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DEVELOPMENT COMPUTATION FOR DERIVING NODE CYCLING STRATEGY IN SENSOR NETWORKS

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ABSTRACT: *Network lifetime optimization is an important aspect of Wireless Sensor Network (WSN) as energy resources in a WSN are very limited. The operations in WSN are purely dependent on battery. Replacing or recharging of battery in the network may be infeasible. Network failure may cause due to failure of battery of one or few nodes. This problem can be overcome by replacing these nodes with their neighboring alive nodes by proper maintaining the network density and this we call deriving node cycling. Network connectivity depends upon the communication protocol and generally cluster based architecture is followed by the most common protocols. In cluster-based architecture, the nodes are grouped in clusters which communicate with a sink node; the sink node gathers information from the nodes in its cluster and transmits the information to the base station. Network connectivity issues include the number of sensor nodes in a cluster depending upon the load handling capability of the sink nodes, as well as the ability of sensor nodes to reach these sinks.*

KEYWORDS: *Wireless Sensor Network*

1.1 INTRODUCTION

In this era wireless sensor networks (WSNs) create a center of attention the researchers further due to their possible applications in weather analysis.[1] The promising field of wireless sensor networks integrate sensing, calculation, and sharing into a private portable device based on the current modifications in micro electromechanical systems (MEMS) technology. WSN can be useful nearly in any environment which calls for observation prior to taking an appropriate action. Development of a wireless system is less expensive and has numerous uses in surrounding monitoring, home building security, bio-habitat observation, disaster organization etc. Wireless Sensor Networks are categorized into proactive and reactive sensor networks. In Proactive sensor networks, nodes at regular intervals switch on their sensors and transmitters, sense the atmosphere and transmit the data on hand with them.

These proactive sensor networks are appropriate for applications that require data monitoring at standard intervals. Alternatively, in Reactive sensor networks, nodes respond to only some events that occur at their end, like noting a great change in the sensed feature. So, reactive sensor networks are appropriate to deal with time crucial systems. Sensor Networks are generally data centric, in which information are requested based on assured attributes similar to the example in which sensors recording above 100° F report to the enquiry generated by sink. This is unlike from the conventional networks, where information is requested from a definite node. WSN term can be mostly sensed as devices variety from mobile phones, laptops or PDAs to very small and simple sensing devices. Currently, the majority of available wireless sensor devices are significantly controlled in terms of computational power, memory, competence and communication abilities due to financial and technology reasons. This is the reason most of the study on WSNs has determined on the design of power and computationally proficient algorithms and protocols, and the functional domain has been restricted to simple data oriented observation and reporting uses. Wireless Sensor Network nodes are battery supplied which were implemented to carry out a specific assignment for a comprehensive period of time may be years. If WSNs nodes are more powerful or mains supplied devices in the surroundings, it is useful to utilize their computation and communication resources for complex algorithms. New network architectures with various devices and expected advances in knowledge are eliminating current limitations and expanding the range of possible applications for WSNs significantly.

Although several algorithms [2]-[16] have been proposed for design optimization of WSNs but many of them fail to address the application specific issues Consideration of the application specific issues makes the design optimization much more complex.

Several interesting approaches like Neural Networks, Artificial Intelligence, Swarm Optimization, and Ant Colony Optimization have been implemented to tackle such problems. Genetic Algorithm (GA) is one of the most powerful heuristics approach for solving optimization problems that is based on natural selection, the process that drives biological evolution. The GA repeatedly modifies a population of individual solutions. At each step, the genetic algorithm selects individuals at random from the current population to be parents and uses them to produce the children for the next generation. Over successive generations, the population "evolves" towards an optimal solution. GAs can be applied to solve a variety of optimization problems that are not well suited for standard optimization algorithms, including problems in which the objective function is discontinuous, non-differentiable, stochastic, or highly nonlinear. Several researchers have successfully implemented GAs in a sensor network design [17]-[25], this led to the development of several other GA-based application-specific approaches in WSN design, mostly by the construction of a single fitness function. However, these approaches either cover limited network characteristics or fail to incorporate several application specific requirements into the performance measure of the heuristic. In this work we have tried to integrate network characteristics and application specific requirements in the performance measure of the GA. The algorithm primarily finds the operational modes of the nodes in order to meet the application specific requirements along with minimization of energy consumption by the network.

1.2 DESIGNING WSN

For designing WSN, we are considering here a square field of *L x L* length units which is further subdivided into grids of unit lengths. The nodes are likely to be placed on the intersections of these grids. An individual in Genetic population is represented by a bit-string and is used to encode sensor nodes in a row by row fashion which can be seen in Fig. 1.1

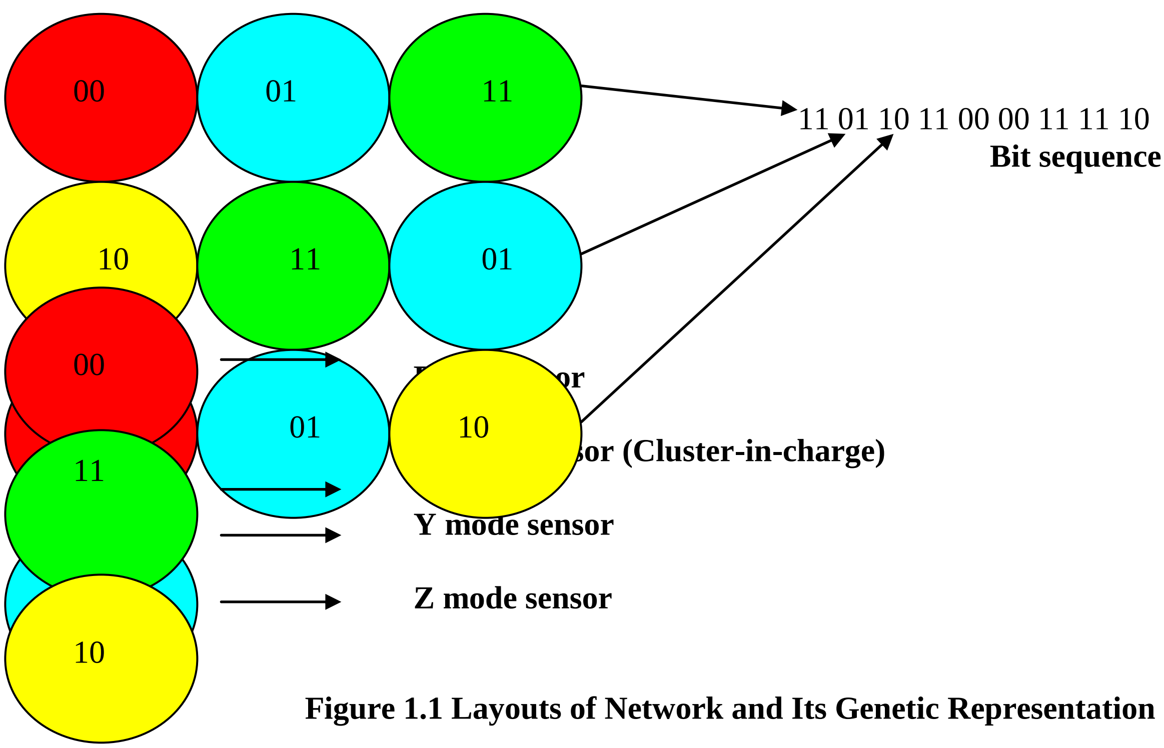

Figure 1.1 Layouts of Network and Its Genetic Representation

The length of bit string here is $2L^2$ as two bits are required to encode four types of sensing nodes i.e. X, Y, Z and inactive nodes. In this bit string the sequence of two bits decides the type of node 00 being dead, 11 being X mode, 01 being Y mode and 10 represents Z mode. Thus if the value of L is 10 then the length of the bit string would be 200. In Fig. 1.1, L is 3 and hence the length of bit string is 18.

1.3 PROBLEM DESCRIPTION

Here, we explore a multi-objective algorithm through GA to design WSN topologies. The algorithm optimizes application specific connectivity and energy based parameters by using two different fitness functions. These fitness functions give the quality measure of WSN topology and further optimize it to best topology. WSN design parameters can be broadly classified into three categories [23]. But we are here considering only the two of them. The first category relates the connectivity parameters such as number of cluster-in-charge and the guarantee that no node remains unconnected. The second category relates the energy based parameters such as the operational energy consumption depending on the types of alive sensors. The design optimization is achieved by minimizing constraints such as, operational energy, number of unconnected sensors. A weighted sum approach has been used to aggregate all these optimization constraints and an objective function is designed as given by the equation (1.1). This objective function is the basis for designing the "fitness function" for the GA.

$$f = \left[\sum_{n=1}^{n} \beta_n A_n \right]_{MIN} \qquad (1.1)$$

Where, A_n be the objective constraint parameter (like; Sensor out of range A_1, sensors per cluster-in- charge A_2, and Network energy A_3) and β_n be the corresponding weight.

1.4 EXPLORING OBJECTIVE PARAMETERS

Here, we are considering these objective constrained parameters to be optimized. The description of these parameters is given below:

1.4.1 Maximum Coverage of Sensors Parameter

The quality communication of a WSN is dependent of sensor deployment process.

The maximum coverage of sensor nodes may be one of the quality parameter which can be described as

$$C_n = \frac{(n_a + n_b + n_c) - (n_{RO} + n_{dead})}{n_t} \qquad (1.2)$$

Where, n_a be the no. of *a* modes which are cluster in- charge, n_b be the no. of *b* modes, and n_c be the no. of *c* modes; n_{OR} be no. of nodes out range; n_{dead} be the no. of dead nodes and n_t be the total no. of sensor nodes.

1.4.2 Sensors-Per-Cluster-in-Charge Parameter

This parameter describes the capacity of sensor-in-charge for handling the sensor data. The parameter will signifies data handling and the physical communication capabilities of the in-charge with the sensors of its group and is given as

$$SC_{inch} = \frac{n_b + n_c - n_{OR}}{n_{inch}} \qquad (1.3)$$

Where, n_{inch} be the no. of sensor cluster in-charges.

1.4.3 Sensors-Out-of-Range Error Parameter

Depending on sensors communication range, this parameter defines whether each node in included in any cluster or not. It can be given as

$$SE_{OR} = \frac{n_{OR}}{n_t - n_{dead}} \tag{1.4}$$

1.4.4. Network Energy Based Parameter

The network energy is another parameter taken into account here which is the measurement of energy consumption of WSN according to the network design. Basically, it depends on the operational modes of the sensing nodes, sensors operating in *a* mode (cluster-in-charge) will consume the highest energy as they require high communication power and perform data aggregation and scheduling tasks, the nodes operating in *b* mode consume less power than *a* mode as their communication range is less than *a* mode and the *c* mode nodes will consume the lowest power as they have lowest communication range. Here, it is assumed that a node in *a* mode consumes α times power than in *c* mode and node in *b* mode consumes β times more power than in *c* mode. Hence the energy consumption parameter (N_E) can be given as

$$N_E = \frac{\alpha.n_a + \beta.n_b + n_c}{n_t} \tag{1.5}$$

1.5 GENETIC OPERATOR-FITNESS FUNCTION

Genetic operator the fitness function evaluates the quality of bit string sequence for every unique Sensor Network Design. The fitness function included correctly representation of all the important design parameters which affect the quality and performance of the WSN design. The fitness function is then minimized by the GA system in the process of evolutionary optimization. After describing design parameters in last section we can formalize our fitness function as

$$f = -AC_n + BSC_{inch} + CSE_{OR} + DN_E \tag{1.6}$$

In above equation first coefficient is showing negative because the GA optimizes the problem by minimizing the value of fitness function and in order to maximize the parameters corresponding to this particular coefficients it has to be multiplied by a negative sign. In this fitness function the significance of each design parameter is defined by setting appropriate weighting coefficients. Initially all the coefficients will set to be unity and the significance of each of the parameter will be determined after some simple GA runs. The optimized values of the weights will then obtained and importance of each design parameter will have to be set. Final weights will be such that network connectivity parameters must be treated as constraints, in the sense that all sensors should be in range with a cluster in-charge and no cluster in-charge should be connected to more than the predefined number of sensors nodes.

1.6 CONCLUSION

The paper demonstrates the use of genetic algorithm for deriving dead sensor nodes to replace active ones for a wireless sensor network. A fixed wireless network of sensors of different operating modes was considered on a grid deployment and the GA system can decide which sensors should be alive and active, which ones should operate as cluster-in-charge and whether each of the remaining live normal nodes should have medium or low transmission range.

In future simulator can also be design to observe the results of the proposed GA based scheme and also, methodologies can be developed for dynamic integration of battery capacity.

REFERENCES

1. M. Ishizuka, M. Aida. Performance study of node placement in sensor networks. Proc. of 24th International Conference on Distributed Computing Systems Workshops, 2004, pp. 598–604.
2. S. Slijepcevic, M. Potkonjak. Power efficient organization of wireless sensor networks. Proc. IEEE Int. Conf. on Communications, Helsinki, Finland, 2001, pp. 472–471.
3. B. Krishnamachari, F. Ordo´nez. Analysis of energy-efficient, fair routing in wireless sensor networks through non-linear optimization. Proc. IEEE Vehicular Technology Conference– Fall, Orlando, FL, 2003, pp. 2844–2848.
4. C. Zhou, B. Krishnamachari. Localized topology generation mechanisms for wireless sensor networks. IEEE GLOBECOM' 03, San Francisco, CA, December 2004.
5. S.Y. Chen, Y.F. Li. Automatic sensor placement for model based robot vision. IEEE Trans. Syst. Man Cyber. 34, Feb2004, pp. 393–408.
6. A. Trigoni, Y. Yao, A. Demers, J. Gehrke, R. Rajaraman. Wave Scheduling: energy-efficient data dissemination for sensor networks. Proc. Int. Workshop on Data Management for Sensor Networks (DMSN), in conjunction with VLDB, 2005.
7. S. Ghiasi, A. Srivastava, X. Yang, M. Sarrafzadeh. Optimal energy aware clustering in sensor networks. Sensors 2, 2002, pp. 258–269.
8. V. Rodoplu, T.H. Meng, Minimum energy mobile wireless networks, IEEE J. Select. Areas Commun. 17 (8) 1999, pp. 1333–1345.
9. J.-H. Chang, L. Tassiulas. Energy conserving routing in wireless adhoc networks. Proc. IEEE INFOCOM'00, Tel Aviv, Israel, 2000, pp. 22–31.
10. D.J. Chmielewski, T. Palmer, V. Manousiouthakis. On the theory of optimal sensor placement. AlChE J. 48 (5) 2002, pp. 1001–1013.
11. A. Arbel. Sensor placement in optimal filtering and smoothing problems. IEEE Trans. Automat. Control 27, February 1982, pp. 94– 98.
12. H. Zhang. Two-dimensional optimal sensor placement. IEEE Trans. Syst. Man Cyber. 25 May 1995, pp. 781–793.
13. K. Chakrabarty, S.S. Iyengar, H. Qi, E. Cho. Grid coverage for surveillance and target location in distributed sensor networks. IEEE Trans. Comput. 51, December 2002, pp. 1448–1454.
14. S.S. Dhillon, K. Chakrabarty. Sensor placement for effective coverage and surveillance in distributed sensor networks. Proc. of IEEE Wireless Communications and Networking Conference, vol. 3, March 2003, pp. 1609–1615.
15. V. Mhatre, C. Rosenberg, D. Kofman, R. Mazumdar, N. Shroff. A minimum cost heterogeneous sensor network with a lifetime constraint. IEEE Trans. Mobile Comput. 4 (1) 2005, pp. 4–11.
16. S. Sen, S. Narasimhan, K. Deb. Sensor network design of linear processes using genetic algorithms. Comput. Chem. Eng. 22 (3) 1998, pp. 385–390.
17. S.A. Aldosari, J.M.F. Moura. Fusion in sensor networks with communication constraints. Information Processing in Sensor Networks (IPSN'04), Berkeley, CA, April 2005.
18. D. Turgut, S.K. Das, R. Elmasri, B. Turgut. Optimizing clustering algorithm in mobile ad hoc networks using genetic algorithmic approach. IEEE GLOBECOM'02, Taipei,Taiwan, November 2003.
19. G. Heyen, M.-N. Dumont, B. Kalitventzeff. Computer-aided design of redundant sensor networks. Escape 12, The Aague, The Netherlands, May 2003.
20. Deif, D. S., & Gadallah, Y., (2014). Classification of wireless sensor networks. Deployment Techniques, 834 – 855.
21. D.B. Jourdan, O.L. de Weck. Layout optimization for a wireless sensor network using a multi-objective genetic algorithm. IEEE Semiannual Vehicular Technology Conference, Milan, Italy, May 2005.
22. S E Roslin, ―Genetic algorithm based cluster head optimization using topology control for hazardous environment using WSN," 2 nd International Conference on Innovations in Information Embedded and Communication Systems, pp. 1-7, March 2015
23. K. Sohrabi, J. Gao, V. Ailawadhi, G.J. Pottie. Protocols for self organization of a wireless sensor network. IEEE Personal Commun. Mag. 7 (5) 2000, pp. 16–27.
24. O. Younis, S. Fahmy. Distributed clustering in ad-hoc sensor networks: a hybrid, energy-efficient approach. INFOCOM 2004, Hong Kong, March, 2005.
25. M. Younis, M. Youssef, K. Arisha. Energy-aware routing in cluster based sensor networks. 10th IEEE/ACM International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS 2002), Fort Worth, TX, October 2003.