Improving the Energy Utilization of BeeSensor using Block Perturbation Strategy for Wireless Sensor Networks

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Abstract

Objectives: The main concept and aim is to utilize the energy as efficiently as possible through implementing bee hive method through proposed block perturbation strategy based bee sensor.

Methods and Analysis: The design scheme of three phase protocols are stimulated from biological systems to create a decentralized features and more advantageous routing protocol, an important performance metrics are implemented especially to improve the protocols behaviors based on analysis. In proposing with an additional parameter of Block Length (BL), the scouting algorithm needs an up gradation. Instead of following the standard scouting, performing the scouting process in a different way can be done.

Findings: At present development in technology the power-aware, scalable and efficient routing protocols for Wireless Sensor Networks (WSNs) plays an crucial role in research area. In this, the main concept and aim is to utilize the energy as efficiently as possible through implementing bee hive method through proposed block perturbation strategy based bee sensor. Bee hives consist of a queen bee, packers, scouts, foragers, swarms. Each members of the colony are taken and their activities are observed. It is resembled that same process is imitated in the wireless sensor networks methods are commonly referred as swarm intelligence.

Improvement: The proposed mechanism has been implemented using network simulator and then evaluated its performances. The performance results exhibits the utilization of three phase protocols to attain the good performance with the minimum communication and costs efficiency for Bee Sensor network.

Keywords: Swarm Intelligence, Routing Protocol, Wireless Sensor Networks, Routing Protocol, Modeling and Simulation, Block Perturbation Strategy.

I. Introduction

The growth of tiny sensor nodes equipped with logic functions, sensing capability and communications are achieved by implementations of Micro Electro Mechanical Systems (MEMS). When scattered these process in a specified target area, then the sensor nodes formed a network that can sense, communicate and respond to manage the environmental conditions. The nodes are generally processed in pervasive infrastructure without the user involvement and for each node the routing process done over the scattered controllers on the basis of partial information and local information available in the sensor nodes which has ability to self-organize the routing decisions with respect to environment variations. In this, the concept of bee colony is adopted in the wireless sensor networks. The path taken by the bee and how there is a structured communication between the members are observed and based on their concept, WSN is structured. The bee-sensor protocol has an advantageous such as a more convenient routing agent(s) behavior, Agent-to-agent communication for identifying the best paths, constant route-discovery-agent size, which saves energy for transmission and it applicable for large networks, and to analyze the protocol behavior. With the assumptions of existing algorithms it is clear that the flat routing protocols are not applicable for arbitrary sized networks because the reason is packet cannot be flooded to large hop lengths. The main impact of this research work to shows the comparative analysis of different protocols for large networks on real time based applications.

The remaining concepts of the paper are organized as follows. In Section 2, the concepts of various algorithms for wireless sensor networks and energy optimizations methods are surveyed. In Section 3, the description about the Bee sensor is given. In section 4, the bee sensor protocol description and steps are studied briefly. In section 5, details about the implementation of proposed block perturbations algorithms are studied. In section 6, experimental results are discussed with the comparative analysis. In section 7, in this section, the paper concluded.

II. LITERATURE SURVEY

The contributions in the development related to sensor applications are Saleem *et al*. (2012) proposed an energy-efficient and scalable routing protocol for WSNs, BeeSensor, are considered from relevant features of BeeAdHoc that is primarily designed for MANET. Besides in, they present and analyze the algorithm in more detail. Like BeeAdHoc, BeeSensor process comprises of working agents are packers, scouts, foragers, and swarms. In the Beehive protocol, Wedde *et al.* (2008), packets search for efficient routes through an IP network in a process modeled after the foraging behavior of bees. Mazhar and Farooq (2012) developed a dendrite cell based distributed misbehavior detection system called BeeAIS-DC for BeeAdHoc, to overcome the drawbacks caused due to AIS. Saleemand Farooq (2012) proposed a bee inspired power aware routing protocol called BeeSensor. The simple bee agent model is used and only little processing and network resources are required. Piotr (2006) as the Smart Metering and the Smart Lighting, last mile communication systems based on PLC or RF technology, create a specific kind of the distributed sensor networks. Guo and Zhang(2014) studied about the survey on intelligent routing protocols in wireless sensor networks. In case of network topology and hardware solutions the RF technology of smart metering are more similar to Wireless Sensor Networks. Abazeed*et al.* (2013) discussed the routing protocols for multimedia sensor network. Masdari and Azarbayjan(2013) introduced the multipath routing protocols in wireless sensor networks. Aswale and Ghorpade(2015)framed a Survey of QoS routing protocols in wireless multimedia sensor networks. Bullock and Dey (1986) dealt with the Bee Hive Model for Heterogeneous Knowledge in Expert Systems. Camazine*et al.* (1991) dealt with the Self-organization in Biological Systems. Gadagkar (1996) studied the honeybee Dance-Language Controversy. The major differences between Smart Metering and Smart Lighting last mile networks is their topologies Artificial Bee Colony Algorithm and its application to Generalized Assignment Problem by Baykasoglu*et al.* (2007). Behavioral Ecology and Sociobiology was studied and implemented by Beekman*et al.*(2007). From Natural to Artificial Systems were studied and proposed by Bonabeau*et al.*(1999). A Bee Hive Model for Heterogeneous Knowledge in Expert Systems were studied and proposed by Bullock and Reilly (1986) - A method of collective nectar source from the honey bees. Self-organization through simple rules was studied by Camazineand Sneyd (1991). The Honeybee Dance-Language Controversy and Robot Bee Comes to the Rescue were proposed by Gadagkar (1996). The Honey Bee Swarm for Numerical Optimization was studied and proposed by Karaboga(2005). A case-based reasoning and recommender system was studied by Lorenziand Ricci (2004).Adaptive Information Agents in Distributed Textual Environments was studied by Menczer and Belew (1998). Menczer and Belew(1998) studied the adaptive Information Agents in Distributed Textual Environments.The shark-search algorithm through application Tailored Web site mapping is studied by Hersovici*et al.* (1998). Ant Focused Crawling Algorithm is by Dziwinski and Rutkowska (2008), ant Focused Crawling Algorithm and Classification of E-nose aroma data of four fruit types by ABC-based neural network. Adak and Yumusak (2016) studied about the hybrid optimization algorithm with Bayesian inference for probabilistic model updating. Betti (2015) studied about the optimal sensor placement in structural health monitoring using discrete optimization. Buyukozturk (2015) studied about the implementation of lifetime optimization model for homogeneous wireless sensor network under retransmission by Liand Xie (2014).Node deployment algorithm based on connected tree for underwater sensor networks was studied by Jiangand Wang(2015). The detailed study about approximation schemes for load balanced clustering in wireless sensor networks weredealt by Kuila andJana (2014).For identifying the efficient gas detector locations on offshore installations wasproposed by Seo*et al.*(2009).Parameter tuning for the artificial bee colony algorithm was described byAkay and Karaboga (2009).

III. BEE SENSOR

Bee Sensor algorithm directs the communication within a bee colony. It means that the software module is given to each sensor node called hive provided with different types of bee agents named as packers, scouts, foragers and swarms. Basically, the data from upper layer are processed by packers which are kept inside the hive. The network source nodes are discovered by scouts in Bee Sensor among them a few nodes can able to access for information beyond hops. The path of source node is analyzed by the packer based on its quality to select a forager. To discover path to new sink nodes scouts are initiated by packers in the hive where it evaluate the quality of paths between a source node and a sink node. The foragers are employed to their paths by scouts while it reaches the source node. Followed by task for Foragers to evaluate quality of the visited paths and transfer data packets. The quality of a given path is defined as the length of path function and the nodes of sensor with their remaining battery levels. It helps to determine cloning of paths within a number of times simulated by scout/forager simulated through waggle dance. There may be two large scenario for cloned number of foragers given as shorter the number of path can have battery with extendable capacity by the nodes, and the packets are waiting with large number of forager will be broken during routing even though it might contain nodes with marginal battery capacity. If there are no data packets to be transported, forager with better routing not to be cloned among them because fellow foragers can perform good transporting of data packets.

IV. PROTOCOL DESCRIPTION

The agents of Bee Sensor are four types such as packers, scouts, foragers and swarms. Among them packers are static agents where the tasks are performed within a sensor node. A brief description of each type of agent is as follows,

A. Packer

In a hive, Packers works as food-stoker bees. The main work is to receive and locate packets from the upper layer to an appropriate forager (route). The packets are kept inside in its payload after finding its forger, then its waits for arrival of the next packet. The existence of node to sink is indicated by packets when it fails to locate a forager.

B. Scouts

As said earlier, sink nodes works on determining the potential sink node in the network. There are two types of scouts forward scouts and backward scouts. The ID agent and the source help in identifying the scouts. The principle of broadcasting propagates forward scouts in the network and cannot form source routing header due to its search over the network. As a result, it provides large network to Beesensor by increasing their size becomes independent of the path length. The event is successfully delivered to the upper load by reaching sink node through forward scout and starts its return journey as a backward scout. Finally, a path is to be built from the sink to the source node where it provides report about the quality of the discovered path.

C. Foragers

In BeeAdHoc, foragers are the main workers in BeeSensor. It works on determining the fixed paths by selecting randomly form the source node to transmit events to the sink nodes. It is repeated by the foragers to group same pat together in BeeSensor. The stored information in intermediate nodes is forwarded by foragers using point-to-point mode. It is given with path identifier (PID) to index the table. Also, the quality of their path is evaluated to provide information to source node foragers. As mentioned, based on quality of path waggle dance is simulated by foragers to cloning itself.The numbers of circuits form waggle dance working with two phases are the waggle phase and the return phase. It involves working of waggle dance using a pattern of small eight figure in worker bee's where a waggle run followed by its turn towards the circle to its right and back to the starting point. Another waggle run is given by turn towards the left of the circle, and so on in a regular alternation between right and left turns after waggle runs.

D. Swarms

In some cases, swarms should completely work on transporting back the acknowledgement packets to the source node where the energy needs to be saved from those packets in link layer by foragers. Swarms are built for waiting foragers can be performed by foragers by taking a period of time at the sink node to take the initiative process. In the payload of swarm it is possible to transport multiple foragers back to the source node. It also employs reverse links during routing where a swarm acts as an individual forager.

E. Scouting

It works on forwarding packets to the packer if an event is detected at the sensor node. Further the event is carried to the sink node by the packer after identify the forager. Suppose if it fails to identify, a forward scout is initiated to encapsulate the event in its payload. In forward scout, including the agent’s type field the header contains four additional field information fields such as scout ID, source node ID, minimum remaining energy and the number of hops (initialized to zero). The forward scout is then broadcast to the neighbors of the source node. Initially, the address of sink node is not available to forward scout where the sink node carries the event in the payload of a scout. It will then convert the forward scout into a backward scout. In default, the broadcasting principle is used by the scouts to explore the path. After finding path scouts transfer the whole information to foragers regarding path to be followed and then foragers transmit the data packets to the destination. As soon as all the forgers reach the destination, they all are sent back to its source node by using swarms. All such foragers on reaching destination are referred as waiting foragers.

F. Routing loops

The routes find out are provided with reward function designed to provide loop freedom. The maximum-reward paths are followed by backward scout moves towards source node to reduce the probability in selecting a node at a larger distance than the current one. Moreover, the forwarding table entry at a node indicates that the backward scout has already visited this node. Therefore, if a backward scout visits a node for the second time, it is dropped by the node and the corresponding entry is flushed. In this way, we ensure that the discovered paths are loop-free.

G. Path maintenance:

Unlike BeeAdHoc protocol, it does not explicit the HELLO or route error (RERR) messages to check the routes validity. Swarming process are more convenient to process the path maintenance. The source node path remains usableeven it has foragers. In the routing table the path dance number becomes zerowhich is invalid and the entry is restricted after a certain time period i.e. $FORAGER_{WAIT}$. They should wait for the foragers for the return journey towards the source node. If it not arrives within the time periodthen it is clear that either the path is damaged or the sinknode has no longer interest for maintaining. The forward scouting isbegan only the paths are damaged and being generated or waiting in cache. Then the TTL value gets link with foragers and if not used then the forager dies. It is concluded that phase 1 protocol are stopped and now phase 2 protocols are deals with key parameters of an ad hoc routing protocol performance.

H. Communication among forward scouts:

The main advantages of the proposed algorithm is that theinterchangeof data's betweenthe various models which belongs to the same agent that reachthe intermediate node by various paths. The first models are processed as discussed below. Though, the nodes obtainanothermodel with same ID, the following process are takes place are:

1. First it checks whether the first models of the present scout ID is transmitted or not

2. In case the first model becomes dropped, then the duplicate modelare destroyed. It is not important to store the routing information at node i in which no backward scout will visit this node to consume it.

3. If node i broadcast the model, then it updates the hop and energy field of new model and calculates the reward. If the new reward is higher than the existing reward in the scout cache, then the past hop and reward are updated. Then the paths with higher rewards take superiority with lower rewards and destroy the new model.It permits the algorithm to identify the best routes without any extra overhead. Furthermore, the scout cache entries are managed for a certain time period and the backward scout is not received within the time period, then entries are denied.

I. Backward scouting

In Bee Sensor the nodes preserves the classified tables such as probability distribution table, routing table and forwarding table. In the given path the first two tables are controlled by the sink or base node and the intermediate nodes by transferring the forward scout to the sink node, then it separates the event from a payload and forwards to given application. After this process it generate a new table entry which includes the unique path id, a next hop id and past hop id. After receiving the previous id from the table then the next hop id is set with the sink id. If a node i obtains a back warding table with the next hop j, then the path id set the value which are included in the header. The header in the field should be update because of the lower energy level for node. Otherwise it remains unchanged.

J. Suppression of multiple scouting

By reducing the route discovery process to make the energy efficient in bee sensor. The nodes are constrained which are beyondthe Hl hops from the source node to the forward scouts with a probability pb and if it has low value which leads to the lesschance of determining the route. To reduce the overhead the source node s begins the scouting process and to detect. To illustrate that, a WSN application are considered fortracing a moving target. If some target has detected, that lies within neighboring node then the node s would generate an identical event as well.

V. PROPOSED BLOCK PERTURBATION BASED BEE SENSOR

As of bee sensor, scouting process is followed by implementing either forward scouting or backward scouting. A new method is proposed with improved ABC algorithm with block perturbation strategy (BABC). Unlike basic ABC this algorithm differs with elements block from the parent solution $x_i$is alteredwith new solution v_i. The new improved ABC algorithm is detailed as, Block perturbation strategy.

In the proposed ABC algorithm, a new parameter, block length (BL), is introduced to determine the block length of elements changed in the perturbation process. Thus, the position updating equation in the basic BeeSensor algorithm can be modified as:

$$v_{ij} = \begin{cases} x_{ij} + \phi_{ij} . (x_{ij} - x_{kj}), & j = b, \quad b+1, \dots, \quad b + rn * BL \\ x_{ij} & otherwise \end{cases}$$

Where b is the start index of the element block and it is randomly chosen from the range of [1, 2, …, D], rn is a random number within [0, 1], BL is less than D but more than 0, and rn × BL must be rounded to an integer. If rn × BL is less than 1, only the element b is updated. When a new solution is produced, an element block with a length of rn × BL from the parent solution is changed. If any index of the element block exceeds the function dimension D, then the index should be rolled back to the first element position of the solutions. It is observed that, only if the value of 'j' jets satisfied, the expression v_{ij} can be valid, else only the term of x_{ij} can be related with v_{ij}.

VI. EXPERIMENTAL RESULTS

In this experiment, the sensor network are designed by assigning the nodes which are randomly placed in 1000*1000square grids. The simulation is carried out by Network Simulator 2 tool in which the energy consumption for various protocols are simulated and compared with other protocols. The bandwidth, energy efficiency, delays and delivery ratio are the important parameters to be considered for sensor network simulation.

A. Packet Delivery ratio

Packet delivery ratio is the ratio of data packets received by the destinations node with respect to the packets which are formed by the sources. Generally it can be represented as PDR= S1+S2. In which S1 denotes the sum of data packets which are received by each destinationnode and S2 denotes the sum of data packets formed by each source.

B. Latency

Latency defined as the delay from input with respect to the desired outcome. It is very difficult to understand the texts, concepts and issues which differ to each system. It affects the electronic, communications and mechanical devices. It is denoted as the time taken for a packets to deliver from one selected point to another point. It can also calculated by sending a packet to one destination which is again return back to the sender, this round-trip time are denoted as latency which are close to zero as possible.

C. Energy Efficiency

Energy efficiency is a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input. Improving your energy efficiency is the first and most important step toward adopting renewable energy. The more efficient use of energy which results in less money spent on energy by homeowners, schools, industries, government agencies and businesses. Due to the stochastic flooding and parallel scouting the bee sensor has less control overhead.

Figure 1. Bandwidth

D. Bandwidth

The bandwidth is said to be larger in BEE, than in FPA,EEAB,Proposed Bee sensor (PBEESE) AND AOMDV.The proposed algorithm results in good performance in terms of energy consumption and packet delivery ratio and high bandwidth value when compared with other existing is shown in Figure 1. On comparing proposed Bee Sensor with AOMDV, the variation is enormously high at a certain point. With this, it clearly shows that on comparing with other algorithm, proposed BeeSensor algorithm is more efficient.

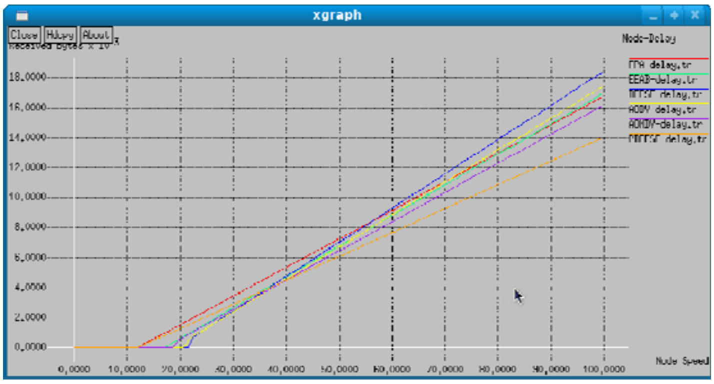

Figure 2.Delay

On comparing in terms of delay, Bee sensor algorithm stands low. This is because of its high throughput efficiency and is shown in Figure 2. Right from the node of 10 to 100, it is noted that delay is been reduced. PBEE sensor has somewhat less delay on it with AOMDV as similar as AODV with BEESE and as similar as EEAB with AODV.

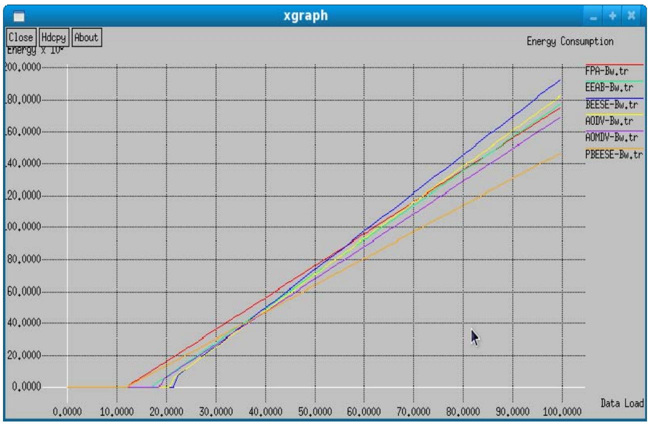

Figure 3.Energy Consumption

Energy Consumption

Figure 3 shows the proposed Bee Sensor's better energy consumption performance. It is clear that from the graph it shows that proposed method performs wellin terms of energy consumption and packet delivery ratio. Suppose if the loss-ratio is high, then it leads to increases of route discovery processes with high energy consumption. Added to this the proposed algorithm convergesmore quickly to attain the high packet-delivery ratio. If the route discoveries process increases, then it shows the variations in the control-overhead with respect to the energy-efficiency of FPA.

Figure 4. Delivery Ratio

Figure 4.Shows the fraction of data packets that are successfully delivered during simulations time versus the packets delivered rate.PBEESE consistently outperforms FPA and EEAB in terms of packetdelivery ratio. The existing methods such as FPA, EEAB, BEESE, AODV and AOMDVshows worst performance because of high convergence time. The FPA has a unicast feature, so it leads to the loss of packets. Furthermore, the BEESE and EEAB are fail to identify the stable routes because of launching interval reduction. From the simulation, it is

noted that PBEESE has high packet delivery ratio, energy efficiency and more advantageous features than other existing algorithms.If there is decrease in route discoveries process in static scenario then the total delivery ratio became close to each other. On having 1000m*1000m landscape in network simulator 2, with many nodes; it is noted that proposed bee sensor algorithm has less bandwidth, less energy consumption, less delay and high delivery ratio. The comparison is based on fixing the values of nodes and time; with this, the evaluation is made which clearly explains that PBEESE algorithm stands unique and is more efficient when compared to other algorithms.

VII. CONCLUSION

As to conclude, that the Bee Sensor offers a good performance in terms of parameters such as packet-delivery ratio, latency with less energy consumption when compared to other existing SI algorithms. The implementations of BeeSensor shows some advantageous features such as more convenient routing-agent model, agent-to-agent communication to identify the best paths, constant route-discovery agents which saves energy for transmission process and applicable for larger networks, restructured control and self-organization which make robust for failures. In this paper, as an alternation of scouting algorithm it is replaced by new block perturbation Strategy (BABC). By this implementation, the performance results show that the BABC are more suitable and convenient scouting algorithm for various real time applications in terms of convergence speed and cost efficiency.

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