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QoS based Optimal Routing in WSN using Hybrid Intelligent Bee Colony Agent

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Abstract- A wireless sensor network is a collection of nodes ordered into a co-operative network. The nodes communicate wirelessly and frequently self-organize after being arranged in an ad hoc manner. In progress proposals for routing in sensor networks were optimize for the limited capabilities of the nodes and the application precise nature of the networks. Existing routing algorithms are not resourceful in sustaining the dynamic characteristics of wireless sensor networks (WSNs) and cannot make sure about sufficient quality of service in WSN applications. This research work proposes an agent-assisted based QoS-based routing algorithm for wireless sensor networks. Through the proposed algorithm, the synthetic QoS of WSNs is chosen as the adaptive value of efficient optimization algorithms to improve the entire performance of network. Whereas, intelligent software agents are employed to monitor the changes that occur in network structure, network communication flow and each node's routing state. These agents can after that participates in network routing and network maintenance. Swarm intelligence techniques have been extensively used in optimization problem for solving many optimization issues in WSNs. In recent years, swarm intelligence approaches have also been used as agents to carry out QoS related tasks such as routing, in WSNs. In order to improve the performance a hybrid algorithm called PSOABC algorithm is proposed. The PSOABC algorithm is a combination of Particle Swarm Algorithm (PSO) and Artificial Bee Colony (ABC) Algorithm to solve the QoS based routing of WSNs is a Non-deterministic Polynomial (NP) hard and finite problem. The proposed new swarm algorithm is very simple and very flexible when compared to the existing swarm based algorithms. From the experimental results, it is said that the proposed algorithm can be used for solving optimization problems.

Keywords--- Non-deterministic Polynomial, Artificial Bee Colony algorithm, Particle swarm optimization, QoS based routing, wireless sensor network

1. INTRODUCTION

In recent years, observe that, a growing interest in organizing large numbers of micro-sensors that work together in a distributed manner on data gathering and processing. Sensors are projected to be reasonably priced and can be deployed in a large scale in ruthless environments, which implies that sensors are typically operating unattended. Energy-efficient data delivery is vital because sensor nodes operate with limited battery power. Now, the majority of the energy-efficient algorithms (Akkaya and Younis, 2005) in wireless sensor network (WSN) are corresponds to the client/server model, where each sensor node sends its sensory data to a back-end processing center or a sink node. Since the link based bandwidth of a WSN is much lower than that of a wired network, a sensor network's data traffic may perhaps go beyond the network capacity. Data collected in WSNs are transmitted between all nodes through routing, and then converged into the sink node (Johnson and Maltz, 1996). Therefore, the routing algorithm determines whether the information can be transmitted completely or not, and significantly affect the performance of the network.

Research on WSNs' routing algorithm is frequently paying attention on some routing metrics, such as the congestion situation, network lifetime performance, energy consumption, etc. Among the great development of hardware designing knowledge, the quality of services of the network is getting more concentration (Haas, 1997). The query to find a path satisfying the QoS guarantees for WSNs can be put together as a Non-deterministic Polynomial (NP) problem. On the other hand, the existing routing algorithms feebly support the dynamic characteristics of network and cannot suit the requirements of the wireless sensor network applications for routing and QoS. In this paper, to improve the performance of the optimization algorithm, called PSOABC algorithm is a combination of Particle Swarm Algorithm (PSO) and Artificial Bee Colony (ABC) Algorithm is used in this research to solve the QoS based routing of WSNs problems.

2. RELATED WORK

The Sequential Assignment Routing (SAR) is proposed (Stefan Dulman *et al.* 2003) for a wireless sensor network builds multiple paths from a source node to the sink node. Path selection looks into both QoS metrics (the flow delay necessities and the source load balancing objective) and energy resources, to stay away from nodes with low QoS and energy reserves.

Felemban *et al.* (2006) introduced the multipath multispeed protocol (MMSPEED) for QoS assurance of dependability and correctness in wireless sensor networks. Wireless Sensor Network (WSN) consists of small and low-cost sensors deployed in a certain region in order to monitor phenomena. The author said that, there are some problems, which have some effects on the performance of WSNs while computing the path from source to the base station.

Sujeethnanda *et al.* (2012) proposed these parameters by designing of software and hardware combination, which have direct impact on the power conservations throughout path computations. The author proposed a protocol aims to present a path from source to base station which consumes less energy based on dynamic TDMA schemes by means of both the local and global fusion algorithms.

3. METHODOLOGY

In this paper, PSOABC is applied to optimize QoS routing and a novel agent-assisted QoS-based routing algorithm for wireless sensor networks is proposed (Crawley *et al.* 1998). By this algorithm, the performance can be apparently enhanced in delay, packet loss and the synthetic QoS, correspondingly, with little energy consumption.

3.1 Routing model for WSNs based on Synthetic QoS

QoS based routing generally means that the QoS parameter constrains are added into the specific routing protocol. It is accessible to provide an improved way of data transfer performance in this routing because QoS based routing protocol can search the sufficient resources path meeting QoS under the conditions of the dynamic topology, limited resources, and so on. In WSNs, a QoS based routing protocol desires to perform the following features: (1) Path determining—to determine the optimal routing path satisfying the demand of the QoS from several paths. (2) Resource reliability—to take advantage of network resource even without the ability of pre-reserving network resources. In general, design of several resource reservation mechanisms in high-level protocol to control the QoS, such as Resource Reservation Protocol (RSVP), etc. (3) Path keeping—to avoid the impulsive dropping of the QoS routing performance.

3.2 Quality of service (QoS) parameters in WSNs

Different network applications will have their own QoS demands. In WSNs, Qos is primarily apparent to various parameters like delay, bandwidth, energy efficiency, etc. Therefore, only one QoS parameter is not sufficient to optimize routing path in a wireless sensor network, and a synthetic QoS is indispensable (Constandinos *et al.* 2006; Deb *et al.* 2003). The principle of the synthetic QoS based routing is to achieve the optimal path, departure from the source node, reaching in destination node, and accumulating all the QoS constraints.

Delay: also called as latency, it is the transmission delay between the two reference points. In the cable network, delay is mainly caused by congestion. Whereas in the wireless sensor networks some other events may possibly trigger data packet delay, together with cohort delay, propagation delay, data flow competition, queue delay, etc (Deng and Huang, 2009).

Bandwidth: bandwidth is one of the most significant metrics of QoS routing protocol; it is mainly for the available bandwidth of path from the source node to the destination node. Though, the bandwidth will change with the movement of nodes. Various routing protocols are annoying to search the largest bandwidth, but the least delay path should be chosen when several paths are synchronously presented.

Jitter: also called adjustable delay; it is the time difference between packets in a group of data flows sent by the same routing. Generally, the application impacted by delay will also be impacted by jitter.

Packet Delivery Ratio and Loss: that is the highest rate of packet loss in the network. Packet loss is generally caused by the network congestion and the node's mobility in wireless sensor networks.

Power Control and Conservation: in certain cases, the sensor network nodes are powered by capacity-limited batteries, which limit the lifetime of the nodes. When the energy of a node gets tired, the topology of network must be changed and the routing required being re-established.

In (Deng *et al.* 2002), primarily consider the synthetic effect of QoS parameters, comprises of delay, bandwidth and packet loss. The WSNs is denoted as a weighted directed graph G (V, E), where V is a set of sensor nodes by a wireless connection. If there are $n+1$ nodes $V, V = \{v_0, v_1, v_2, v_3, \ldots, v_n\}$ the communication radius of each node is r_i its communication area is A_{vi} and the edge $e = (v_i, v_j) \in E$ represents the two-way wireless connection among two nodes (v_i, v_j). The path $P\,(v_1, v_n)$ in G is an orderly compositing sequence of edges:

$$P\,(v_1, v_n) = \big((v_1, v_2), (v_2, v_3) \ldots (v_{i-1}, v_i) \ldots (v_{n-1}, v_n)\big), V_i \in V, 2 \leq n \leq |V| \quad (1)$$

$P\,(v_1, v_n)$ is a multi-hop path, the number of edges correspond to the hop distance between node v_1 and node v_n. Each node in the path can be regarded as an independent router. The first node of the path is the source node, and the final node is the destination node is called as v_s and v_d. Each node has its adjacent nodes. Each edge $e = (v_i, v_j) \in E$ represents v_i and v_j are the mutual adjacent nodes. $N_{vi} = \{v_j | e = (v_i, v_j) \in E, i \neq j$ is a set of adjacent nodes of v_i; it is established by the discovery mechanism of the adjacent nodes, which is called as HELLO information exchange. After sending HELLO message, the node adds its QoS parameters to HELLO information. Whereas, provided a path $P\,(v_s, v_d)$ its synthetic QoS metrics can be defined by the delay, bandwidth and packet loss, that can be reflected on the node v and the link e for every node $v \in V$ the metrics are delay function—Delay(v), band width function— Bandwidth(v), packet loss function— Packet loss(v), and energy function—Energy(v).

In view of that, in the network, every link $e = (v_i, v_j)$ has its corresponding QoS metrics, which are respectively delay function— Delay(e), bandwidth function— Bandwidth(e), packet loss function— Packet_loss(e), and energy function—Energy(e).

After defining the QoS metrics of the node and the link, the QoS metrics of the path $P\,(v_s, v_d)$ can be considered. Given the source node $v_s \in V$ and the destination node $v_d \in V$, the subsequent QoS metrics of path $P\,(v_s, v_d)$ are computed as the following:

$$Delay\big(p(v_s, v_d)\big) = \sum_{v \in P\,(v_s, v_d)} Delay(v) + \sum_{e \in P\,(v_s, v_d)} Delay(e) \quad (2)$$

$$Bandwidth\big(p(v_s, v_d)\big) = \min_{e \in P\,(v_s, v_d)} \{Bandwidth(e)\} \quad (3)$$

$$Packet_{loss(p(v_s, v_d))} = 1 - \prod_{e \in P\,(v_s, v_d)} (1 - packet_{loss(e)}) \quad (4)$$

If the path$P\ (v_s, v_d)$ satisfying all the QoS metrics, it must meet the following requirements:

$$Delay(p(v_s, v_d)) = \sum_{v \in P\ (v_s,v_d)} Delay(v) + \sum_{e \in P\ (v_s,v_d)} Delay(e) < D$$

$$Bandwidth(p(v_s, v_d)) = \min_{e\ \in P\ (v_s, v_d)} \{Bandwidth(e)\} > B$$

$$Packet_{loss(p(v_s,v_d))} = 1 - \prod_{e \in P\ (v_s,v_d)} (1 - packet_{loss(e)}) < PL$$

where D, B, and PL are the QoS guarantees of the WSN network.

After representing every QoS function of the routing model, can start the synthetic QoS model for every path. In the synthetic QoS model, in which every QoS indicator should meet the QoS constrain, any inconformity will significantly cut down the metrics role and convey the negative and punitive influence to the synthetic QoS.

For instance, if$\mathrm{Delay}(\mathrm{p}(\mathrm{v_s}, \mathrm{v_d})) < \mathrm{D}$,the delay of the path may satisfy the constraint conditions, then

$$\mathrm{f_{delay}} = 1 - \frac{(1-\mathrm{k})\mathrm{Delay}\ (\mathrm{p}(\mathrm{v_s}, \mathrm{v_d}))}{\mathrm{D}} \quad (5)$$

Take k close to1, such as 0.9, then the value of $\mathrm{f_{delay}}$ will be between 0.9 and 1.

If $\mathrm{Delay}(\mathrm{p}(\mathrm{v_s}, \mathrm{v_d})) > \mathrm{D}$, it denotes that the delay indicator of path cannot convince the constraint demands for delay application, then

$$\mathrm{f_{delay}} = (1 - \mathrm{k}) - \frac{\mathrm{Delay}(\mathrm{p}(\mathrm{v_s}, \mathrm{v_d}))}{\mathrm{D}} \quad (6)$$

These agents can then participate in network routing and network maintenance. Therefore, the algorithm performance can be improved in delay, packet loss, and the synthetic QoS, respectively, with energy consumption.

3.3 An agent model for QoS based routing

In QoS based routing, the synthetic QoS metrics are added additionally into the data structure of agent. Hence, the data structure of the agent consist of the agent ID and its type, the source node ID, the destination node ID, the current node ID, the hop distance of agent, the start time and reach time, etc., and also comprises of the mobile records of the agent. In the network structure of the mobile records, the QoS metrics are defined, such as delay, bandwidth, packet loss, energy, etc.

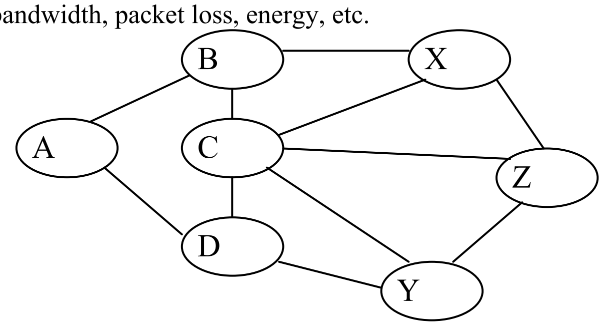


Figure 1: Topological structure of the node A

In the QoS based routing algorithm, the forward agent and the reverse agent are structured to begin the routing approach of WSN nodes. Routing tables are updated as the forward agent sends a packet from the source node to the destination node. Once it reaches its destination, each forward agent says that the traveling time information and other QoS parameter to the reverse agent, which updates the routing tables as it traces the path of the forward agent in reverse.

Routing Table

Routing table is a table stored in router, and plays the role of path discovery in node routing (Shakshuki and Malik, 2006). Since every node in WSNs acts as a router, every node contains a routing table. Table 1 show an example of the routing table for the node A as seen in Figure 1. In Table 1, the first column denotes the destination nodes and the first row denotes the adjacent nodes of the source node A. The values in Table 1 correspond to the synthetic QoS metrics from the source node A to the destination nodes by its adjacent nodes, for instance 0.84 for A to B. Table 1 shows the source node A has three neighbors B, C, and D. Data packets are sent from the source node A to the destination nodes such as X, Y, and Z. How to update the above routing table is to be clearly known. In order to get the information of packet transmission, a multi-agent model wants to be designed.

The intelligent agent (Dorigo *et al.* 2004) can be calculated a appropriate carrier to use the intelligent algorithm in WSNs; the agent can be applied to apperceive the changes in network structure, the network communication flow, and each node's energy state, and can also take part in network routing and network maintenance, as shown in Figure 2. Agent is based on objective and abundant with communication languages; it can give more flexible interaction and cooperation mode, and can meet the requirements of the interaction of node in distributed network environment.

Table 1: The Routing table of node A

The Source node A	The Adjacent node B	The Adjacent node C	The Adjacent node D
The destination node X	0.84	0.57	0.70
The destination node Y	0.71	0.44	0.85
The destination node Z	0.73	0.38	0.29

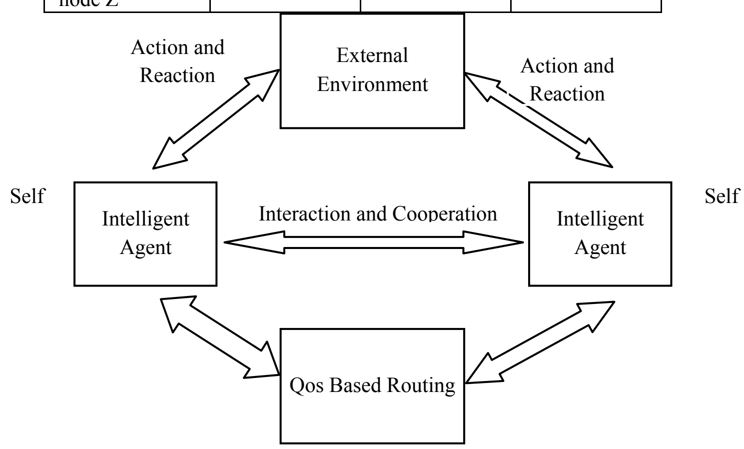
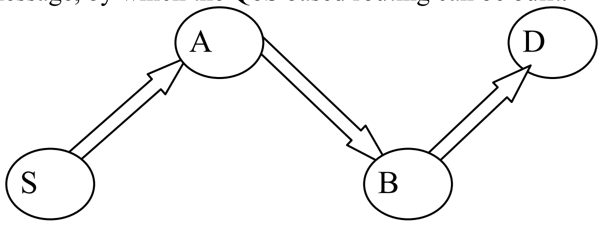


Figure 2: Behavior abstraction of the agent

Forward agent

If the node s hopes to launch routing with other nodes, the node s produces a forward agent in the creation time of the forward agent message and writes into its own address, and then constantly sends the forward agent to each adjacent node in flooding mode. When node v_k receives a forward agent, it implements the following tasks. At the beginning, the forward agent checks whether there stay alive of some visited nodes in its travel records. If presents, it shows that circulation come into sight in agent travel, and deletes it from the stacks. If the travel information of the forward agent is accumulated by a stack, the delete operation can be completed through simple stack pop-up operation. After that, the forward agent adds a new data item into the mobile records, which point to a animatedly increasing list. Data item includes the identification and comparative information of the node v_k according to the algorithm requirements.

Next, if the node v_k is not the destination node, the value of the routing counter in the forward agent adds 1. Every source node deal with and its serial number contained in the forward agent are only definite, and every intermediate node will record the source node address and the maximum serial number (the maximum serial number is the serial number of the newest forward agent received by the current node and sent from the same source node). If the serial number received by the current node is not larger than the maximum serial number from the same source node, the forward agent will be redundant. Since the forward agent and the data message have the same priority and follow the First-In First-Out (FIFO), the forward agent will experience the same delay and congestion as the data message, by which the QoS based routing can be built.



Current node	Local time	Travel record
S	t_S	S
A	t_A	S, A
B	t_B	S, A, B
D	t_D	S, A, B, D

Figure 3: The change of the data structure in the routing process of the forward agent

If broadcasting the forward agent, all of the adjacent nodes of the node $v_k$will receive the message commencing from the forward agent. At last, the forward agent will arrive at the destination node. The forward agent might be deleted when the value of the routing hop counter is ahead of the setting value. By the flooding communication, the intermediate nodes can copy and transmit the forward agent. Hence, the destination node may not directly receive more than one forward agent from the source node v_s which forms the different routing paths between the source nodes $v_s$and the destination nodev_d.

Assume the routing-choose method to select the next node of the forward agent, the routing table of the node $v_k$will establish the next node, to which the forward agent will go. Figure 3 shows the change of the agent data structure in the routing process of the forward agent. The source node S produces a forward agent, and starts the initial travel record in node S. Through the routing table of the node S, it transmits the forward agent to node A and then adds the travel record in. Likewise, the forward agent can reach at the node B and finally arrive at the destination node D.The travel record only lists the node identification.

ABC Algorithm

The QoS based routing of WSNs is a Non-deterministic Polynomial (NP) problem. The Artificial Bee Colony algorithm has been proposed by Dervis Karaboga and Bahriye Basturk (2007). The artificial bee colony consists of three groups of bees, namely, employed bees, onlookers and scouts. A promising solution to the optimization problem is denoted as the position of a food source and the nectar amount of a food source significant to the quality (fitness) of the related solution. The number of the employed bees is equivalent to the number of solutions in the population. At the initial step, a randomly distributed initial population is generated. An employed bee produces changes on the source position in its memory and measures the fitness at that position (calculates the nectar amount). If the fitness (nectar amount) of the new position is higher than that of the preceding position, the bee stores the new source position and replaces the old one; or else it keeps the position of the old one in memory. After all the employed bees have examined the new positions, the onlookers bees go to these positions with more onlookers going towards better positions and less onlookers going towards less fit positions. The onlookers also formulate a change on that position and calculate the fitness at that position. The scouts randomly select positions to assess.

This cycle maintain until the termination criteria is meet. Furthermore if the fitness of definite employed bee does not progress for some time then that employed bee is converted to a scout bee.

It is known from that there are three control parameters employed in the essential ABC: The number of the food sources which is equal to the number of employed or onlooker bees (SN), the value of frontier and the maximum cycle number (MCN). The continued analysis and improvement of the bee colony are based on the fast discovery and efficient use of the best food resources. Likewise, the best solution of tricky engineering problems is associated to the relatively fast discovery of good solutions especially for the problems that required to be solved in real time. In a robust search process, exploration and exploitation processes should be carried out at once. In the ABC algorithm, while onlookers and employed bees carry out the exploitation process in the search space, the scouts control the exploration process.

A random population $(X_1, \dots, X_S)$ is initialized, where, $X_i = \{x_{i1}, x_{i2}, \dots, x_{iD}\}$. Each solution vector is generated by the following equation

$x_{ij} = x_j^{min} + \left(x_j^{max} - x_j^{min}\right) \text{rand}\,[0, 1]$ (7)

where, j = 1, 2,…, D; $i = 1, 2, \ldots, w$

x_j^{max} and x_j^{min} respectively correspond to the upper and lower bounds for the dimension j

Thus, in the initial step of the ABC, random solutions are produced in the certain range of the parameters $\vec{x_i}(i = 1, \ldots \ldots, w)$, where, w is the number of the food sources.

Then, each employed bee found new sources whose quantity is equal to half of the total sources. Equation 8 is used to find a new source v_{ij}.

$$v_{ij} = x_{ij} + \varphi_{ij}(x_{ij} - x_{kj}) \quad (8)$$

where, φ_{ij} denotes a uniformly distributed real random number within the range [-1, 1]

k represents the index of the solution chosen randomly from the colony (k = int(rand S) + 1) j = 1. . . D; D denotes the dimension of the problem.

Behind generating the new food source, the nectar amount will be evaluated and a greedy selection will be performed. If the quality of the new food source is better than the current position, the employed bee foliage its position and travel to the new food source. Also that, if the fitness of the new food source is equal or better than that of X_i, the new food source takes X_i in the population and develop into a new member. Hence, after creating $\vec{v_i}$, they compared $\vec{x_i}$ solutions and the best one was used as the source.

In the third step, onlooker bees select a food source with the probability given in Equation 8 produces a new source in selected food source by equation (7). Once the new food source is generated, it will be calculated and a greedy selection will be functional, as like employed bees. As for employed bee, the better source is determined to be increased.

$$P_i = \frac{fit_i}{\sum_{j=1}^{S} fitj} \quad (8)$$

where, fit_i is the fitness of the solution $\vec{x_i}$

Scout bees do not employ any prior knowledge and particulars when they are considering for nectar sources, and as such, their research was arbitrarily done. The scout bees are chosen between the employed bees with regard to the limit parameter. If a solution that denotes a source is not understands with in a particular number of trials, then this source is discarded. The bee of that source identifies new source as a scout bee. The number of incomings and outgoings to a source is obtained by the 'limit' parameter. Identifying a new source of a scout bee is given in Equation 9.

$x_{ij} = x_j^{min} + \left(x_j^{max} - x_j^{min}\right) * \text{rand}$ (9)

Based on the above equation, each employed bee searches the neighborhood of its current food source to determine a new food source.

In ABC, the employed and the onlooker bees give out in the operation and the scouts serve in the process of exploration. Bees work for the maximization of the quantity of the foods that are brought to the nest. The maximization of the objective function is $F(\theta_i)$.

where, $\theta_i \in R^p$ is done in the maximization problem

θ_i represent the position of the ith source

$F(\theta_i)$ denotes the nectar amount in this source

3) $P(c) = |\theta_i(c)|, i = 1, 2, \ldots, S$ is the population of the sources including the positions of all the sources. Selecting a source of onlooker bees is based on the value of $F(\theta)$.

The more nectar amount of a source denotes more probability that the source would be selected. It means that, the probability of selecting a nectar source in the position is:

$$P_i = \frac{F(\theta_i)}{\sum_{k=1}^{S} F(\theta_k)} \quad (10)$$

$\theta_k(c)$, where k is different from i, are randomly formed indices of a solution in the population.

After the onlooker bee observes the dance of the employed bees and selects the source with the equality (equation (6)), it identifies a neighboring source and takes its nectar. The position information of the chosen neighbor is computed by the following equation:

$$(c + 1) = \theta_i(c) \pm \phi(c)$$

where, $\phi(c)$ denotes by considering the difference of certain parts of $\theta_i(c)$ and $\theta_k(c)$.

If the nectar amount of $\theta_i(c + 1)$, $F(\theta_i\ (c+1))$, is greater than the nectar amount in the position $\theta_i(c)$, in that case the bee moves to its beehive and shares this data with the further bees and remain $\theta_i(c + 1)$ in the mind as a new position. If not, it goes on observance $\theta_i(c)$ in mind. If the nectar source of the position θ_i is not understand by the number of 'limit' parameter, then the source in the position θ_i is redundant and the bee of that source becomes scout bee. The scout bee creates random researches and identifies a new source and the newly found source is assigned to θ_i. The algorithm iterates to the preferred cycle number, and the sources having the best nectar in mind denote the possible values of the variables. The obtained nectar amount denotes the solution of the object function.

Particle Swarm Optimization

PSO was developed by Kennedy and Eberhart (1995). PSO algorithm is motivated by the social behavior of a collection of migrating birds trying to reach an unknown destination. In PSO, each solution is called as bird in the flock and is known to as a particle. A particle is corresponding to a chromosome (population member) in Genetic Algorithms (GAs). Unlike GAs, the evolutionary process in the PSO does not produce new birds from parent ones. As an alternative, the birds in the population only develop their social behavior and as a result their movement towards a destination.

The process is initiated with a collection of random particles (solutions), N. The ith particle is denoted by its position as a point in S-dimensional space, where S denotes the number of variables. All through the process, each particle i observes three values namely its current position (X_i), the best position it arrived in previous cycles (P_i), its flying velocity (V_i). These three values are denoted as follows:

Current position $X_i = (x_{i1}, x_{i2}, \ldots, x_{iS})$

Best previous position $P_i = (p_{i1}, p_{i2}, \ldots, p_{iS})$ (11)

Flying velocity $V_i = (v_{i1}, v_{i2}, \ldots, v_{iS}$

In each time interval (cycle), the position (P_g) of the best particle (g) is computed as the best fitness of all particles. Thus, each particle updates its velocity V_i to get closer to the best particle g, as follows (Chen *et al.* 2003):

$$\text{New } V_i = \omega \times \text{current } V_i + c_1 \times \text{rand}() \times (P_i - X_i) + c_2 \times \text{Rand}() \times (P_i - X_i) \quad (12)$$

As such, using the new velocity V_i, the particle's updated position becomes:

$$\text{New position } X_i = \text{current position } X_i + \text{ New } V_i$$
$$V_{max} \geq V_i \geq -V_{max} \quad (13)$$

where c_1 and c_2 represent two positive constants named learning factors (as a rule $c_1 = c_2 = 2$); rand ( ) and Rand ( ) denotes two random functions in the range [0, 1], V_{max} is an upper limit on the maximum change of particle velocity (Ghandeharizadeh and Shayandeh, 2007), and ω represents an inertia weight used as an enhancement proposed by Shi and Eberhart (1995) to manage the influence of the previous history of velocities on the current velocity. The operator ω balances the global search and the local search and was commenced to minimize linearly with time from a value of 1.4–0.5 (Chae *et al.* 2002). As such, global search initiates with a large weight and then decreases with time to favor local search over global search (Turrini and Panzieri, 2002).

It is to be noted that the second term in equation (12) represents cognition, or the private judgment of the particle when comparing its current position to its own best position. The third term in equation (12) represents the social collaboration between the particles, which evaluate a particle's current position to that of the best particle (Turrini and Panzieri, 2002). Furthermore, in turn to control the change of particles velocities, upper and lower bounds for velocity change is restricted to a user-specified value of V_{max}. Once the new position of a particle is calculated via equation (3), the particle, then, flies towards it. Hence, the main parameters used in the PSO are: the population size (number of birds); number of generation cycles; the maximum change of a particle velocity V_{max} and ω.

3.4 Proposed QOS-PSOABC Process

In QoS-PSOABC algorithm, the agent based routing provides an initial path for ABC. In this method of hybridization, ABC runs till its stopping criterion, which in this case is the maximum number of iterations, is met. Then the optimal values of individuals are produced by the ABC algorithm which is given to the PSO as its starting point. Normally the PSO randomly generates its first individual sets, however in case of hybridization that is taken care by providing the starting point for the PSO who is the final values for individuals generated by the ABC.

Every node in the network creates and preserves a routing table for all the other nodes, and multiple routes between the source node s and destination node d are constructed in the routing table. When a source node required sending a data packet to the destination node, the source node expects to build a routing with the destination node and initiates an agent based routing discovery mechanism if no related routing information can be seen in the routing table. By routing discovery mechanism, the source node generates a forward agent, whereas note its own address and data produce a time to the agent, and then communicate the agent to every adjacent node. The forward agent in routing discovery process is communicates on the way of broadcasting. When the forward agent reaches at the destination node, a route path is identified. The forward agent will be transformed to a reverse agent. The reverse agent returns to the source node along the way of the forward agent broadcasting and in the meantime adjusts the node routing tables passed based on the network situation. This process is called as multi-agent based routing discovery. The forward agent routing uses the way of broadcasting; therefore, multiple forward agents will reach at the destination node. That is, there will be more paths between the source node and the destination node, which can be regarded as the initial swarm of PSOABC algorithm.

Proposed PSOABC and agent based algorithm for the QoS routing model

Then, the QoS-ABC algorithm can be performed by the following steps:

Step 1: Select the source node and the destination node, and apply the forward agent and the reverse agent to establish the path set (swarm) between the source node and the destination node.

Initialize the PSABC

Generate the initial population $X_i; i = 1,2, \ldots, SN$.

Select half part of bees as employed bee with PSO

Step 2: Calculate the synthetic QoS for each path (particle) to obtain Pi, and select the best $\theta_k(c)$ as Pi.

Evaluate the fitness (synthetic QoS for each path)(fi= Pi) of the population

Step 3: Use the iteration formulas of ABC to get a new routing path.

For each employed bee Do

Produce new solution V_i of synthetic QoS

Calculate the value f_i of synthetic QoS

Apply greedy selection process

Calculate the probability values pi for the solutions X_i

For each onlooker bee

Select a solution $X_i$depending on pi

Produce new solution V_i

Calculate the values f_iApply greedy selection process

If there is an abandoned solution for the scout Then replace it with a new solution which will be randomly produced

Memorize the best solution so far

Step 4: When QoS of a path (Bee) is better than P_i, use it to replace Pi. When the best $P_i$is better than $\theta_k(c)$, use it to replace P_i.

Step 5: If the iteration time of the algorithm is beyond the designated maximum or the QoS computing value meets the requirements, the algorithm stops. Otherwise, turn to Step (3).

Step 6: Determine the path, and modify the routing table.

cycle = cycle + 1

until cycle=MCN

4. EXPERIMENT RESULTS

This project mainly focuses on providing an efficient QoS based routing through Agent assisted system. This project is simulated using Network Simulator (NS2). The system is installed with Red hat Linux version. Then the TCL files for existing PSO algorithm and the proposed algorithms are imported and evaluated. The performance of the proposed PSOABC approach is compared with the PSO approach based on the parameters such as Through put and Power delay. The corresponding graphs are obtained and the performance is evaluated

4.1 Simulation Parameter

Table 2: NS2 Simulation Parameter

Simulation Parameter	Value
Number of nodes	50
Area size	500 x 500 m
Mac	802.11
Traffic Source	CBR
Transmit Power	0.02w
Receiving Power	0.01w
Active Power	240w
Inactive Power	2.4w
Transmission Range	50m
Initial Energy	1J
Packet Size	512 bytes
Antenna	Omni Antenna
Radio propagation	Two ray Ground
Interface Queue	Drop tail
Queue Length	50
Channel Type	Channel/Wireless channel

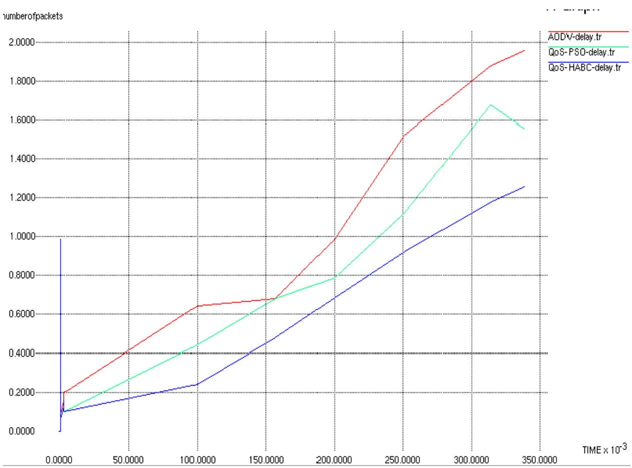


Figure 4: Delay Comparison Graph

From the above figure 4, it is noted that the proposed PSOABC algorithm less delay when compared with the existing PSO technique.

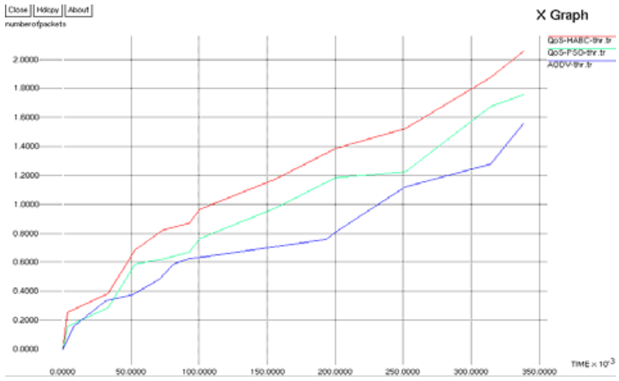


Figure 5: Throughput Graph

Figure 5 shows the throughput comparison of the proposed PSOABC approach and the existing PSO approach. It is noted that the proposed particle swarm optimization with Artificial Bee Colony algorithm attains higher throughput when compared with the existing PSO technique. It is clearly observed that, the proposed Hybrid ABC algorithm attains higher throughput when compared with the existing PSO algorithm at all the stages of iterations.

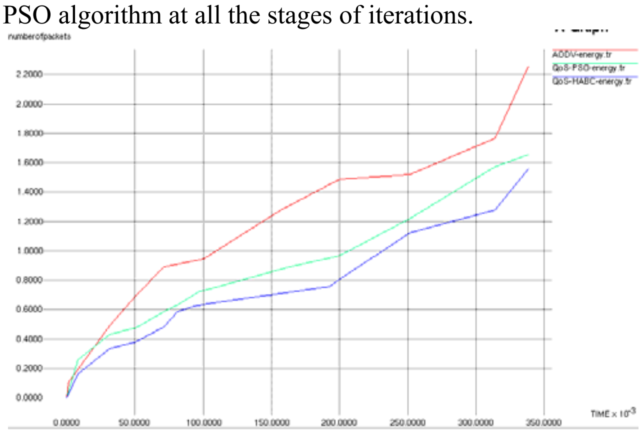


Figure 6: Energy comparison graph

From the figure 6, it is noted that the proposed PSOABC algorithm consumes less power when compared with the existing PSO technique. It is clearly observed that, at the initial stage of the iteration, the difference between two algorithms is very less but when the number of iterations increases, the proposed PSOABC algorithm consumes lesser energy when compared with the existing PSO algorithm.

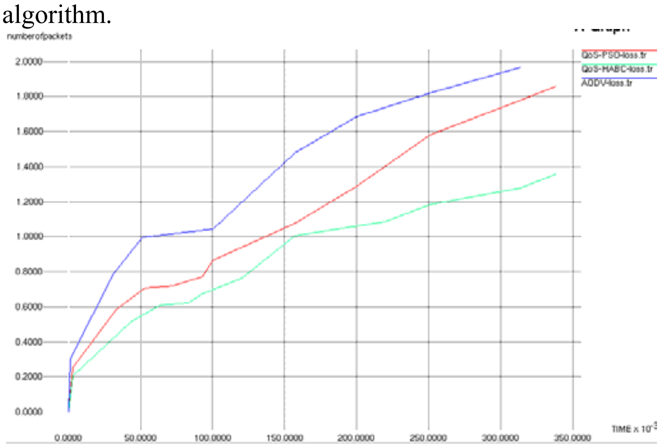


Figure 7: Packet loss Graph

From the figure 7, it is clearly observed that, however, with the number of nodes increasing in the network, the communication flows will surge. Under this condition, the packet loss caused by the network congestion will significantly increase, and the packet loss of AODV is more than that of QoS-PSO and QOS-PSOABC, that is QOS-HABC algorithms, between which QoS-PSO algorithm misobviously better.

5. CONCLUSION

This research mainly focuses on the effective optimization algorithm to improve the overall performance of the network. Intelligent software agents are employed to monitor changes in network structure, network communication procedure and each node's routing state. In this existing work, a QoS-PSO algorithm for the synthetic QoS routing model has been presented to increase the QoS level of WSN. The model applies the synthetic QoS parameters as the objective function of PSO to deal with an optimal path for node routing, and the multi-agent based routing table offers an initial path for QoS-PSO algorithm. In this research work, Hybrid algorithm which is the Particle swarm optimization combined with artificial bee colony algorithm to overcome the drawbacks of the PSO algorithm and to increase the overall system performance. Finally, compared with the existing approach, the QoS-PSOABC algorithm obviously shows its improvement in the quality of service of WSN including delay, packet loss and the synthetic QoS. The future enhancements of the present research work are to improve the overall performance of the system. Advanced and Hybrid Optimization algorithms can be used as the agents in the future enhancement. Other QoS parameters can be taken for consideration in this present research work.

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