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Research paper

Current Research Impacts in Wireless Sensor Networks

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Abstract

Wireless Sensor Networks (WSN) play vital role in the present era as it provide effective solution to many application. The potential impacts on scientific research and enormous uses of WSN have drawn incredible attention and hence several researches are emerging regarding WSN. This paper is about to categorize new contributions to various fields of WSN. Various contributions are sorted into four classes as Energy, Routing, Security/Control and Applications. Under each group we precisely describe some of the work done. In routing section we have categorized some of the routing protocols. This paper helps to know about the different research interests in WSN.

Keywords: *WSN, Energy, Routing, Security, Applications*

1. Introduction

The development in various fields such as wireless transmission, computational capacity of devices, miniaturized electro mechanical systems have induced the rapid growth of WSN. A WSN is a network consisting of several low power and autonomous sensors that are deployed randomly over a physical environment in ad hoc manner. Every sensor node is equipped with devices to convert observed information into electrical signal, to process and store data, transmission equipment and energy source. Sensor nodes are capable of capturing, processing, gathering and communicating data with other nodes including sink/gateway.

Data accumulated at sink can be accessed via internet, mobile device or a dedicated system. Wireless Sensor Networks support wide range of applications such as surveillance, ambience monitoring, agriculture, tracking, industrial applications, health care, remote monitoring, automated and smart homes, air traffic control, robot controland detection of wildfire.Fig. 1, illustrates the basic architectural diagram of wireless sensor networks.

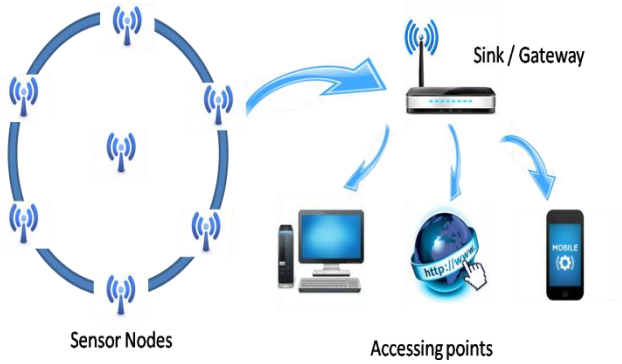

Fig.1: Architecture of WSN

As shown in Fig. 2, from the perspective of various areas of research contribution, this paper provides study of current research evolution on WSN. The current solutions are categorized into four main groups: Energy, Routing, Security/Control and Applications.

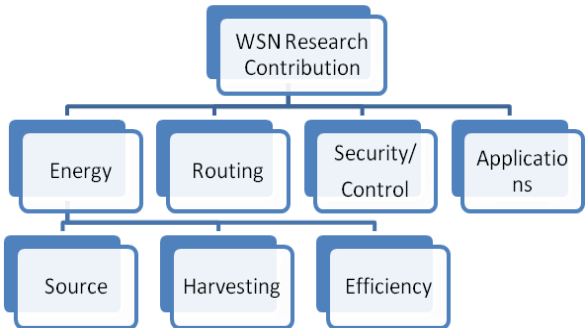

Fig.2 WSN Research Contribution

2. Energy Contribution

Nowadays wireless sensor networks (WSNs) depend on the battery duration, hence energy utilization, finding new energy resource and energy harvesting become important aspects. For the functioning of WSN energy plays vital role and its consumption has to be made optimum.

1.1 Energy Source

Peng Guo et al [1] formulated the Concurrent Charging Scheduling Problem. Aim of the proposed modes is fast and complete power dissemination to sensors.As nodes are equipped with battery, amount of minimum available power is always a major issue. To extend the period, different wireless charging techniques have been developed to give sensor networks additional energy supply.

New advancements in radio energy harvesting techniques, providing supply via a fixed charger is possible.Increased charger's capacity leads to the provisionof long-distance charging. Alternatively many chargers can be deployed at various places to provide power supply simultaneously. These kinds of multiple chargers can be used to increase charge at sensor and to extend the charging area. Parallel charging scheduling problem is formulated. Two efficient greedy algorithms for stable charging and coverage problems are given. A genetic algorithm is designed to address the charging .issue.

1.2. Energy Harvesting

Hongkuan Zhou et al. [2] investigated the source estimation problem. Problem state is a WSN that have energy harvesting devices. Their aim is to approximate calculation of an unfamiliar source during a period of time. Number of available power harvesting devices is considered for this estimation.In the proposed investigation deterministic model and stochastic models are used to analyze energy scheduling. The average mean square error minimization problem is considered and is explored over a finite and infinite horizon for deterministic and stochastic models respectively. Lypunov technique is utilized to obtain better solution.

Mingyuan Gao et al [3] investigated Design, model, simulation, and vibration testing associated to electromagnetic energy harvesters. Renewable energy source become vital in the present era in various applications. Energy gathering is an area that make used of available renewable energy in the ambience. These harvesting techniques can be grouped under one of three main streams such as electrostatic, electromagnetic, and piezoelectric energy harvesters. Energy obtained through vibration of train wheels and rail can be utilized in conversion of vibration energy to electrical energy. An Electromagnetic Harvester device is designed in five setups. Four devices are resonant and one is magnetic rising device.

Han-Bae Kong et al [4] concentrated on energy harvesting from ambient radio frequency sources. Radio Frequency (RF) power harvesting techniques are used to transform energy of RF signals into direct current power. There are two important energy sources which are mainly considered in Radio Frequency energy harvesting networks, namely dedicated and ambient RF sources. In the case of dedicated RF sources, dedicated RF energy transmitters are employed to radiate RF signals which will be converted to address energy need of sensors. The ambient radio frequency sources carry static and dynamic sources. A closed-form statement is provided to find the mean of the collected energy. Network parameters to be considered in calculating the amount of harvested energy are number of the RF bases, transfer energy at the RF bases, the RF - DC power transformationeffectiveness, and so on. Probability density function of the gathered energy and a higherbound of the power outage probability are provided. To determine the power outage probability a semi closed form expression is derived. Both in and out of band transmission are considered.

1.3. Energy Efficiency

Kyeong Soo Kim et al [5] presented an energy efficient time synchronization method. It is to achieve submicrosecond time harmonization accuracy. Major contributions of this work are three-fold: First is minimization of bi directional message transmissions. Secondly, performance measures of the proposed method are described. It provides separate models for logical and physical clocks which help to capture the activeness of the proposed scheme. Recursive updates of a node's logical clock are done based on values measured in its equivalent node. Thirdly, analysis of both regular and inverse bi directional data exchange is done based on estimated time.

3. Routing Contribution

WSN is monitoring systems consist of sensors broadlydistributed in a physical environment. The gathering, transmitting, and processing of detecteddata among several sensors is attainedoverprecise communication protocols. The data is forwarded to the sink through several intermediate nodes. As sink acts as the control point methods to forward data to sink should be optimized. Nature of the network, cause of deployment is to be considered while designing the routing schemes.Fig.3 represents a routing scenario in WSN.

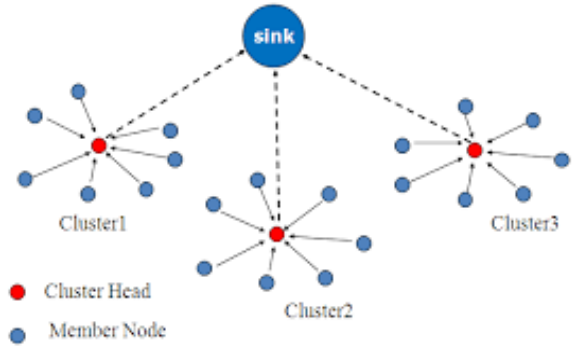

Fig.3: Routing scenario in WSN

Xiangling Li et al [6] proposed a dynamic cooperative multi-input multi-output based routing algorithm. Aim of the proposed algorithm is to save energy. Information gathering using Comprehensive Sensing in multi-hop WSN is considered for this investigation. Random walks are employed for data compression. This can be used to provide better measure of the reconstruction accuracy of Compressive Sensing. Different communication modes are adapted to save energy in each hop in each walk. The number of transmitters and receivers as well as the set of the Cooperative Nodes is optimized. For simplicity, virtual multi-input single-output model is considered. Since variations in transmission distances influence the route optimization, it is considered to derive number of the transmitters.

Min-Te Sun et al [7] proposed an algorithm, named Articulation Points (AP) Collaborative Exploration. The proposed algorithm finds

articulation points which are a subset of nodes to send information inside that subset. A node will be able to decide that whether it is an articulation point or not. This decision is taken by observing probes.AP learns about the physical structure of node deployment with in the subset. The proportion of time spent for communicating with all nodes is saved by the proposed method. This leads to more availability of bandwidth and improved transmission power. Hence we can achieve higher network efficiency.

In the proposed algorithm, as the initiation of complete process, some nodes are considered as initiators that sends probe packets to all other nodes. The collaborative mechanism presented in this paper consists of three major modules. In initiator election and initialization phase initiators are selected for exploration. In this method nodes advertise their neighbor density. The nodes with smaller number of neighbor nodes are selected as initiators. In collaborative exploration phase a node that received exploration message from its neighbor starts the procedure. Tree table updating is taken place on the reception of that message and decision making regarding sending that message back or to send it to other neighbor based on the time to live value is done. In articulation point identification phase articulation point is selected based on the proposed theorem. They have given the theorem to find articulation point along with the proof. Based on number of neighbor and hop count of the children node the articulation point is selected.

Hongyu Gong et al [8] proposed a distributed algorithm, Toward Source Tree Algorithm, to build a multicast tree. It is an approximate shorter distance multicast tree representation. Aim of the proposed algorithm is to reduce energy consumption, to implement easily and to reduce computational complexity. The algorithm is designed at areasonablerate on the sub-optimality of tree span. The wireless sensor network, sensor nodes are considered as a Graph and Vertices of graph respectively. Communication link between nodes is considered as Edge that connects two vertices. Steiner Tree problem is used to find a sub graph in the given graph with no loops. This sub graph is a tree that covers certain nodes with total minimum cost. A mathematical approach is used to represent the network.The proposed algorithm has three stages. In the first stage, the originating nodes send an alert message to all nodes that are chosen to activate specific receivers. In the next phase, every receiver chooses the neighbor receiver that has the shortest distance from the receiver as well as shortest length to the source. A virtual topology that consists of all receivers is constructed.Suitableintermediate nodes are nominated to retainmulticast group members while monitoring the tree length. Loops are eliminated to minimize tree length and to evaderepeated transmissions. The proposed algorithm does not consider QOS metrics and is designed for stationary networks and mobile networks are not considered.

Yunquan Dong et al [9] offered a cluster-based routing protocol referred to as the Distance and Energy Aware Routing with Energy Reservation. This protocol is designed to handle the issue of energy deficiency at cluster head nodes. Cluster based routing protocols for Energy Harvesting WSN (EHWSN) is considered. In this model cluster heads are selected based on the space to the sink and max energy-arrival speed. Non cluster head nodes are allowed to store a part of the collected energy for forthcoming use. In this system, network function in series of stages. In each stage nodes are specified as cluster heads and non-cluster heads. Node that consume lower energy in transmission to sink and that more resist to energy shortage has higher chance to become cluster heads. The protocol's cluster selection process is energy and distance aware. An energy storage policy is proposed in order to address energy shortage problems in cluster head. This methodology is to enhance the network lifetime. A model to assess the performance of routing algorithms in EHWSN is presented. Self-centered nodes may attain their best individual transmission ratio if they avoid serving as cluster heads. The table, Table.1 precisely describes, various algorithms used for routing approach.

4. Security/Control Contribution

Sabato Manfredi et al [10] framed a distributed control algorithm of node transmission range in order to reduce the network energy depletion that permits to prolong the life of the overall Energy Harvesting – Wireless Sensor Network system and to maximize the network connectivity which rises the performance of the monitoring/control algorithm. They proposed DERC – Distributed Energy-based Radii Control algorithm. The proposed solution is formulated without considering QOS and propagation delay.

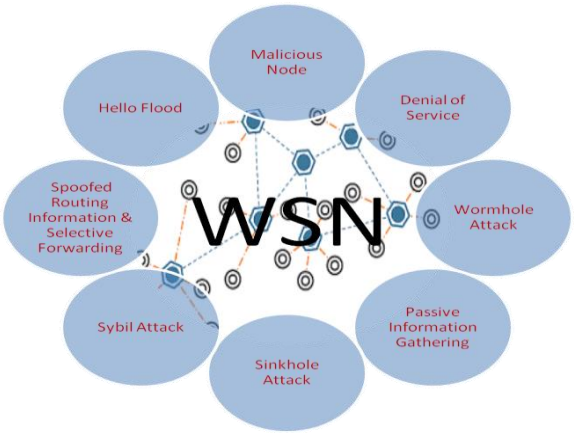

Fig. 4: Security threats in WSN

Table.1: Analysis of Various Routing Approaches

S.no	Routing Approach	Algorithm	Goal	Snags
1	Fault tolerant and Energy-aware [16]	DEFTR	To achieve equal sized network partitions and to design multi-facet routing protocol	Mobility of nodes
2	Energy balanced position-based [17]	FSS	Selection of best relay node based on the remaining energy, number of nodes, distance, and angle.	QoS
3	Energy-aware distributed [18]	DEEHC	Selects the CHs to setup a connected backbone network	Path Selection
4	Latency optimization [19]	Optimal Scheduling Algorithm	Finds the scheduling with the minimal latency	Uni path
5	Energy-Efficient Heterogeneous Ring Clustering[20]	E2HRC	To solve the energy balance problem in original RPL	Selection of cluster head
6	Lifetime Maximization[21]	Hamiltonian	Optimal control problems are formulated	Properties are considered for single mobile node

8	Distributed Multicast Tree [8]	TST	To construct an approximate minimum-length multicast tree	Designed for static networks

WSNs are scattered ad hoc networks with a wide range of applications in surveillance and environment observing. Fig.4 shows possible security threats for WSN. Providing security to network and captured data is one of the most important aspects. Mohammad Sayad Haghighi et al [11] studies data dissemination forms in sensor networks. A model to represent unsecure points is developed using mathematical approach. Method to show the way of providing coverage to vulnerable places is proposed. A mathematical approach is developed to show the changes of data dissemination in wireless sensor networks. Shape of boundary on malware transmission has significance effect. To explain this scenario curved boundaries are introduced and patch deployment is analyzed. An approach that originates from low level sensor nodes and grows to cover whole network is designed. Geometrical constraints are considered. Patch positioning analysis is used to find best positions to insert patches. Anti-malware program is used for fixing the issue. Affected network is recovered by covering or eliminating the worm/virus. Factors such as structure of the network, rate of issue and time taken to identify location influences on the best position to initiate patching from.

Vittorio P. Illiano et al [12] proposed a technique for discovery of malicious data additions. It is measured in the existence of refined collusion schemes.They highlighted that identifyingirregularities in the measurements is not enough to efficientlyavoid them. Method to identify the changes in the malicious extentsas well as affected nodes is given. The recognized anomalies are analyzed. Genuine faults may occur during failure of one or more sensors.

Measurements of such nodes will not associate with those of unaffected sensors. This situation may cause an incorrectinference that there was an attack. By exactly describing main features of genuine faults it is possible to understand when the difference is most likely malicious. A comprehensiveprocedure to deal with detecting, characterizing and analyzing malicious data injections in WSNs is proposed. The method is tested for its soundness on following datasets – artificial set of heat quantities in a wildfire observing WSN and anactual dataset of seismic quantities in an earthquake observing WSN.

5. Application Contribution

As sensor networks has potential impact on new scientific era its applications grows tremendous. Observing - Environment, habitat, greenhouse, climate, automation of home, city and industries, water monitoring and personal health monitoring are few promising applications of sensor networks.

Erik Aguirre et al [13] analyzed urban railway transport system. They have considered characteristic of the wireless medium and its effect on quality of the system for the analysis. The goal is to provide environment awareness for train passengers. The user density, inter wagon communication, intra wagon communication, wagon to infrastructure operation, communication disturbance level and elements used for communication are considered to deploy the wireless sensor network. After the analysis an Android mobile application is implemented to provide solution.A neat System Architecture is given. WSN motes can be placed inside the wagon, train stops and communication gateways. These gateways are generally access points to public or local wireless utilities.The system can be expanded when there is an increase in number of passengers and also during increased usage. Fig 5 lists the major applications of WSNs.

Fig. 5: Applications of WSN

Alessandro Lo Schiavo et al [14] presented a wireless sensor network for aboard observing of railway freight wagons. In this network all the nodes are energetically independent. Sensor nodes as well as sink node are provided with energy harvesting system. Such setup is recommended to get autonomous networks [15] for each wagon. Hence several issues related to a single network for the whole train can be addressed, but it essentials a noteworthy reduction of the energy depletion of the sink node. This reduction should not affect the quality of service [16]. To achieve this, authors proposed a communication scheme that alters activeness of a node, an advanced management scheme for GPS, an optimized management scheme of sleep mode by a consumption model of the GPRS transceiver.

6. Conclusion

As the need of wireless sensor is a rapidly growing, new research contribution in WSN leads towards the development of several efficient applications. This paper is to highlight major challenges and recent works to address those challenges in WSN. The analysis of routing techniques will be helpful to understand the various challenges of routing in wireless sensor networks, important solutions and algorithms that are proposed.

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