March-April 2020
ISSN: 0193-4120 Page No. 6974 - 6981

Virtual Node based Optimal Route Selection using Modified ACO for Wireless Sensor Network

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Abstract:
As result of the various exclusive features, the Ad-Hoc network routing protocols not suitable to sensor networks. The energy efficiency requirement is an essential feature which differentiates the sensor network by others. The limited energy is reserved because of most of the battery operated sensors. A significant role is played by the radio communication as it is observed by analyzing the consumption of energy for node. Therefore, network lifespan enhanced an essential characteristic of the overall layers of the network protocol. As a result of limited scalability as well as dependency upon the repeated flooding, the optimum outcomes are not yielded by the conventional methods in which routing is established between the sensed data as well as sinks using the flat topology i.e., through the shortest routes of the additional data-centric methods like directed diffusion. Creating a classified network infrastructure within an essentially flat structure of MANET as well as the sensor network is the main objective of Virtual Backbone. A novel distribution heuristic procedure in which the Energy-Aware Ant colony Optimization based Virtual Backbone nodes (EA-ACO-VBN) is proposed in this method and it is used as communication infrastructure on behalf of WSN (wireless sensor network). An approach of threshold energy level as well as RSSI towards the participants of the virtual backbone is introduced in this paper. The responsibility of the backbone node in order to forward packets of additional nodes within network and the respective packets is the motive for this method.

Keywords: *Routing Protocol, Optimization, Energy consumption, WSN, ACO, Energy aware routing, Network Performance, EA-ACO-VBN.*

I. INTRODUCTION

Wireless sensor networks (WSNs) rapidly growing well now a days due its merit and aptness based on large-scale applications monitoring is unattended and autonomous. Examples of applications are from earth to cosmic, terrestrial to aquatic, residency and offices at international borders, agriculture to jungle [1]. Most applications are required in deploying thousands of battery-operated tiny sensors with low-cost and expected to operate for longer period. Advantages in different views for WSN [2–4], network lifetime has perfect barriers for deploying of (WSNs) Wireless Sensor Networks in applications like large-scale because nodes of sensor will loss energy when routing mechanisms is complex takes place.

Based on metrics we select optimal route for data, which has minimum hop, minimum broadcast cost, high remaining energy, etc., [5-8]. By single-route approach is very easy and also scalable, though it is easy we choose this optimal route only transmission of data for all routes may not increase sensor network lifetime [9]. In sensor networks with multipath routing gives us efficient energy procedure over sensor in the network by distributing traffic load, by this we expand the network lifetime. Challenging in WSNs routing is another difficulty of networks lifetime is referred to nodes in neighbor of sink, due to this it is effected by high traffic for sequence of nodes. In extra to this process for sink neighbor it has a complexity to deal with many networks basics with mobile capacity [10]. Recent

March-April 2020
ISSN: 0193-4120 Page No. 6974 - 6981

times relate to bio-inspired techniques [11] optimization techniques is added since optimizing the path creation stage is taken place. Depends on sensor scheme bio-inspired routing protocols are deliberated, to preserve high energy they tried to create short route between source and sink node.

Bionic algorithms behavior is alive things on the Earth. Reason is to achieve optimal results & goals. This summarized the heuristic rules to distribution of operation [12]. ACO algorithm have good characteristics and novel common heuristic algorithm for framework to solve the combined optimization problems. Some characteristics of this distributed positive feedback, computing, and dynamic adaptation. This ACO algorithm have above your head advantages and several research works in same direction [13]. To solve optimization problems globally they are searching this only ACO algorithm due it perfect performance [14].

II. Literature Survey

The literature [15] design an ACO-EEAODR (Ant Colony Optimization Energy-Efficient Ad-Hoc On-Demand Routing protocol) seeing residual energy & length of the node path. In a protocol weighting factors for 2 parameters having different values based on different scenarios, and every node is updated based on residual energy. So this protocol, for path selection is depends on more energy of a node than shortest path, and upto some extent we balanced network energy consumption.

The scheme for routing are to rise lifetime of network in WSNs has deliberated here [16, 17]. Routing protocol for data-centric as Gradient-Based Routing (GBR), Directed Diffusion (DD), ACQUIRE, Rumor Routing, COUGAR, MCFA (Minimum Cost Forwarding Algorithm), EAD (Energy-Aware Data-Centric Routing), SPIN (Sensor Protocol for Information via Negotiation) have discussed by et al. [18]. Energy Balance non-homogeneous Clustering Gradient based routing (EBCAG) [19] transfer information message with gradient parentage path to destination based on gradient rate where least number of hops are determined from source and sink. Depends on the Gradient routing [20] data along route is send to target by selecting routing protocol which has directed diffusion and also with highest gradient rate with least number of hops are determines. Based on this Gradient routing [21] is competitive algorithm Gradient based routing-C & confine adaptive gradient depending on routing-C, are used in forwarding hops by two ways in-order to decrease probability to resend data. Article [22] explains about EAD protocol that every node may act as gateway. We use awareness of Energy method to choose the gateways and report it. This protocols in the WSN is conveyed by et al. to improve networks lifetime in network in search of least path in the graphs [23]. Ming-hua, et al. [24] used the LEACH along ACO to calculate the network energy. Ling yun [25], obtain by acceptance for network to optimized path to improved algorithm of AC (Ant Colony). In Alaya I. et al. [26] discussed about several multi objective problems in the Wireless Sensor Networks. In Long Chengzhi et al. [27] recommended scheme for load balance which is depends going on ACO technique for WSN. Xue Wang, et al. [28] reports about effectiveness and accuracy of the data fusion in WSN.

Literature [29] use SA (simulated annealing algorithm) for search global optimal path, mixing the SA with ACO. This algorithm primarily select which node is having the SA in next hop, and updates pheromone with ACO rules. Other side of existing approach is time taken to determine distance & routing path of it stay high while comparing with usual ACO algorithm. Literature [30], mixing firefly algorithm by the ACO, this algorithm is used in listing leader nodes, density of nodes and distance between nodes. Behavior of firefly algorithm has setting optional for next hop in zone which node has large density. Convergence speed is faster, and for routing we use strategy for ACO's transition. Based on literature [31], number of iterations are used to find equilibrium constant value and adjusted accordingly. Starting iteration ant explores with novel path & path discovers to destination in

March-April 2020
ISSN: 0193-4120 Page No. 6974 - 6981

topology of network is possible. Later a while, topology discovered in network tends to stay constant, convergence speed, and equilibrium constant is reduced the acceleration of discovering the route. Though algorithm overlooks that fact some paths are higher than another paths significantly, that takes place in several repetitions in search path with optimal & decreases convergence speed of algorithm.

III. Proposed Framework

A novel distribution heuristic procedure in which the Energy-Aware Ant Colony Optimization based Virtual Backbone nodes (EA-ACO-VBN) is proposed in this method and it is used by means of the communication infrastructure on behalf of a WSN. An approach of threshold energy level as well as RSSI towards the participants of the virtual backbone is introduced in this paper. The responsibility of the backbone node in order to forward packets of additional nodes within network and respective packets is the motive for this method. Therefore, an acceptable energy level for performing the kinds of functions must be present within it. Thus, EA-ACO-VBN includes the nodes using energy levels beyond a predetermined threshold. The reconstruction in the variations of the energy levels as well as the conditions (on/off) of nodes is done by EA-ACO-VBN and the movement of the sink nodes nearby network for the distribution of the rates of energy consumption evenly within WSN. The overall network is covered by every single EA-ACO-VBN. The construction of various node disjoint EA-ACO-VBNs called as multi-EA-ACO-VBN is done by sink node with the improvement of sturdiness of ACO-VBN. A unique id is assigned towards every single EA-ACO-VBN by sink node. The delivery of the data packet is done in addition to the EA-ACO-VBN whenever the energy depletion of more than one participants is break down by EA-ACO-VBN. The old EA-ACO-VBN message is destroyed by Sink node. Network of the network enhanced by the effective resolution with even distributions the traffic load amongst nodes within network along with involvement of sturdiness. Figure 1 shows the flowchart of proposed system.

A. EA-ACO-VBN construction

The connection of dominating set (CDS) is done basically a virtual backbone. Leaf node is referred as the sensor node which is not belonging to the backbone. A node by means of the individual hop neighbor is present within each node. This node is termed as the corresponding leaf node's dominator. The representation of Energy level of a node is done by 'e_n^{th}level' and Eth is used to represent the Threshold energy level. The standard graph-theoretical symbols is used within this. A graph G = (V, E) is presented which group of overall adjoining vertices (within range of wireless transmission only) of a node v (v ϵ V) and represented as N (v) and is known as neighbors of node v. It is assumed that the respective N (v) is known by every single node. With the help of periodic or event-driven < hello > message, achievement of data is done. Two kinds of vertices is considered in this method. The fixing up or removing of present possible resolution of one vertex is done at every single round. The formation of VBN is done by assuming all initial nodes within network. Therefore, overall nodes are unremoved as well as unfixed initially. The respective status out of the unremoved as well as unfixed vertices are changed by executing the procedure of certain nodes. The VBN on behalf of the network is formed out of the fixed as well as the unremoved vertices finally. It is assumed the link (v, u) is active on behalf of vertex v whenever, the removal of u is not done out of VBN earlier. In the same way, the entire neighboring nodes v i.e., fixes as well as non-fixed are used by the active neighbors of the nodes v. As the entire additional links causes the vertices that are not a part of VBN which is final, the transmission of the messages is done via the active links. An assumption is made that SN are considered as the initial vertex through which the algorithm is initiated. With the No. of the nodes of the node 'v' including the level of energy as well as the RSSI beyond a threshold level, the degree of term of node

March-April 2020
ISSN: 0193-4120 Page No. 6974 - 6981

'v' is considered. The leader executes it wherein the initiation of ACO algorithm is done by running the Fitness-test.

B. Energy aware Ant Colony Optimization algorithm (EA-ACO) for VBN node selection

Through the foraging performance of the ants, the stimulation of the ACO (Ant colony optimization) procedure is performed. Pheromone is left within every node by the ants. Depending upon the possibility upon every node, the identification of the shorter routes from the sources of food towards the destination. The VBN that can overcome the necessities of energy as well as RSSI is found in this paper. The performance of this method is explained below.

1. The launching of a forward ant, k is done regularly for finding a path till the destination is reached. Over a memory Mk, the every visited node identifier is saved and the ant carries it out.
2. The next hop node is selected at every node r with the help of similar probabilistic instruction which is presented in ACO meta heuristic:

$$Pk(r,s) = \frac{[T\ (r,s)]^{\alpha}\ [E(s)]^{\beta}}{\sum_{u \in Mk}[T\ (r,s)]^{\alpha}\ [E(s)]^{\beta}} \quad (1)$$

Where, Pk (r,s) represents probability wherewith ant k prefers moving from r node towards node s, table of routing where quantity of trials in connection (r,s) that is stored by each node is represented as T, E denotes visibility function is assumed as 1/ (C−es) (the C represents starting energy level of nodes & es denotes actual node s level of energy), and α & β are factors which switch related necessity of trail vs visibility. Probability of selecting trade-of amid concept for the visibility (represents that node having additional energy must selected by higher probability) as well as actual trail intensity (i.e., on connection (r, s) and this connection uses high traffic.

3. Once the destination node is reached by a forwarder node, the transformation of it is done within the backward ant that has an intention of updating a pheromone trail of applied path so that reaches destination which is stored within the memory.
4. The number of the pheromone trails which are dropped in the duration of the journey is computed by the destination node earlier to the initiation of the return journey by k.

$$Tk = \frac{1}{N - Fdk} \quad (2)$$

5. The respective routing table is update once backward ant based on a neighbors node is received by a node r as follows.

$$Tk\ (r,s) = (1 - p)Tk(r,s) + Tk \quad (3)$$

Here, ρ represents coefficient of evaporation for trail from previous time Tk (r,s) is updated is represented by (1−ρ).

6. The elimination of the ant is done once the initial position of its creation is reached by the backward ant.

With respect to residual energy as well as RSSI for constructing the VBN and for sending a packet to a particular destination, the optimum neighbors are known by the every node with the implementation of this method on behalf of each iteration.

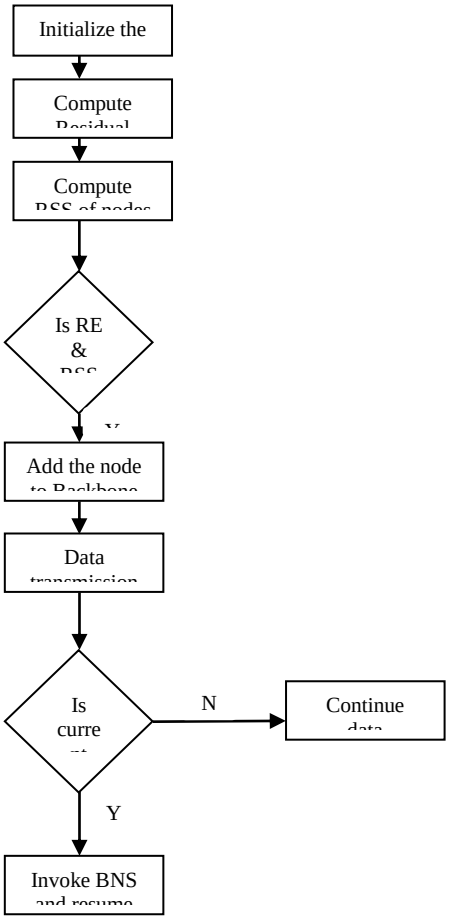

Figure1: Flowchart of Proposed system

March-April 2020
ISSN: 0193-4120 Page No. 6974 - 6981

IV. Result and Discussion

The EA-ACO-VBN protocol performance contrary to existing MFTORP in addition to PSO-BFT protocols is evaluated in this section by the usage of NETWORK SIMULATOR (version 2). E-2-E (End to End) Delay, EC (Energy consumption), Networks Lifetime & Throughput are parameters used for comparison performance and assessment. In Table 1 shows parameters of Simulation & its values.

TABLE I
Simulation parameters and its values

Simulation Parameters	Values
Simulation Tool	NS-2.35
No. of nodes	30
Simulation time	10 s
Simulation area	1000*500 m
Routing protocol	AODV
Routing methods	PSO-BFT, MFTORP, EA-ACO-VBN
Packet rate	1024 bytes /0.05ms
Traffic type	CBR
Mac layer	802.11, Mac / TDMA
Antenna type	Antenna/Omni antenna
Channel type	Wireless
Initial energy	100 j

In a region of 1000 x 500 m2, there exist 30 nodes in the Simulation context. Intended for unstructured ideal, the Random Way Point (RWP) mobility is utilized & the range of transmission is set at 250m. At an average speed of 5m/ms, the Nodes move. In relation to UDP protocol, random traffic is generated first by (code.tcl) and two scripts are utilized for constant Bit Rate (CBR) of 1024 bytes. For the overall experiments, Simulation time is set to 10 s.

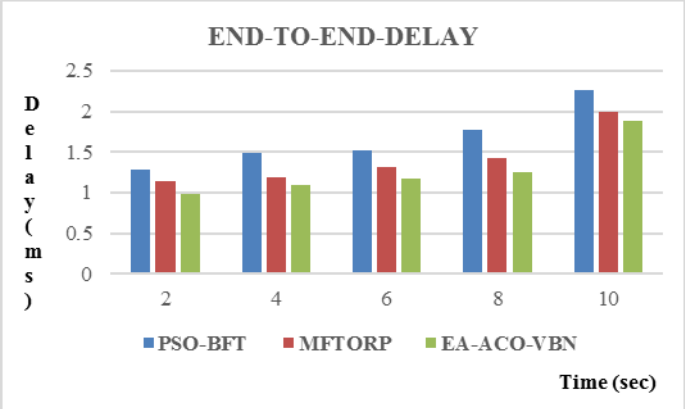

Figure2: Performance on Delay

In Figure 2 demonstrates E-2-E (end-to-end) delay vs simulation time. Delay reduced in our proposed work i.e., EA-ACO-VBN while comparing with the existing works like MFTORP and PSO-BFT. No optimal path is present in the existing methods, while coming to the proposed method it has optimal path selection so it gives us better performance's that's why the delay is reduced by selecting the optimal path so delay time reduced.

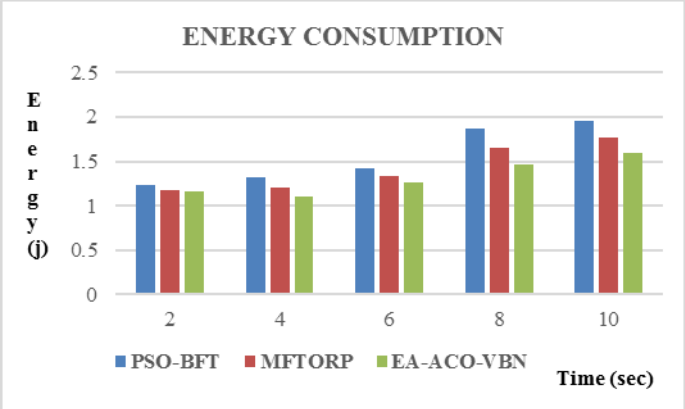

Figure3: Energy consumption

In the Figure 3. We observe consumption of energy in different methods as Energy vs Simulation time The Energy Consumption is reduced in our proposed work i.e., EA-ACO-VBN while comparing with the existing works like MFTORP and PSO-BFT. In existing methods no optimal path is present, while coming to proposed method it has optimal path selection so it gives us better performance's that's why energy consumption is reduced by selecting optimal path so energy consumption is less.

March-April 2020
ISSN: 0193-4120 Page No. 6974 - 6981

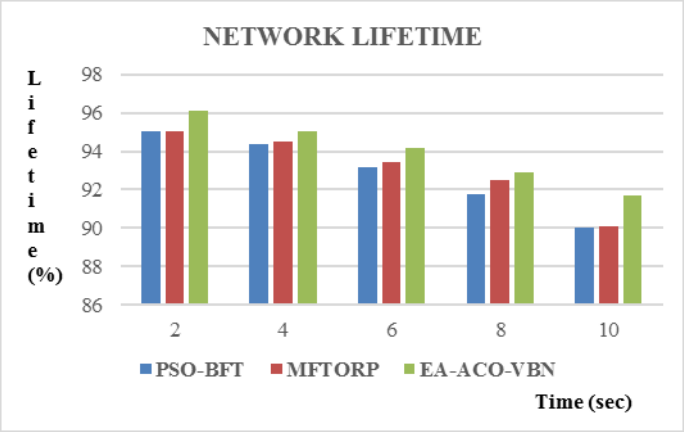

Figure4: Lifetime of Network

The Figure 4 represents Lifetime of the Network vs Simulation time. This is increased in our proposed work i.e., EA-ACO-VBN while comparing with the existing works like MFTORP and PSO-BFT. No optimal path is present in the existing methods, while coming to the proposed method it has optimal path selection so it gives us better performance's that's why lifetime of network is increased by selecting optimal path.

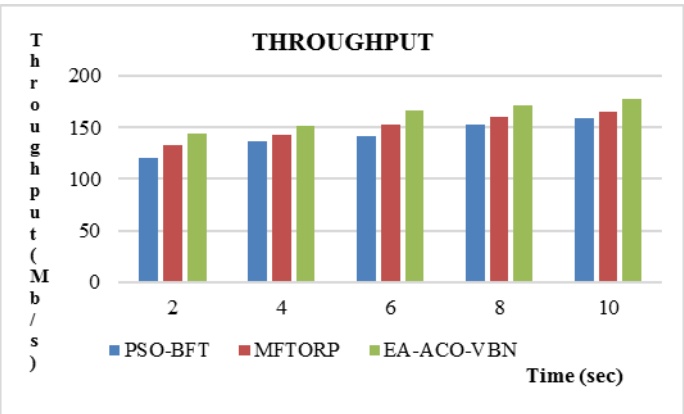

Figure5: Network Performance

In Figure 5 Throughput vs simulation time is represented. It is obvious that with average 16Kb/s, the throughput of EA-ACO-VBN is higher when compared to the PSO-BFT and MFTORP with average 13.6Kb/s which is approximately constant. So Throughput is increased in our proposed work i.e., EA-ACO-VBN while comparing with the existing works like MFTORP and PSO-BFT. In existing methods no optimal path is present, while coming to proposed method it has optimal path selection so it gives us better performance's that's why throughput is maximized by selecting optimal path.

V. Conclusion

A novel distribution heuristic procedure in which the Energy-Aware Ant Colony Optimization based Virtual Backbone nodes (EA-ACO-VBN) is proposed in this method and it is used by means of the communication infrastructure on behalf of a WSN. An approach of threshold energy level as well as RSSI towards the participants of virtual backbone is introduced in the paper. Providing dynamic selecting procedure with the intention that the sufficient energy levels for performing the packet transmission as well as the respective transmission as well as reception of packet are involved by the entire members of the resulting virtual backbone. The practical significance is possessed by this method because of the individual distribute behavior. Additionally, the routing is simplified greatly in this method. In comparison with the additional techniques, the efficiency of this method is shown in the simulation study. Moreover, the robustness of the communication infrastructure is improved by EA-ACO-VBN.

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