also is I would like to implement a mechanism which will control the traffic and congestion of the packet before and after leader node selection, by putting energy threshold value so that only those node which has reach the threshold value can respond to the source node and nominated to be selected as leader node.

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