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Review on "Energy Efficient WSN Techniques in Environmental Monitoring"

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Abstract: Environmental monitoring is major application of Wireless sensor networks. WSNs consist of sensor nodes. Each sensor node accoutered with low cost sensor, small battery and a microcontroller. Environmental monitoring need battery powered sensor nodes active for long period, which tends to drain battery easily. Repeatedly charging or changing of batteries is not practical solution. In order to widen network lifetime, reduction in energy consumption of sensor nodes is a major challenge. So, energy efficiency of WSNs need to be improved. The different WSN energy efficient techniques used in environment monitoring are review here.

Keywords: Environmental monitoring system, Energy efficiency, Wireless sensor network, GPS, Zigbee.

I. INTRODUCTION

Environmental monitoring includes sensing, computation and communication. Wireless sensor networks fulfil these requirements by small devices i.e. nodes. These devices are connected and powered in order to achieve efficient monitoring and to extend lifespan of system. Most important design metrics for WSNs is energy efficiency. Sensor data is always processed to compress and to remove redundancies by processors at node location; thus already achieves energy saving [4]. But communication between nodes is also major parameter in energy consumption. Communication techniques focuses on reduction of energy consumption. Energy is consumed in communication for sending the location as well as computed data of sensor. Here, different techniques in WNSs used to achieve energy efficiency in environment monitoring are reviewed.

II. RELATED WORK

Wireless sensor network (WSN) consists of sensors, microcontroller and communication device. Sensor nodes vary in size from shoebox to dust particle. Continuously battery powered nodes are active for long time in monitoring applications. After initial deployment, human interference is not available. This lead to draining of battery over short period of time. So efficient energy techniques is need for modern communication.
GPS communication stands most accurate and real time in open spaces. It gives benefit in environment monitoring. The main setback of GPS is its energy consumption. Fixed duty cycle traditional GPS consume high power due to high sampling frequency. Sensor nodes having GPS receivers thus tend to drain battery at high rate. For trajectory based applications, [1]Xiaohan Li, Fengpeng Yuan and JanneLindqvist have proposed to use most energy efficient duty cycle of GPS, without compromising accuracy. Results of real life traffic monitoring stated in this paper claims to save 78% energy, when sampling period is increased beyond 120 seconds. Loss of accuracy stabilize around 23%, compared to continuous sampled GPS.

Environment monitoring is large domain which includes air pollution monitoring, forest fire detection, landslide detection, water quality monitoring etc. In case of forest fire incident early detection of the event is crucial. In "Energy-Efficient Data Mining Techniques for Emergency Detection in Wireless Sensor Networks" [2], early detection technique for such event is proposed. Instead of harvesting large quantity of data to detect hazard, each node contributes individual data to cluster. Fire detection is done using artificial neural network classification technique. When node detects fire, it sends data to cluster head. Cluster heads are routed via gateways to sink. This technique is termed as data mining (DM). Due to individual communication by nodes, data size is reduced. Small data packets increase speed of network communication and also increases network lifetime. Technique is tested using CupCarbon simulator. Energy consumed is reduced considerably here.

Beihua Ying [3] has proposed an adaptive data compression technique to improve the energy efficiency for the whole network. Data compression is best way of reducing energy consumption in WSN, but compressing data can be tedius task. Adaptive compression technique proposed here use prediction and feature extraction of relevant parameters for each sensor node in the network. Sensor nodes density varies depending on deployment strategy. In heavily dense area, sensor data is compressed to avoid redundancies in sensor network. According to simulation results; the data

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communication is completed for all nodes in a network with minimal energy consumptions. The maximum deviation against the ideal condition is less than 5%.

Environmental air pollution monitoring system based on the IEEE 1451 standard is proposed by NihalKularatna and B.H.Sudantha [4]. Design and implementation of STIM (smart transducer interface module) is proposed here. Similar to traditional wireless sensor networks, STIM is combination of microcontroller and group of various sensors like CO2, CO, NO2 and O3. Graphical representation of results is presented using. STIM and the PC are connected via IEEE 1451 standard transducer independent interface.

[5] Design and development of a ZigBee based energy efficient environmental monitoring, alerting and controlling system for environmental monitoring is proposed by K.Lokesh Krishna, J.Madhuri and Dr.K.Anuradha. Paper illustrated wireless monitoring of agricultural field, which allow the farmers to lessen the human power and helps to keep real time accurate data of changing parameters in the field. The proposed system helps to keep track of various environmental parameters such as temperature, humidity, gas density, soil humidity and light availability. Being highly robust, proposed system is highly recommended for environment monitoring over large areas.

Sensor nodes are made low-cost, low-power and multifunctional due to advanced research in microelectro-mechanical systems technology, wireless communications and digital electronics. I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci [6] have done survey of design of sensor network considering communication architecture, algorithms used for each layer and deployment techniques. By reviewing various techniques in WSN, paper discusses about various new applications open in remote sensing. Also, expresses need of new wireless efficient energy consumption techniques.
Today's world is embedded world. Controlling and monitoring plays important role to enable end user to decide course of action [7]. P.Suchetha and T. VenuMadhav have designed energy efficient environmental monitoring system using a ARM processor, three sensors and web server. Data is communicated to laptop using serial port. IOT is trending in WSN.

In this paper, L-SYNC synchronisation protocol is implemented and results are analysed for Wireless Sensor Networks [8]. Every pair of sensor nodes of same cluster or different cluster can be synchronized as per need. Proposed technique in here calculates clock offset and clock skew with respect to cluster head. This synchronization reduces number of required to move from one cluster to remote cluster. Reduction in hops saves network energy and increases network lifetime. This protocol provides efficiency for homogeneous network topology clustering. For analyzing results the synchronization precision of two remote nodes is considered and NS 2.31 simulator under the Linux operating system is used. L-SYNC does have limitations for heterogeneous networks. For heterogeneous network topologies, L-SYNCng (L-SYNC next generation) protocol is proposed here. For better synchronization and scalability, L-SYNCng protocol is good but it is unreliable in noisy environments.

NajmehKamyabPour[9] in his research thesis on "Energy Efficiency in Wireless Sensor Networks" present an Energy Driven Architecture (EDA) for reducing the total energy consumption of WSNs. The idea of overall energy consumption in WSNs is main discussing point of paper. To optimize and balance energy consumption of sensor node overall energy consumption map helps and thus enhances network lifespan. To justify this model, simulation is done by deploying 100 sensors in 500*500 pixel area. These sensor nodes reports data from environment event at random time.

Sensor nodes deployed in environment are either with rechargeable batteries or one time chargeable power source. Networks with rechargeable power source are called as wireless rechargeable network. Mobile recharging vehicle charges sensor nodes as per predefined schedule [10]. In real time applications, sensor deployment topology causes low charging efficiency of sensor nodes and can hamper node lifetime. In this paper [10], effects of charging distance and angle on charging is considered. Proposed solution in this paper concentrates on recharging of sensor nodes to increase network lifetime. Instead of changing distance or angle of charging, route of mobile charging vehicle is proposed as "shortest Hamiltonian cycle". Authors claim to improve charging efficiency. Simulation results of proposed solution manages to decrease total charging time by 50%.

Considering different geographical area needs different kind of monitoring, Kaushledra Kumar Pandey, Bhagyashree, BabliKumari and Sonali Biswas [11] has proposed excellent solution of clustering energy efficient techniques. LEACH and TEEN clustering techniques are cooperatively combined to ensure robust wireless communication. Proactive and reactive clustering techniques makes sure to monitor area on periodic and regular basis. Both LEACH and TEEN protocols are energy efficient by nature and considers residual energy of each node before selecting cluster head. This intelligent use of sensors takes care that all sensors live longest life possible and thus increases network lifetime. Proposed technique is analyzed by comparing sensor node live rate in traditional LEACH and TEEN technique and cooperative technique. Results shows that proposed cooperative technique increase network lifetime by 72-89%.

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Like [11], Feng Li , Li Wang, LiminMeng, Yu Zhang[12] also considers cooperative transmission method to achieve efficient use of available power resource in WSN. Key parameter is to manage energy between sensor node's own task and communication of other nodes data in hopping network. In this paper, the resource allocation problem in sensor node is addressed over Rayleigh fading channels by applying the Nash game approach. Proposed framework is analyzed for feasibility and performance.

Table 1: Summary of different WSN communication techniques

	Title	Author name	Energy efficiency	Remark
1	Feasibility of software-based Duty cycling of GPS for trajectory based services	Xiaohan Li, Fengpeng Yuan and JanneLindqvist	Saves 78% energy when sampling period is increase beyond 120 second	Loss of accuracy stabilize around 23%
2	Energy-Efficient Data Mining Techniques for Emergency Detection in Wireless Sensor Networks	MassinissaSaoudi, AhceneBounceur, Reinhardt Euler, TaharKechadi and Alfredo Cuzzocrea	Reduction in data packet size, reduces energy consumption	High performance and quick result
3	An Adaptive Compression Algorithm for Energy-Efficient Wireless Sensor Networks	Beihua Ying	Optimal energy consumption	Accuracy deviates not more than 5%
4	An environmental air pollution monitoring system based on the IEEE 1451 standard for low cost requirements	N. Kularatna and B. H. Sudantha		Design and implementation of STIM
5	A ZigBee based Energy Efficient Environmental Monitoring Alerting and Controlling System	K.Lokesh Krishna, J.Madhuri, Dr.K.Anuradha	Optimal energy use	Highly robust
6	A Reliable and Efficient Time Synchronization Protocol for Heterogeneous Wireless Sensor Network	MasoumeJabbarifar, AlirezaShameliSendi, AlirezaSadighian, NaserEzzatiJivan, Michel Dagenais	Reduction in energy consumption due to efficient hops	Scalable in unreliable and noisy environments
7	Energy Efficiency in Wireless Sensor Networks	NajmehKamyab Pour	Network architecture map is optimized to reduce energy consumption	Network lifespan is enhanced
8	Optimal Recharging With Practical Considerations in Wireless Rechargeable Sensor Network	Xunpeng Rao, Panlong Yang, Yubo Yan, Hao Zhou, (Member, Ieee), And Xuangou	Total charging time of sensor nodes is decreased by 50%	Good solution for high energy consuming sensor systems
9	An Energy efficient hierarchical clustering technique for wireless sensor network	Kaushledra Kumar Pandey, Bhagyashree Saud, BabliKumari and Sonali Biswas	Efficient energy use by sensor node and cluster, without sacrificing any sensor	Increased network lifetime by 72-89%.
10	Time-pattern design for transmission energy allocation in wireless sensor networks	Feng Li , Li Wang, LiminMeng, Yu Zhang	sensor node retains enough transmission energy for its own sensing task and utilizes energy completely	Smart sensor node behavior is achieved

III. CONCLUSION AND FUTURE SCOPE

Different techniques for reducing energy consumption in WSN are reviewed here. Energy hungry parameters in traditional methods have identified. By modifying these parameters required energy efficient performance can be achieved. Techniques modifying GPS duty cycle have promising future due to high accuracy and real time performance. However, in limited area IEEE standard protocols can serve the purpose.

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