VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

ACHIEVING INCREASED QOS, MAXIMIZED LIFETIME, BETTER ROUTING AND TARGET COVERAGE IN WIRELESS SENSOR NETWORKS

Devipriya C., N. Saravanaselvam and Saradha S.
Department of Computer Science Engineering, Sri Eshwar College of Engineering, Coimbatore, India
E-Mail: 163devipriya@gmail.com

ABSTRACT

In this paper, we focus on the various aspects related to wireless sensor networks, their features and how to increase the lifetime of the sensor and network nodes, better target coverage and the most important issues like Quality of service and routing. Wireless sensor networks (WSNs) have received a huge attention and focus among the emerging areas of the researches due to its application in wide areas like battle fields, habitat monitoring, underwater and underground monitoring, mobile robots, etc. There can be several environmental conditions which may make a sensor node to die and can also be due to depletion of battery power. The basic composition of a WSN is motes which pose only scarce resources like limited computational capabilities and memory features. The first challenge in the implementation of WSNs is source location privacy. A tree-based diversionary routing scheme for preserving source location privacy using hide and seek strategy can be used for this where the lifetime of WSNs depends on the nodes with high energy consumption or hotspot. The other design challenge in designing a (WSN) is to maximize the network lifetime, since each sensor node of the network is equipped with a limited power battery. To overcome this, different methods were proposed like network protocols, data fusion algorithms using low power, energy efficient routing, and locating optimal sink position. We focus on finding the optimal sink position. To improve WSNs' reliability, we should consider that a sensor covers targets with users' satisfied probability. To overcome this, introduce a failure probability into the target coverage problem to improve and control the system reliability. Energy savings optimization becomes one of the major concerns in WSN routing protocol design, due to the fact that most sensor nodes are equipped with the limited non rechargeable battery power. Using the principle of opportunistic routing theory, multihop relay decision to optimize the network energy efficiency can be made based on the differences among sensor nodes, in terms of both their distance to sink and the residual energy of each other.

Keywords: wireless sensor networks (WSN), quality of service (QoS), target coverage, lifetime, routing.

1. INTRODUCTION

A Wireless Sensor Network comes under Chip based technology where storage, sensing, computation, communication are all in a single chip. Furthermore, these nodes have to be minimized in terms of size and increased in terms of battery life and node lifetime. There are strict constraints on the battery and processing power, memory needed for programming and the bandwidth available for usage. As of now, the advances in technology has brought out improvements in manufacture of minimized and cheap nodes which are capable to communicate wirelessly with other systems and also be able to sense and perform computations on its own.

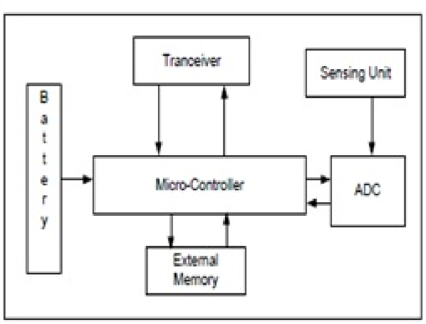

Figure-1. Sensor node structure.

Figure-1 provides the view of sensor node architecture. The components of a sensor node include transceiver, micro controller, sensing unit, Analog to Digital converter (ADC) and most importantly a battery and memory part. A transceiver is a unit which does the job of transmitting the signals to other sensor nodes or the station controller and receiving the signals from other devices which are transmitting signals that are useful for the operating sensor node. The Micro controller unit is the master part which controls the entire operations of the node and it operates at low frequency compared to traditional contemporary processing units. The sensing unit is responsible for the gathering of information related to various environmental aspects in which it is deployed like temperature, humidity, climatic changes, and pressure variations and so on. The information gathered by the sensing unit will be in the form of analog signals which needs to be converted into digital signals to be able to transmit to other receiving nodes. This task is done by the ADC and the converted signals are fed into the master unit of the node which is the micro controller. Then either continuously or at periodic times this information is transmitted by the transceiver based on the control signals issued by the micro controller.

The design criteria depend on the application of the sensor system node. Some of them are wildlife monitoring, habitat monitoring, traffic monitoring and control of signals, process monitoring and control, battle field surveillance and home automation, underwater/underground sensing, volcano eruption monitoring and other such. These sensor nodes has to be densely deployed in the field of sensing and with the possibility of multi-hop communication it should use distributed processing with other nodes in order to assure fault tolerance and achieve high quality in the network of sensor nodes. The areas of application of the sensors are rapidly growing and recent researches are focused to overcome various issues in the design of perfect sensors.

a) Quality of service

A WSN node is limited in terms of energy and processing capacities. Hence designing energy-efficient and low-overhead communication protocols which is able to satisfy the performance requirements of different applications is considered to be more important [2, 3]. The design of efficient protocols for Quality of Service (QoS) improvement is complicated due to the features such as link unreliability and high sensitivity to interference [4]. The traffic generation pattern is the influencing factor for the performance of routing protocols, and this is the reason why different applications demand different routing strategies. Single-path routing strategy cannot support high data rate event reporting. In this, a single path is established based on the QoS requirements of the underlying application to transmit data packets from the source nodes to the sink node. Therefore, the capacity of a single path is the limiting factor for the end-to-end throughput [5]. Due to the constant flow of data through a specific set of the nodes, these nodes consume their energy quite fast. This leads to problems like network disjointedness and reduction of sensing coverage. In contrast, multipath routing protocols enable the source nodes to discover several paths towards the destination. Since in multipath routing technique data packets are propagated over several paths, it provides higher throughput, more balanced energy consumption and improved latency.

MarjanRadi [6] proposed a load balancing algorithm together with the multipath routing protocol to distribute source node traffic over the established paths. This load balancing algorithm estimates the optimal traffic rate of the paths based on their relative quality. Paths with higher interference levels are assigned with a lower traffic rate. Since finding and establishing interference-minimized paths may be time consuming, this scheme proposed by the author starts packet transmission immediately after the first path is established. This leads to reduction in time interval between event detection and packet reception at the sink. Afterward, whenever a new path is created, the load balancing algorithm redistributes the source node traffic according to the relative quality of the paths. This multipath routing protocol is composed of three phases: initialization phase, route discovery and establishment phase, and route maintenance phase. In the initialization phase, each node acquires its neighborhood information which will be used in the route discovery and establishment phase to find the best next-hop node towards the sink. The route discovery and establishment phase is triggered whenever an event is detected. The outcome of this phase is multiple interference- minimized paths between the source and sink. Finally, the route maintenance phase handles path failures during data transmission.

2. LIFETIME MANAGEMENT

Md NafeesRahman [7] introduced relay nodes in conjunction with the PSO based algorithm. These relay nodes reduce the burden of the data traffic on the sensor nodes, especially when they are close to the sink, by carrying the data traffic to the sink. Hence the consumption of energy, of the sensor nodes decrease and the lifespan increases. The optimal location of the sink with respect to those relay nodes is found by using the PSO based algorithm. A PSO based algorithm is used to locate the optimal sink position with respect to those relay nodes to make the network more energy efficient. Instead of communicating with sensor nodes, the relay nodes communicate with the sink node. This approach can save at least 40% of the energy and prolong the network lifetime. Wang *et al*.[8] proposed the use of mobile relays along with the sensor nodes for extending the network lifetime. But the locations of mobile relays are limited to only two-hop distance from the sink. Hou *et al*.[9] worked on optimal sink selection for anycast routing. Here the authors considered multiple sinks in a wireless sensor network, which may not be feasible for many applications. In Ref. [10], the author's approach was based on PSO algorithm for locating the best position of the sink where multi-hop communication was considered. But in multi-hop communication the sensory data collected by all the nodes of the network reach the sink through the nodes close to the sink and thus these nodes tend to die soon as they have to pass a huge amount of data.

The particle swarm optimization is a population based optimization technique, introduced by Kennedy and Eberhert in 1995[11]. The model of this algorithm is based on the social behaviour of bird flocking. It works through initializing population of random solutions and searching for the optima by updating generations. The PSO technique uses several particles, each represents a solution, and finds the best particle position with respect to a given fitness function [12].

In PSO, each single solution is a “bird” in the search space. We call it “particle”. All of particles have fitness values that are evaluated by the fitness function to be optimized, and have velocities that direct the flying of the particles. Each particle flies through the problem space by following the current optimum particles. PSOis now initialized with a group of random particles (solutions) and then searches for optima by updating generations. In every generation, each particle is updated by following two “best” values. The first one, which is based on the fitness is the best solution achieved so far. The fitness value is also stored and the value is called pbest. Another “best” value is tracked by the particle swarm optimizer, obtained

VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

so far by any particle in the population. This best value is considered a global best and called gbest. After the findingof the two best values, the particle updates its velocity and positions. The particle swarm optimization concept at each time step, changes the velocity of (accelerating) each particle towards its pbest and gbest locations. Acceleration is weighted by a term called random term, with the generations of separate random numbers for acceleration toward pbest and gbest locations.

a) Routing

Juan Luo proposed [13] an energy-efficient routing algorithm for above 1-D queue network, namely, Energy Saving via Opportunistic Routing (ENS_OR). ENS_OR adopts a new concept called energy equivalent node (EEN), which selecting relay nodes based on opportunistic routing theory, to virtually derive the optimal transmission distance for energy saving and maximizing the lifetime of whole network. Since sensor nodes are generally static, its sensor's unique information, such as the distance of the sensor node to the sink and the residual energy of each node, are crucial to determine the optimal transmission distance; thus, it is essential to consider these factors together for opportunistic routing decision. ENS_OR selects a forwarder set and prioritizes nodes in it, according to their virtual optimal transmission distance and residual energy level. Nodes in this forwarder set that are closer to EENs and have more residual energy than the sender can be selected as forwarder candidates. Our scheme is targeted for relatively dense 1-D queue networks, and can improve the energy efficiency and prolong the lifetime of the network.

b) Target coverage

Since sensors are often deployed in remote or inaccessible environments where replenishing the sensor energy is usually impossible, a critical issue in WSN applications is conserving sensor energy and prolonging the network lifetime while guaranteeing the coverage of desired areas or targets, which is called the Coverage problem. The coverage problem is a fundamental problem in WSNs for environment monitoring and surveillance purposes. The coverage concept is subject to a wide range of interpretations due to the variety of sensors and applications. Generally, coverage which has direct effect on the network performance can be considered as the measure of quality of service in a WSN [14]. The authors in [15, 16] propose an efficient way to extend the network lifetime by organizing the sensors into a maximal number of sensor sets that are activated successively. Only the sensors from the current active set are responsible for monitoring all targets and for transmitting the collected data, while all other nodes are in a low-energy sleep mode. The authors in Ref. [17] consider the status scheduling of a sensor with multiple sensing ranges. A collaborative task scheduling algorithm is proposed to minimize the energy consumption. It employs a two-level scheduling approach to the execution of tasks collaboratively at a group and individual levels among neighboring sensor nodes. Our approach differs from the aforementioned solutions by adding reliability restrictions to get non-disjoint sensor sets and by allowing the sets to operate for different time intervals. Specifically, our approach is to find the active non-disjoint sensor sets to fully cover all targets in a distributed manner to maximize the network lifetime within a preset reliability threshold. Jing He [18] introduced a new concept which is the failure probability of sensor sets for reliability. Only when the failure probability of sensor sets is greater than the preset threshold, can these sets be set to active. The reliability of a network is a measure of the Quality of Service (QoS) of the sensing function and is subject to a wide range of interpretations due to a large variety of sensors and applications.

3. CONCLUSIONS

In this paper we have provided an overview of the various areas related to the wireless sensor networks and the solutions provided by the researchers in this area. There are similar work spaces in this WSN which enables the research to be carried out in analyzing the performance of the available operating systems, motes, improving network lifetime. Since most sensor nodes are battery operated and difficult to replace these batteries, it is important to improve the reliability of the network. We can schedule in such a way that the alternate nodes sleep and awake periodically according to the schedule. By making use of the relay node, the network is able to have a longer lifetime. They can be able to collect the sensed data from the sensor nodes and pass it to the sink nodes. The number of relay nodes has to be calculated to have the network connected successfully. Implement opportunistic routing theory to virtually realize the relay node when actual relay nodes are predetermined which cannot be moved to the place according to the optimal transmission distance. This will prolong the lifetime of the network.

REFERENCES

[1] Reddy V., Kumar P., Janakiram D. and Kumar GA. 2009. Operating Systems for Wireless Sensor Networks: A Survey. Int.J.Sens. Netw. Vol. 5, pp. 236-255.

[2] Yick J., Mukherjee B. and Ghosal D. 2008. Wireless sensor network survey. Computer Networks, Vol. 52, No. 12, pp. 2292-2330.

[3] Li Yanjun, Chen Chung-Shue and Song Ye-Qiong. *et al.* 2007. RealtimeQoS support in wireless sensor networks: A survey. In: Proceedings of the 7th IFAC International Conference on Fieldbuses & Networks in Industrial & Embedded Systems (FET '07). Toulouse, France, pp. 373-380.

[4] Son D., Krishnamachari B. and Heidemann J. 2006. Experimental study of concurrent transmission in

wireless sensor networks. In: Proceedings of the 4th International Conference on Embedded Networked Sensor Systems (SenSys ’06). Boulder, Colorado, USA, pp. 237-250.

[5] Li Jinyang, Blake C. and Couto D. S. J. D. *et al.* 2001. Capacity of adhoc wireless networks. In: Proceedings of the 7th Annual International Conference on Mobile Computing and Networking (MobiCom ’01). Rome, Italy, pp. 61-69.

[6] Marjan Radi, Behnam Dezfouli, Kamalrulnizam Abu Bakar, Shukor Abd Razak and Mohammad Ali Nematbakhsh. 2011. Interference-Aware Multipath Routing Protocol for QoS Improvement in Event-Driven Wireless Sensor Networks Tsinghua Science And Technology, Vol. 16, No. 5, October pp. 475-490.

[7] Md Nafees Rahman and M. A. Matin. 2011. Efficient Algorithm for Prolonging Network Lifetime of Wireless Sensor Networks, Tsinghua Science And Technology, Vol. 16, No. 6, December, pp. 561-568.

[8] Wang Wei, Srinivasan V, Chua Kee-Chaing. Extending the lifetime of wireless sensor networks throuh mobile relays. IEEE Transactions on Networking, 2008, 16(5): 1108-1120.

[9] Hou Y. Thomas, Shi Yi and Sherali Hanif D. 2006. Optimal base-station selection for any cast routing in wireless sensor networks. IEEE Transaction on Vehicular Technology, Vol. 55, No. 3, pp. 813-821.

[10] Showkat M. J., Paul B. and Matin M. A. *et al.* 2009. Optimal sink location in wireless sensor networks using particle swarm optimization. In: Proc. 2009 IEEE International Conference on Antennas, Propagation and Systems (INAS 2009). Johor Bahru, Malaysia, pp. 1-4.

[11] Kennedy J., Eberhart R. C. 1995. Particle swarm optimization. In: IEEE International Conference on Neural Networks. Perth, Australia, Vol. 4, pp. 1942-1948.

[12] Shi Y. 2004. Particle swarm optimization. IEEE Connections, Vol. 2, No. 1, pp. 8-13.

[13] Juan Luo, Jinyu Hu, Di Wu, Renfa Li,Opportunistic Routing Algorithm for Relay Node Selection in Wireless Sensor Networks, IEEE transactions on industrial informatics, Vol. 11, No. 1, February, pp. 112–121.

[14] Slijepcevic S. and Potkonjak M. 2001. Power efficient organization of wireless sensor networks. In: Proceedings of the IEEE International Conference on Communications (ICC’01). Helsinki, Finland, pp. 472-476.

[15] Cardei M., Thai M. and Li Y. *et al.* 2005. Energy-efficient target coverage in wireless sensor networks. In: Proceedings of the 24th the IEEE International Conference on Computer Communications, INFOCOM’05. Miami, USA, pp. 1976-1984.

[16] Naderan M., Dehghan M. and Pedram H. 2011. A distributed dual-based algorithm for multi-target coverage in wireless sensor networks. In: Internatinal Symposium on Computer Networks and Distributed System. Tehran, Iran, pp. 204-209.

[17] Shih K. P., Deng D. J. and Chang R. S., *et al.* On connected target coverage for wireless heterogeneous sensor networks with multiple sensing units. Sensors, Vol. 9, No. 7, pp. 5173-5200.

[18] Jing He, Shouling Ji, Yi Pan and Yingshu Li. 2011. Reliable and Energy Efficient Target Coverage for Wireless Sensor Networks, Tsinghua Science and Technology, Vol. 16, No, 5, October, pp. 464-474.