Asian Journal of Information Technology 15 (17): 3232-3237, 2016
ISSN: 1682-3915

A Review on Different Genetic Algorithms for Lifetime Enhancement of Nodes in Wireless Sensor Network

[1]M. Radhika and [2]P. Sivakumar
[1]Anna University, Chennai, Tamil Nadu, India
[2]SKP Engineering College, Tiruvannamalai, Tamil Nadu, Chennai, India

Abstract: This study reviews the concept of different types of Genetic Algorithm (GA) deployed in the Wireless Sensor Network (WSN). Compared with conventional optimization methods (like random search, LEACH, Random Placement Algorithm (RPA), Tornqvist Algorithm (TA), Stable Election Protocol (SEP), Energy Efficient Heterogeneous Cluster (EEHC), Efficient Three Level Energy Algorithm (ETLE), Minimum Transmission Energy protocol (MTE) and Direct Transmission (DT)) Genetic Algorithm are considered to be high efficient, reliable and more stable. This study reviews the outline of different types of Genetic Algorithm (GA) deployed in the Wireless Sensor Network (WSN).

Key words: Genetic algorithm, network lifetime, wireless sensor network, node stability, GAEEP

INTRODUCTION

A WSN consists of opaque assigned nodes that support sensing, signal processing, embedded computing and connectivity; sensors are logically linked by self-organizing means. WSNs have unique characteristics, such as, but not limited to power inhibit and bounded battery life for the WNs, redundant data acquisition, low duty cycle and many-to-one flows. There are four essential fundamentals in a sensor network: distributed or localized sensors interconnecting network clustering and computing resources to handle data correlation, event trending, status querying and data mining. A WSN is expected to provide meaningful information. Hence, new paradigms of using such network are mandatory along with new interfaces and new ways of thinking about the service of a network.

Challenges in WSN (Akyildiz *et al*., 2002): the major challenge of the vision of wireless sensor networks with respect to characteristics and required mechanisms are as follows.

WSN characteristics:

- Types of services: The service type rendered by a conventional communication network is evident
- Fault tolerance: WSN fault may occur due to the following reasons nodes may run out of energy Nodes may get damaged communication interrupt between 2 nodes to tolerate node failure redundant deployment is necessary (Fig. 1)

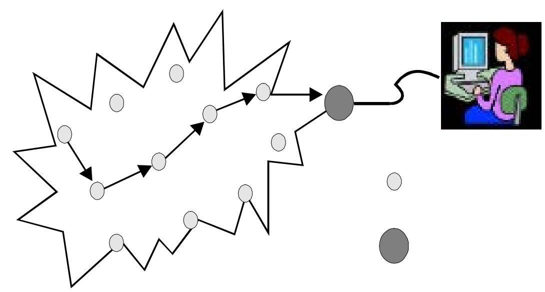

Fig. 1: Wireless sensor network

- Quality of Service (QoS): Long established quality of service requirements usually coming from multimedia type applications like
- Bounded delay or minimum bandwidth
- Delivery of packets
- High Reliability
- Delay
- Packet delivery ratio
- Reliable detection of events
- Temperature map

Lifetime: The lifetime of a WSN becomes a very important figure of merit. Nodes will have to rely on a limited supply of energy. Supplement to energy supplies a limited power sources like solar cells might also be available for sensor nodes. The lifetime of a network also has direct tradeoffs against QoS. Investing more energy can increase quality but decrease lifetime.

Corresponding Author: M. Radhika, Anna University, Chennai, Tamil Nadu, India

Scalability: WSN might include large number of nodes, the employed architecture and protocol must able to scale to the numbers.

Wide range of densities: Different applications will have different node quantity. Frequently may vary over time and space because node fails or move Density also does not have to homogeneous in the entire network and the network should adapt to such variations

Programmability: Nodes should be programmable and their computing must be unpredictable during operation.

Maintainability: Network could also be able to interact with external maintenance mechanism to ensure its extended operation at a required quality.

WSN mechanism

Multihop wireless communication: Communication over long distance is only possible using high transmission power. The use of intermediate node as relays can reduce the total required power for many forms of WSNs, so Multihop communication will be a necessary ingredient.

Energy efficient operation: To support lifetimes, energy efficient operation is a key technique. Energy efficient data transport between two nodes is more important, which is used to determine the requested information, it is measured in Joules/bit.

Auto configuration: WSN will have to configure most of its enterprise framework, sovereign self-reliant of extraneous contour. Nodes should be able to determine their geographical positions only using their nodes of the network by self location. Network should be able to endure failing nodes or to assimilate new nodes.

Collusion and in network processing: A single sensor is not able to decide whether an event has to go on but several sensors have to conspire to expose an event and only the joint data of many sensors provides ample information. Information is refined in the network itself in various forms to achieve this collaboration as hostile to having every node transmit all data to an external network and process it at the edge of the network.

Data centric: In the traditional communication, the transfer of data between two specific devices. Each equipped with one network address. The operation of such network is address Centric, whereas the data centric approach is closely related to objection approach known from collection of data, it also combines well with collaboration in network processing and aggregation.

Locality: The principle of locality will have to be embraced extensively to ensure scalability. Nodes which are very restricted in resources like memory, should attempt to limit the state that they accumulate during information protocol processing.

MATERIALS AND METHODS

Genetic Algorithm (GA): Earlier 1970's, John Holland invented Genetic Algorithm, who named as father of GA. Based on developed ideas on Genetics and Darwinism, Genetic Algorithm (Salvatore Scellato) are referred as adaptive heuristic search algorithm for solving optimization problems. Later Charles Darwin defines the fittest survival, which is the basic approach for Genetic Algorithm. It offers outstanding benefit over other optimization approach like heuristic, breath-first, praxis, linear programming and depth-first. The capacity of the algorithm to consider and use simultaneously, a raising amount of theoretical explanation and victorious application to real-world trouble strengthen, that GA's are powerful, optimization and robust technique.

Implementation of GA: After the randomly selected initial population it evolves three operators (Mahmoud and Xia, 2014): selection-equates the fittest survival, crossover-representing individual mating, mutation-random modifications.

Selection operator: Provide preference to better individuals, allowing them to pass on their genes to the next generation. The morality of each individual based on its fitness.

Fitness may be found by an objective function or by a subjective judgment. Crossover operator: prime differentiate factor of GA from other optimization techniques. With the help of Selection operator, choose two individuals. Randomly choose bit string and crossover site. Exchange the two string values. If S1 = 111111 and S2 = 000000 and the crossover point is 3 then S1' = 000111 and S2' = 111000. Mating creates two new offspring for next generation population (Fig. 2).

Mutation operator: Some portion of new individuals bit flipped with low probability. Its main goal to maintain diversity and premature convergence. It alone persuades a free walk through the search space. Noise-tolerant, hill-climbing algorithms are created by mutation and selection-without crossover. Limitations of genetic algorithm:

- Fitness identification
- Premature convergence
- No effective terminator

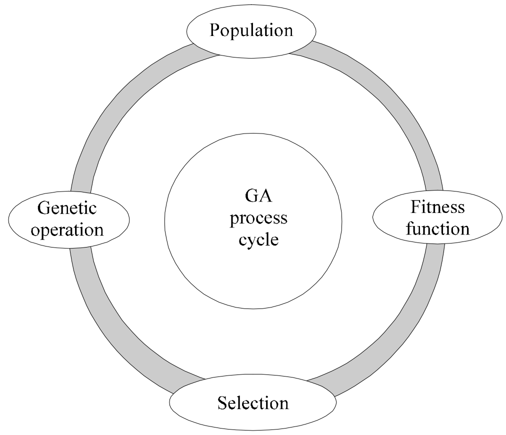

Fig. 2: GA process flow

- Couple with local search engine
- Need of larger fitness function
- No straight forward configuration

RESULTS AND DISCUSSION

Different Genetic Algorithm (GA): SGA: "Spatial Genetic Algorithm (SGA)" is a combination of deterministic and genetic search operation to optimize and speedup search. SGA is a population based probabilistic gradient search (Krzanowski and Raper, 1999). It will automatically model a more complex design of wireless network. SGA can work or overcome with many design problems like variable traffic pattern, radius of cell, cell shape, new constrains, mode objective and location dependent radius of cells. SGA provided 30% improvement on site selection over RPA and 10-19% site selection improvement over TA (Fig. 3). Where RPA (Random Placement Algorithm) is an algorithm in which random placement of transmitter is deployed, whereas TA (Tornqvist Algorithm) belong to local hill climbing search deterministic algorithm.

GAL: Self adaptive "Genetic algorithm for Localization (GAL)" of WSN with the approximation of distance between the out of communication radius, i.e., unknown node and anchor node. Self adaptive GAL has an advantage with high accuracy environmental position with obstruct and open space. With Communication radius of 200 and 300 m sensor nodes in the 1000×1000 m area, GAL obtain less localization error, i.e., for 13% anchor node it reaches a localization error of <15% (Jiang *et al*., 2013). However, MDS (Shang *et al*., 2003) gives better localization accuracy than GAL and other classical methods but it has high localization error. Hence, GAL has high robustness than any other localization algorithm.

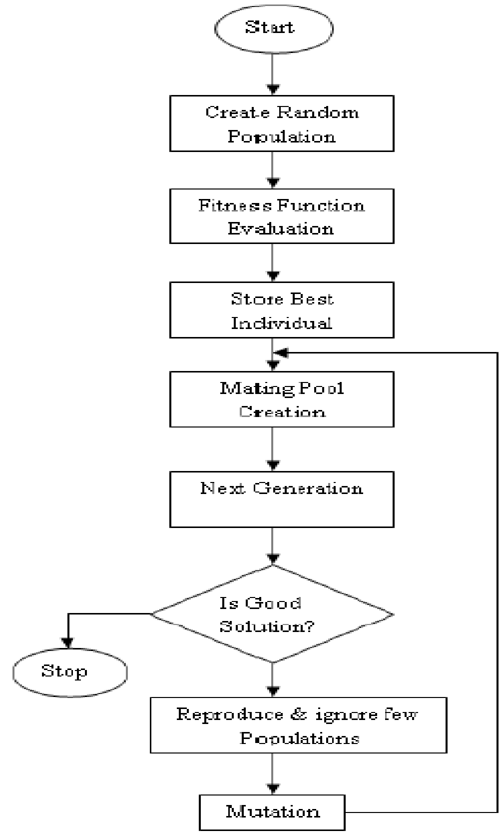

Fig. 3: GA flow chart

MGA: "Monte Carlo Genetic Algorithm (MGA)" is anEffective Genetic Algorithm for maximum coverage Sensor Deployment Problem (MCSDP). MGA is two time faster than Pure Genetic Algorithm (PGA) (Shang *et al*., 2003). MGA deploys Boolean disk coverage model for area coverage problem. It not only solves the coverage problem but also reduces the number of sensor to cover the field. With assuming binary search tree model, restricted size, weight and cost, the experimental result obtained from Aadhil and Roselin (2014), OPHTGA provides the best solution than Random, PGA, MGA, OPTGA and VFA by initial 10000 random samples and increased by 10000 per 100 generation. However, speed up technique MGA reduces time cost than OPTHGA (Fig. 3 and 4).

IGA: "Improved Genetic Algorithm (IGA)" (Ly *et al*., 2015) includes the overlapping, new fitness function using a heuristic technique to initialize population and a dynamic mutation. IGA has high efficiency and reduced computation complexity. From the experiment setup of three sensors deployed in 100×100 m as of in Ly *et al*.

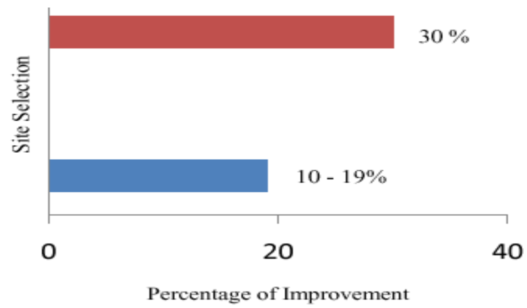

Fig. 4: Improvement of SGA over TA and RPA

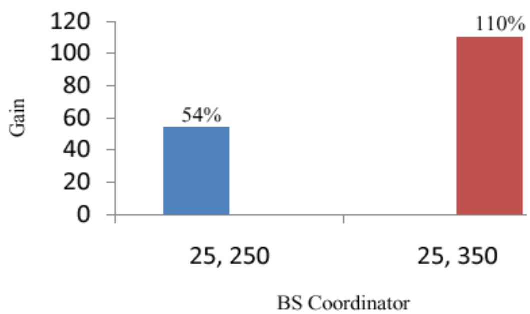

Fig. 5: LEACH-GA Gain performance

(2015), it proves that with OPTHGA, IGA has superior about the stabilization and quality of solution. With small tightness ratio, IGA is extremely effective. Finally, it shoes that IGA is better than OPTHGA in terms of computation time, solution quality and stabilization.

ETLE: Lifetime of heterogeneous WSN will be enhanced with the use of Genetic Algorithm. Genetic Algorithm outperforms over "Stable Election Protocol (SEP)", "Energy Efficient Heterogeneous Cluster (EEHC)" and "Efficient Three Level Energy Algorithm (ETLE)" in terms of network lifetime. The network lifetime has been extended up to 10% by EEHC when compare to LEACH protocol (Kumar *et al*., 2009) but the first node dies earlier when compare to ETLE. The Simulation result (Heinzelman *et al*., 2002) shows that the first sensor node will die at 38 round later when compare to the ETLE. Hence, GA increases the network lifetime over ETLE.

LEACH-GA: Optimal energy efficient clustering LEACH-GA outshine in terms of network lifetime over the existing "M inimum Transmission Energy protocol (MTE)" (Shepard, 1996; Krishnamachari *et al*., 2002), "Direct Transmission (DT)" (Intanagonwiwat *et al*., 2003) and LEACH method (Liu and Ravishankar, 2011). This method is similar to LEACH except an additional

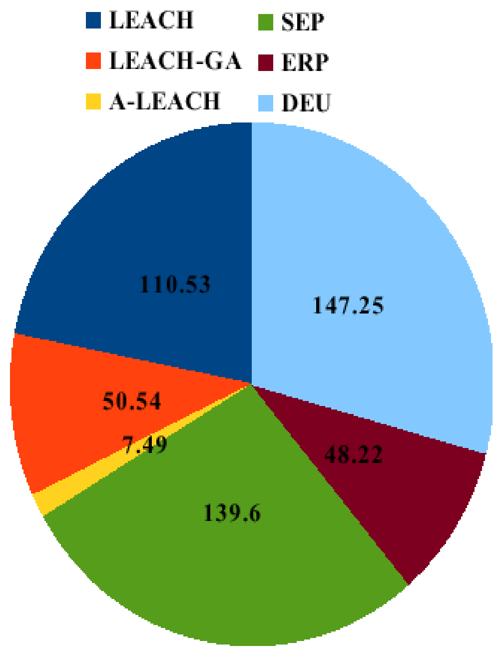

Fig. 6: Life time improvement of GAEEP over other algorithym

preparation phase. In the additional preparation of phases, before sending the candidate cluster head status, base station position and node ID will carry out cluster head selection process. In DT, directly transmitting the sensed data to base station whereas MTE is not a direct transmission; data are sent through a multi-hop relay. Both MTE and DT rating poor disseminate for node energy consumption. With the simulation result of (Jenn-Long 0, 20, 40% of improvement site selection RPA TA 30, 10-19% (Bayrakly and Erdogan, 2012), LEACH-GA achieves high gain when compared to LEACH protocol as 54 and 110%, when the co-ordinates of base station are (25,250) and (25,350), respectively (Fig. 5).

GAEEP: Next generation genetic algorithm with increasing lifetime and stable wireless sensor is "Genetic Algorithm based Energy Efficient adaptive clustering hierarchy Protocol (GAEEP)". More reliable and high energy efficient clustering GAEEP Protocol has improved lifetime of network by Zahhad *et al*. (2014) 110.53, 50.54, 7.49, 139.6, 48.22 and 147.25% over LEACH (Heinzelman *et al*., 2002), LEACH-GA (Liu and Ravishankar, 2011), A-LEACH (Vijayvargiya and Shrivastava, 2012), SEP, ERP and DEU. GAEEP Protocol extended its improvement on stability in (25, 25) co-ordinates base station by Aadhil and Roselin (2014) 1834.7, 1720.7 and 1515.7 rounds over LEACH, LEACH-GA and A-LEACH, respectively (Fig. 5).

Table 1: Summary of different GA

Different GA	Summary of GA
SGA	Combination of deterministic and genetic search operation to optimize and speedup search. SGA is a population based probabilistic gradient search SGA can work or overcome with many design problems like variable traffic pattern, radius of cell, cell shape, new constrains, mode objective and location dependent radius of cells
SAGA	Localization of WSN with the approximation of distance between the out of communication radius, i.e., unknown node and anchor node. High accuracy
IGA	Includes the overlapping, new fitness function using a heuristic technique to initialize population and a dynamic mutation. High efficiency and reduced computation complexity. IGA is better than OPTHGA in terms of computation time, solution quality and stabilization
GAEEP	Searching the less number of Cluster Head (CH) and their location based on low energy consumption. More reliable high energy efficient clustering
LEACH	GA It is similar to LEACH except an additional preparation phase. In the additional preparation phase, before sending the candidate cluster head status, base station position and node ID, it carryout cluster head selection process
MGA	An Effective Genetic Algorithm for Maximum Coverage Sensor Deployment Problem (MCSDP). MGA deploys Boolean disk coverage model for area coverage problem. It not only solve the coverage problem, but also reduces the number of sensor to cover the field

Table 2: Summary of performance analysed with different algorithms

Parameters algorithms	Computation complexity	QoS	Stability	Lifetime	Site coverage
GAL	×	✓	×	×	×
MGA	×	×	×	×	✓
IGA	✓	✓	✓	×	×
GTLE	×	×	×	✓	×
LEACH-GA	×	×	✓	✓	×
GAEEP	×	×	✓	✓	×

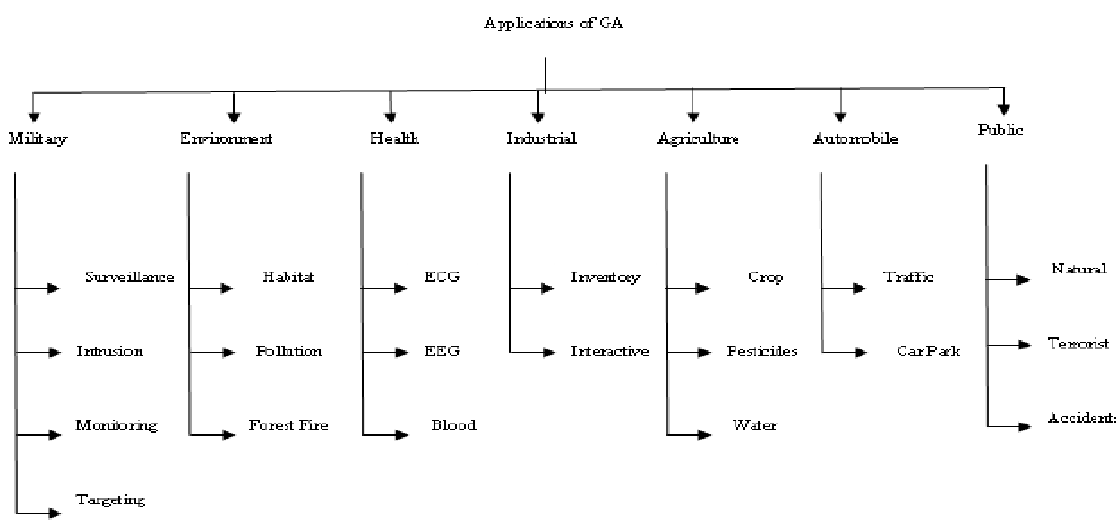

Fig. 7: Application of GA

Table 1 gives the summary of different existing algorithms and the analysed performance of WSN is given in Table 2. However, this GAs can have wide range of applications shown in Fig. 7.

CONCLUSION

Comparing with the conventional optimization methods like LEACH, Random Placement Algorithm (RPA), Tornqvist Algorithm (TA), Stable Election Protocol (SEP), Energy Efficient Heterogeneous Cluster (EEHC), Efficient Three Level Energy Algorithm (ETLE), Minimum Transmission Energy protocol (MTE) and Direct Transmission (DT), genetic algorithm based optimization techniques provides improvement over the different parameters such as lifetime, stability, QoS, coverage and computation complexity. This study is a comprehensive outline of different GAs employed in WSN scenario and corresponding performance results. This survey justifies GAEEP method is the most optimum technique to increase the lifetime of the Wireless Sensor Node.

REFERENCES

Aadhil, M. and M.J. Roselin, 2014. Maximization coverage problem using genetic algorithm in wireless sensor algorithm. NCCC. IJETAE, 2: 65-70.

Akyildiz, I.F., W. Su, Y. Sankarasubramaniam and E. Cayirci, 2002. Wireless sensor networks: A survey. Comput. Networks, 38: 393-422.

Bayrakly, S. and S.Z. Erdogan, 2012. Genetic algorithm based energy efficient clusters (gabeec) in wireless sensor networks. Procedia Comput. Sci., 10: 247-254.

Heinzelman, W.B., A.P. Chandrakasan and H. Balakrishnan, 2002. An application-specific protocol architecture for wireless microsensor networks. IEEE Trans. Wireless Commun., 1: 660-670.

Intanagonwiwat, C., R. Govindan and D. Estrin, J. Heidemann and F. Silva, 2003. Directed diffusion for wireless sensor networking. IEEE/ACM Trans. Network, 11: 2-16.

Jiang, N., S. Jin, Y. Guo and Y. He, 2013. Localization of wireless sensor network based on genetic algorithm. Intl. J. Comput. Commun. Control, 8: 825-837.

Krishnamachari, B., D. Estrin and S. Wicker, 2002. Modelling data-centric routing in wireless sensor networks. Electr. Eng., 2: 1-11.

Krzanowski, R.M. and J. Raper, 1999. Hybrid genetic algorithm for transmitter location in wireless networks. Comput., Environ. Urban Syst., 23: 359-382.

Kumar, D., T.C. Aseri and R.B. Patel, 2009. EEHC: Energy efficient heterogeneous clustered scheme for wireless sensor networks. Comput. Commun., 32: 662-667.

Liu, J.L. and C.V. Ravishankar, 2011. LEACH-GA: Genetic algorithm-based energy-efficient adaptive clustering protocol for wireless sensor networks. Intl. J. Mach. Learn. Comput., 1: 79-85.

Ly, D.T.H., N.T. Hanh, H.T.T. Binh and N.D. Nghia, 2015. An improved genetic algorithm for maximizing area coverage in wireless sensor networks. Proceedings of the 6th International Symposium on Information and Communication Technology, December 3-4, 2015, ACM, New York, USA., ISBN: 978-1-4503-3843-1, pp: 61-66.

Mahmoud, M.S. and Y. Xia, 2014. Networked Filtering and Fusion in Wireless Sensor Networks, CRC Press, New York, Pages: 464..

Shang, Y., W. Ruml, Y. Zhang and M.P.R.J. Fromherz, 2003. Localization from mere connectivity. Proceedings of the 4th ACM International Symposium on Mobile ad Hoc Networking and Computing, June 1-3, 2003, Maryland, USA., pp: 201-212.

Shepard, T.J., 1996. A channel access scheme for large dense packet radio networks. ACM. SIGCOMM. Comput. Commun. Rev., 26: 219-230.

Vijayvargiya, K.G. and V. Shrivastava, 2012. An amend implementation on LEACH protocol based on energy hierarchy. Intl. J. Curr. Eng. Technol., 2: 427-431.

Zahhad, M.A., S.M. Ahmed, N. Sabor and S. Sasaki, 2014. A new energy-efficient adaptive clustering protocol based on genetic algorithm for improving the lifetime and the stable period of wireless sensor networks. Int. J. Energy Inf. Commun., 5: 47-72.