COMPARISON OF ANT BASED ROUTING ALGORITHM TO IMPROVE ENERGY EFFICIENCY OF WIRELESS SENSOR NETWORK

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ABSTRACT

Wireless Sensor Networks mainly having specific problems because of sensor nodes such as limited energy availability, low memory and reduced processing power. But wireless sensor network also have enormous potential applicability, e.g., medical care, military surveillance or traffic control. Till date so many algorithms have been developed for Wireless Sensor Networks that try to overcome the problems in wireless sensor networks as listed above. From all that algorithms Ant based routing algorithms can add a significant contribution to maximize the network life-time, but this is only possible by means of an adaptable and balanced algorithm that takes into account the Wireless Sensor Networks main restrictions. This paper presents how a new routing protocol IEEABR, which is based on the Ant Colony Optimization. This protocol is found to be more energy efficient than other three protocols namely BABR, IABR, EEABR. The protocol compared with other three protocols as BABR, IABR, EEABR using parameters average energy spent, minimum energy spent, energy efficiency by simulation for several Wireless Sensor Network scenarios such as performance for static scenario, mobile scenario and for different initial energy levels and the results clearly show that IEEABR minimizes energy spent and maximizes energy efficiency.

Keywords— ***WSN, limited energy availability, ant colony optimization, average energy, minimum energy, energy efficiency***

I. INTRODUCTION

WSN is a wireless sensor network consisting of specially distributed autonomous devices using sensors to co-operatively monitor physical or environmental conditions. Due to sensor nodes, WSN presents unique characteristics in ad hoc networks. WSN is built of nodes from few to several. Each sensor node has several parts such as radio transceiver, antenna, microcontroller, battery. Due to this WSN is facing problems such as reduced memory, battery life & decreased processing abilities. It is necessary to build algorithms that can reduce memory, processing power and can increase lifetime of network. ACO is one of the better options for these improvements. ACO is nothing but colony of artificial ants that travels through WSN to search shortest and energy efficient path between sensor node & destination node to maximize the lifetime of WSN. Each ant chooses next node based on amount of pheromone deposited on the connection between node & function of node energy. This paper presenting a WSN algorithm called Improved energy efficient ant based routing (IEEABR) algorithm, which is compared with three other algorithm namely BABR, IABR, EEABR. The remainder of this paper is organized as follows. Section II is a review of the previous works related to some of the well known ACO-based routing algorithms in WSNs is given. In Section III the IEEABR algorithm is described, in conjunction with three other algorithms such as BABR, IABR and EEABR. Section IV contains performance analysis of proposed algorithm for static phenomenon and mobile phenomenon. Conclusion is presented in the last section.

II. RELATED WORK

Algorithms for wireless sensor network do not offer some of the sensor networks requirements such as high power battery, memory, and the routing tables grow up with the network length and do not support diffusion communication. These are the main reasons why it is necessary to design new algorithms to improve energy efficiency. Previously so many ant based routing algorithms built. Some of them are as follows:

a. Ant-AODV (Ant Ad hoc on demand distance vector) [1] uses fixed number of ants going around the network in a more or less random manner, keeping track of the last n visited nodes and when they arrive at a node they proactively update its routing table.
b. ARA (Ant-colony based routing algorithm) [2] is a purely reactive scheme which uses forward ants and backward ants to create fresh routes from a node to a destination.
c. PERA (Probabilistic emergent routing algorithm) [3] reactively establishes route to the destination using delay as the metric. Multiple paths are set up, but only the one with the highest pheromone value is used by data.
d. ANSI (Ant hoc networking with swarm intelligence) [4] deployed two types of ants namely; Local proactive ants and global reactive ants.
e. AntHocNet (ant-based hybrid routing algorithm) [5] is congestion-aware protocol which only finds routes on-demand, but once a route is established, the route is proactively maintained.
f. AntNet [6] algorithm tries to manage both delay and energy concerns using the concept of ant pheromone to produce two prioritized queues, which are used to send differentiated traffic. But such approach can be infeasible in current sensor nodes due to the memory required to save both queues. So it becomes necessary to build energy efficient protocol to eliminate these disadvantages.

III. ENERGY EFFICIENT ALGORITHMS

The brief description of BABR, IABR, EEABR, and IEEABR can be given as follows.

3.1 Basic Ant Based Routing Algorithm(BABR):

A basic implementation of the Ant Net [7] algorithm can be described as follows.

1) A forward ant k is launched whose mission is to find a path until the destination.

2) At each node r, a forward ant selects the next hop node using probability rule which is the probability of ant k chooses to move from node r to node s,

3) Calculates routing table at each node. Also considers parameters used to control the relative importance of trail versus visibility.

3) When a forward ant reaches the destination node, it is converted in to a backward ant to update the pheromone trail of the path it used to reach the destination and that updated pheromone trail is stored in its memory.

4) Before the return journey of backward ant k starts , the destination node computes the amount of pheromone trail which the ant will drop during its journey

5) Routing table will get updated after receiving the backward ant at node r from node s.

6) (1 - ρ) is get calculated which represents the evaporation of trail.

6) When backward ant reaches the node where it was created, now mission of backward ant is finished. So now the ant is eliminated. When this algorithm is performed several times, each node will be able to know which would be the best neighbors to send packets from source to destination.

3.2 Improved Ant Based Routing Algorithm(IABR):

This section proposes two improvements in the basic ant-based routing algorithm in order to:

(i) Reduce the memory used in the sensor nodes

(ii) To increase the energy quality of the paths found by the ants.

In BABR, there is no specific destination for forward ants, means ant will check for every node in network and then will calculate shortest path. For that again ant would have to contain identification and levels of pheromone trail of all the nodes which are in neighborhood in routing table. For this nodes would need to have big amounts of memory to save all the information about the neighborhoods. This can be achieved by changing the algorithm. This is nothing but the IABR algorithm. In this forward ants are sent directly to the sink-node, so now the routing tables will only contain identification and pheromone trail of neighbor nodes that are in the direction of the sink-node. So the size of routing tables will get reduced and because of this we can save the memory of nodes. Also the quality of a given path between a sensor node and the sink-node will get determine in terms of the energy level of that path. Now in basic algorithm determine the amount of pheromone trail that the backward ant will drop during its returning journey which will also consider energy levels of nodes of its path.

3.3 Energy Efficient Ant Based Routing Algorithm(EEABR):

This section proposes some changes in IABR to reduce communication load and also to reduce energy spent during communications. In WSN maximization of lifetime is most important requirement, which is nothing but saving as much energy as possible. If we use IABR algorithm for communication in that case if we consider huge network means almost with hundred to thousand number of nodes, memory of the ants would have to be too big which would be unfeasible to send the ants through the network. So in EEABR the memory M*k* of each ant is reduced to just two records, the last two visited nodes. So now record will contain previous node, the forward node, the ant identification and a timeout value. Whenever a forward ant is received, the node looks into its memory and searches the ant identification for a possible loop [8]. If ant does not found any record, the node saves the required information and restarts a timer and then and will get send to next node. But, if a record is found, the ant is eliminated. When a backward ant reaches to the node, it searches its memory to find the next node to where the ant must be sent. Timer is used to delete the record that identifies the backward ant, if for any reason the ant does not reach that node within the time defined by the timer. Now forward ant k, will now only carry the average energy till the current node, and the minimum energy level registered. Now node will update these values when it will receives any forward ant. And when ant reaches the sink-node these values are used to calculate the amount of pheromone trail used by the corresponding backward ant. By doing these changes ants length would get reduced and energy will get saved. Routing tables will get updated at each node.

3.4 Improved Energy Efficient Ant Based Routing Algorithm(IEEABR):

The improved version of EEABR [9] we make changes in EEABR as now in new algorithm available power of nodes will get considered. The energy consumption of each path will get considered. By this we can improve memory usage and can find the optimal path and multiple candidate paths from source nodes to sink nodes. This algorithm is used to prolong the lifetime of network but not by using energy of nodes on the optimal path. This algorithm will prolong the lifetime of the network by preserving network connectivity.

Modification in EEABR:

(1) Routing tables has to initialize and also has to give priority to neighboring nodes which simultaneously could be the destination,

(2) When node or link gets failed routing tables will get update in intelligent manner.

(3)For congestion control, reduce the flooding ability of ants.

IV. PERFORMANCE ANALYSIS:

This section present the experimental results obtained for the three algorithms described in above section: the basic ant based routing algorithm (BABR), the improved ant-based routing algorithm (IABR) and the energy-efficient ant-based routing algorithm (EEABR) and improved energy-efficient ant-based routing algorithm (IEEABR). To better understand the differences between the three algorithms, two distinct scenarios were used:

1. Performance in sensor network with static phenomenon.

2. Performance in sensor network with mobile phenomenon

In all scenarios the nodes were deployed in random fashion, since in real sensor networks the device deployment, in general, cannot be controlled by an operator due to the environment characteristics. The number of deployed sensor nodes varied between 10 and 100 nodes. This paper presents the results for both scenarios. The first scenario simulates static scenario. In this, the location of the phenomenon and the sink-node are not known. Nodes are responsible to monitor the phenomenon and send the relevant sensor data to the sink-node. Other scenario is a mobile scenario. The phenomenon of mobility degrades the performance of the algorithm, which is understandable and expected since more nodes become sources of data packets, increasing the number of packets in the network. But the IEEABR protocol presents the best results when compared to the others protocols but results can be better in static phenomenon. Red color represents BABR, blue IABR, green EEABR and yellow IEEABR in each graph.

4.1 Results for static phenomenon:

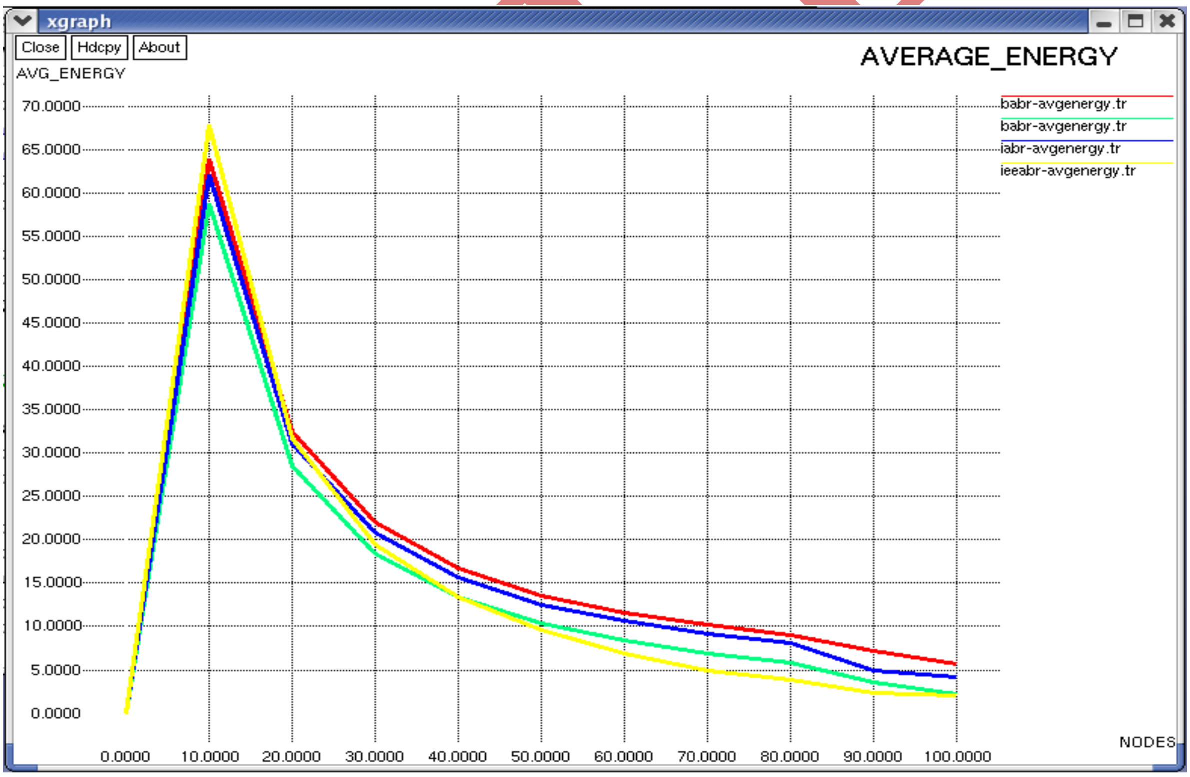

Fig 1: Average energy graph for static phenomenon

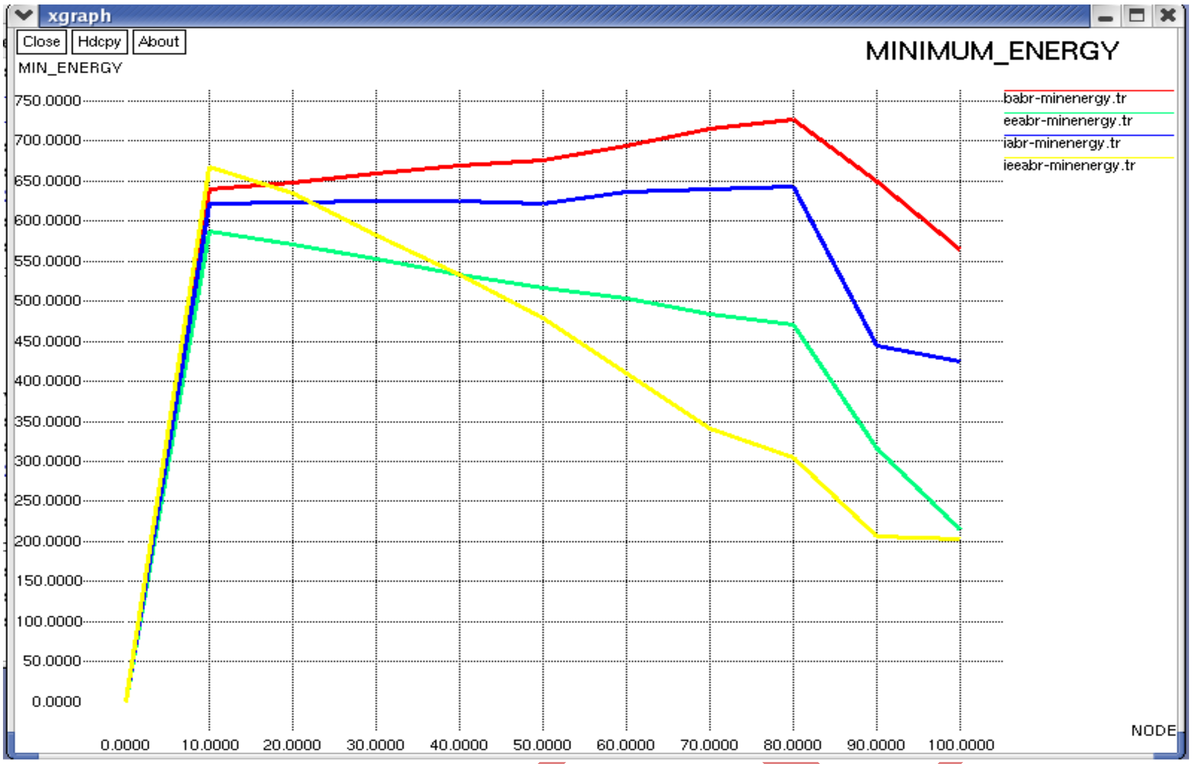

Fig 2: Minimum energy graph for static phenomenon

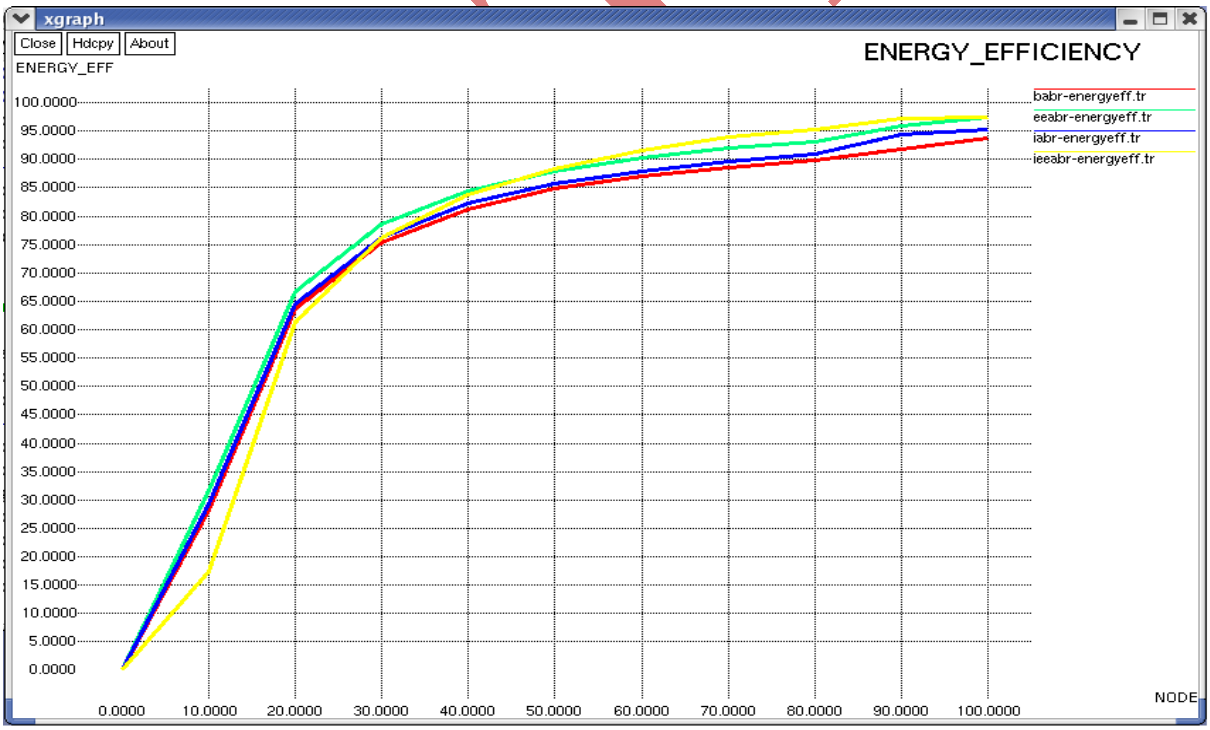

Fig 3: Energy efficiency graph for static phenomenon

4.2 Results for mobile scenario:

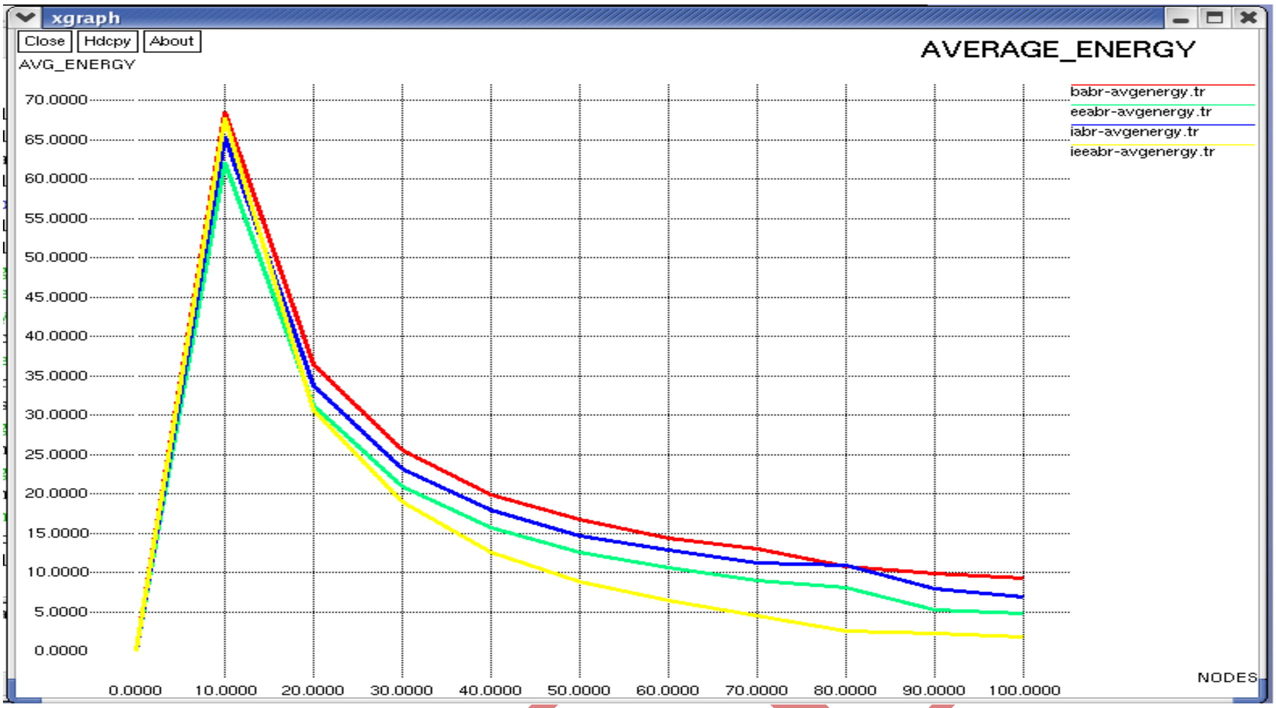

Fig 4: Average energy graph for mobile phenomenon

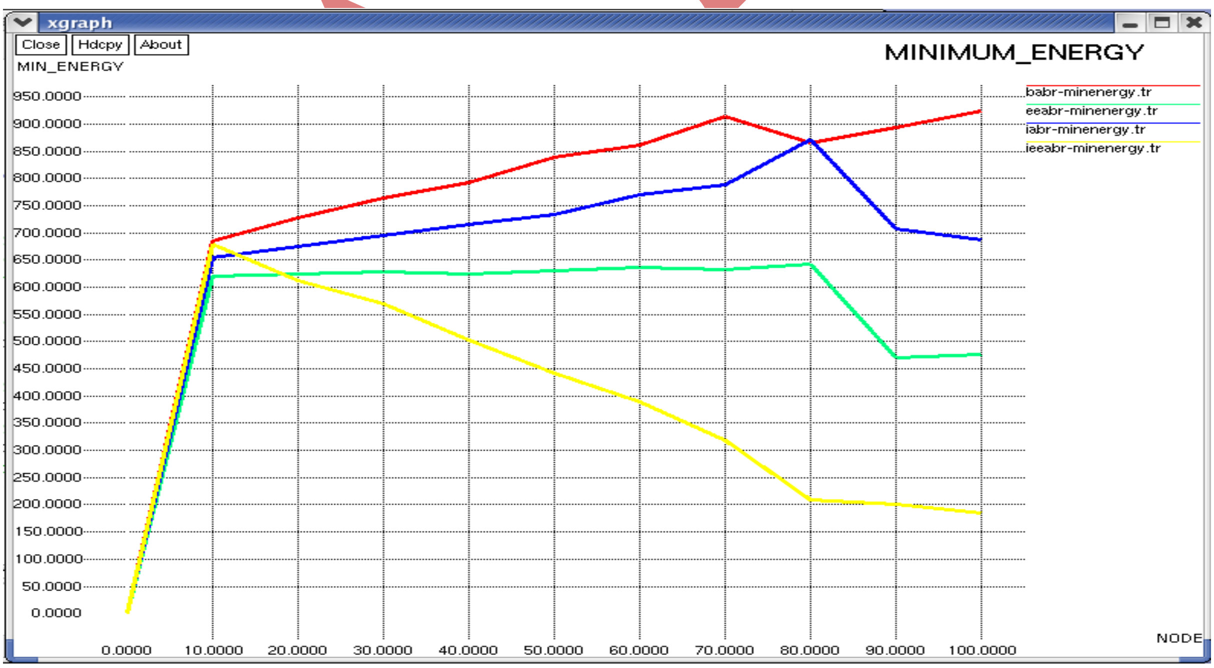

Fig 5: Minimum energy graph for mobile phenomenon

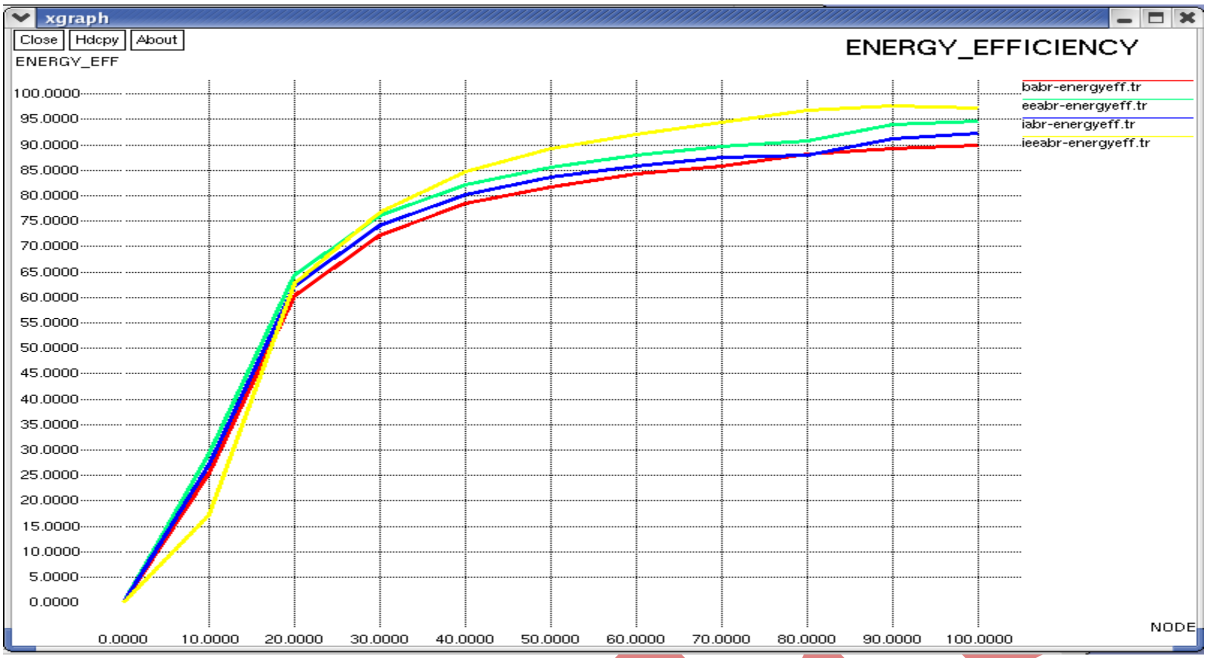

Fig 6: Energy efficiency graph for mobile phenomenon

From all the above results it can be easily concluded that performance of IEEABR in both the phenomenon as static and mobile is better than BABR, IABR and EEABR. Even though in mobile scenario the phenomenon of mobility degrades the performance of the algorithm, which is understandable and expected since more nodes become sources of data packets, increasing the number of packets in the network. But still the IEEABR algorithm presents the best results when compared to the others protocols. IEEABR spends less average energy and minimum energy, also it is more energy efficient than other three algorithms such as BABR, IABR and EEABR.

V. CONCLUSION

Wireless sensor network having sensor nodes which faces the problems such as low battery life, low energy efficiency, low memory. IEEABR protocol performs better than BABR, IABR and EEABR in mobile and static phenomenon in sensor network to overcome these issues. IEEABR uses ants which minimises energy levels and distance between sensor and sink nodes which indirectly saves energy and also minimises the communication load in network. IEEABR also increases the lifetime in both scenarios.

REFERENCES:

[1] S. Marwaha, C. K. Tham, and D. Srinivasan, “Mobile agents based routing protocol for mobile ad hoc networks”, Proceedings of IEEE GLOBECOM 2002, Nov 2002, Taipei, Taiwan.

[2] M. Gunes, U. Sorges, and I. Bouazizi, “ARA--The ant-colony based routing algorithm for MANETs”, Proceedings of ICPP Workshop for Ad Hoc Networks, IEEE Computer Society Press, 2002.

[3] J. S. Baras and H. Mehta, “A probabilistic emergent routing algorithm for mobile ad hoc networks”, Proceedings of Modeling and Optimization in Mobile, Ad Hoc and Wireless Networks, 2003.

[4] S. Rajagopalan and C.-C. Shen, “ANSI: a unicast routing protocol for mobile ad hoc networks using swarm intelligence”, Journal of Systems Architecture, Nature-Inspired Applications and Systems, vol. 52, issues 8-9, August 2006, pp. 485-504.

[5] G. Di Caro, F. Ducatelle, and L.M. Gambardella, “AntHocNet: an ant-based hybrid routing algorithm for mobile ad hoc networks”, Proceedings of the PPSN VIII-Eighth International Conference on Parallel Problem Solving from Nature Lecture Notes in Computer Science, 3242, SpringerVerlag, Birmingham, UK, 2004.

[6] Dorigo M. and Di Caro G., "AntNet: a mobile agents approach to adaptive routing", Tech. Report, IRIDIA-Free Brussels University, Belgium, 1997.

[7] Di Caro G., Dorigo M., "AntNet: Distributed Stigmergetic Control for Communications Networks", Journal of Artificial Intelligence Research (JAIR), Vol. 9, 1998

[8] Tiago Camilo., Carlos Carreto., Jorge Sá Silva., Fernando Boavida.,"An energy efficient ant based routing algorithm for wireless sensor network", Ant Colony Optimization and Swarm Intelligence Lecture Notes in Computer Science Volume 4150, 2006

[9] Adamu Murtala Zungeru., Kah Phooi Seng., Li-Minn Ang., Wai Chong Chia., "Energy Efficiency Performance Improvements for Ant-Based Routing Algorithm in Wireless Sensor Networks " Hindawi Publishing Corporation Journal of Sensors Volume 2013.