Applications and Techniques in Wireless Sensor Networks: A Survey

K . Vijaya Bhaskar [#1]
[1#] Research Scholar,
Dept of Computer science
SV University,
TIRUPATI, AP, India

Dr . R . Seshadri [*2]
[2*] Professor & Director,
Computer Centre , SV University,
TIRUPATI, AP, India

Dr . A . Rama mohan Reddy[@3]
[3@] Professor , Dept of CSE,
SV College of Engineering ,
SV University,
TIRUPATI, AP, India

***Abstract*— A Wireless Sensor Network (WSN) can be quite a wireless network including things like spatially distributed autonomous devices designed to use sensors for watching and recording the physical conditions from the surroundings and organizing the gathered information with a location. the idea of sensor networks which includes been adapted viable from the convergence of micro-electro-mechanical systems technology, wireless communications and digital electronics. First, the sensing tasks as well as the potential sensor networks applications are explored, along with a review of things influencing the planning of sensor networks is provided. Because of this problem, every solution elaborated for these networks needs to be aimed towards minimizing the energy consumption. This paper provides short summary of the energy consumption techniques of energy-efficient topologies for wireless sensor networks.**

Keywords— wireless sensor, Networking, Security, Attacks. Routing.

I. INTRODUCTION

Sensor networks may contain many different types of sensors for instance seismic, low sampling rate magnetic, thermal, visual, infrared, acoustic and radar, which can be capable to monitor lots of ambient circumstances which include the subsequent[14]:

- Temperature,
- Humidity,
- Vehicular movement,
- Lightning condition,
- Pressure,
- Soil makeup,
- Noise levels,
- The presence or lack of some types of objects,
- Mechanical stress ranges on attached objects, and
- The present characteristics including speed, direction, and sized an object.

Sensor nodes may be used for continuous sensing, event detection, event ID, location sensing, and local control of actuators. The technique of micro-sensing and wireless connection of the nodes assurance many new application areas. We classify the applications straight into military, environment, health, home along with other commercial areas. You are able to expand this classification with an increase of categories for instance space exploration, chemical processing and disaster relief.

1.1. Military applications

Wireless sensor networks is definitely an integral a part of military command, control, communications, computing, intelligence, surveillance, reconnaissance and targeting (C4ISRT) systems. The rapid deployment, self-organization and fault tolerance characteristics of sensor networks make sure they are a very ensuring sensing technique for military C4ISRT. Since sensor networks depend on the dense deployment of non reusable and low-cost sensor nodes, destruction of some nodes by hostile actions has no effect on a military operation just as much as the destruction of the traditional sensor, making sensor networks concept an improved method for battlefields. Many of the military applications of sensor networks are keeping track of friendly forces, equipment and ammunition; battlefield surveillance; reconnaissance of opposing forces and terrain; targeting; battle damage assessment; and nuclear, biological and chemical (NBC) attack detection and reconnaissance.

1.1.1 Keeping track of friendly forces, equipment and ammunition:

Leaders and commanders can constantly monitor the status of friendly troops, the situation as well as the accessibility to the equipment and also the ammunition in a very battlefield through sensor networks. Every troop, vehicle, equipment and critical ammunition could be attached with small sensors that report the status. These reports are gathered in sink nodes and delivered to the troop leaders. The information may also be forwarded for the upper quantity of a command hierarchy while being aggregated with all the data from other units each and every level.

1.1.2 Battlefield surveillance:

Critical terrains, approach routes, paths and straits might be rapidly covered with sensor networks and monitored for that activities from the opposing forces. Because the operations evolve and new operational plans have decided, new sensor networks may be deployed anytime for battlefield surveillance.

1.1.3 Reconnaissance of opposing forces and terrain:

Sensor networks is usually deployed in critical terrains, and several valuable, detailed, and timely intelligence concerning the opposing forces and terrain may be gathered in minutes prior to the opposing forces can intercept them.

1.1.4 Targeting:

Sensor networks might be integrated into guidance systems with the intelligent ammunition.

1.1.5 Battle damage assessment:

Prior to or after attacks, sensor networks might be deployed within the target area to get together the battle damage assessment data.

1.1.6 Nuclear, biological and chemical attack detection and reconnaissance:

In chemical and biological attack, staying close to ground zero is very important for timely and accurate detection with the agents. Sensor networks deployed inside the friendly region and used as being a chemical or biological warning system provides the friendly forces with critical response time, which drops casualties substantially. We are able to just use sensor networks for detailed reconnaissance after an NBC attack is detected. For example, we are able to produce a nuclear reconnaissance without exposing a recce team to nuclear radiation.

1.2. Environmental applications:

Some environmental applications of sensor networks include tracking the movements of birds, small animals, and insects; monitoring environmental conditions that affect crops and livestock; irrigation; macro instruments for large-scale Earth monitoring and planetary exploration; chemical/ biological detection; precision agriculture; biological, Earth, and environmental monitoring in marine, soil, and atmospheric contexts; forest fire detection; meteorological or geophysical research; flood detection; bio-complexity mapping with the environment; and pollution study [27,32,37,1,2,44,5,52,11,12 ,28,53,46,8,25].

1.2.1 Forest fire detection:

Since sensor nodes could be strategically, randomly, and densely deployed within a forest, sensor nodes can relay the exact origin from the fire towards the end users before the fire is spread uncontrollable. An incredible number of sensor nodes could be deployed and integrated using radio frequencies/optical systems. Also, they could be designed with effective power scavenging methods [3], for example solar cells, considering that the sensors might be left unattended for months and also years. The sensor nodes will collaborate with one another to accomplish distributed sensing and overcome obstacles, for instance trees and rocks, that block wired sensors' line of view.

1.2.2 Biocomplexity mapping from the environment [2]:

A biocomplexity mapping with the environment requires sophisticated methods to integrate information across temporal and spatial scales [33,7]. The advances of technology within the remote sensing and automated data collection have enabled higher spatial, spectral, and temporal resolution with a geometrically declining cost per unit area [49]. In addition to these advances, the sensor nodes also provide the opportunity to connect to the Internet, that allows remote users to manage, monitor and take notice of the biocomplexity from the environment.

Although satellite and airborne sensors are helpful in observing large biodiversity, e.g., spatial complexity of dominant plant species, they may not be fine grain enough to look at small size biodiversity, helping to make up the majority of the biodiversity within an ecosystem [51]. Consequently, there exists a requirement of ground level deployment of wireless sensor nodes to see the biocomplexity [36,35]. One of these of biocomplexity mapping with the environment is finished for the James Reserve in Southern California [2]. Three monitoring grids with each having 25100 sensor nodes is going to be implemented for fixed view multimedia and environmental sensor data loggers.

1.3 Flood detection [41]:

One particular flood detection may be the ALERT system [24] deployed in the US. Various kinds sensors deployed within the ALERT system are rainfall, groundwater level and weather sensors. These sensors supply information towards the centralized database system within a pre-defined way. Research projects, including the COUGAR Device Database Project at Cornell University [41] and also the Data Space project at Rutgers [50], are investigating distributed approaches in getting together with sensor nodes within the sensor field to deliver snapshot and long-running queries. Precision Agriculture: A few of the benefits may be the capability to monitor the pesticides level from the drinking water, the quality of soil erosion, as well as the amount of air pollution in real time.

1.4. Health applications

A few of the health applications for sensor networks are offering to you interfaces with the disabled; integrated patient monitoring; diagnostics; drug administration in hospitals; monitoring the movements and internal processes of insects or other small animals; telemonitoring of human physiological data; and keeping track of and monitoring doctors and patients inside of a hospital [37,28,38,29,8]. Telemonitoring of human physiological data: The physiological data collected through the sensor networks might be stored for a long time [42], and may be taken for medical exploration [34]. The installed sensor networks could also monitor and detect seniors's behavior, e.g., a fall [9,20]. These small sensor nodes permit the subject a better freedom to move and enable doctors to recognize pre-defined symptoms earlier [54]. Also, they facilitate a greater quality lifestyle for that subjects when compared to treatment centers [40]. A ''Health Smart Home'' was created within the Faculty of Medicine in Grenoble France to validate the feasibility of such system [38].

1.4.1 Tracking and monitoring doctors and patients within a hospital:

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Each patient has small , light-weight sensor nodes mounted on them. Each sensor node have their specific task. For example, one sensor node could possibly be detecting the heart rate while another is detecting hypertension. Doctors might also carry a sensor node, that allows other doctors to find them inside the hospital.

1.4.2Drug administration in hospitals:

If sensor nodes could be attached with medications, the chance of getting and prescribing an incorrect medication to patients might be minimized. Because, patients could have sensor nodes that identify their allergies and required medications. Computerized systems as described in [6] show that they'll help minimize adverse drug events.

1.5. Home applications:

1.5.1 Home automation:

As technology advances, smart sensor nodes and actuators may be buried in appliances, for example vacuum cleaners, micro-wave ovens, refrigerators, and VCRs [16]. These sensor nodes within the domestic devices can communicate with one another along with the external network through the Internet or Satellite. They permit end users to handle home devices locally and remotely with less effort.

1.5.2 Smart environment:

The design of smart environment may have two different perspectives, i.e., human-centered and technology-centered [22]. For human-centered, a good environment needs to accommodate the requirements of the end users when it comes to input/ output capabilities. For technology-centered, new hardware technologies, networking solutions, and middleware services must be developed. A scenario of how sensor nodes may be used to produce a smart environment is described in [10]. The sensor nodes might be embedded into furniture and appliances, and they also can communicate with one another as well as the room server. The room server also can communicate with other room servers to understand about the services they offered, e.g., printing, scanning, and faxing. These room servers and sensor nodes could be integrated with existing embedded devices to become self-organizing, self-regulated, and adaptive systems according to control theory models as described in [10]. Another demonstration of smart environment may be the ‘‘Residential Laboratory’’ at Georgia Institute of Technology [26]. The computing and sensing within this environment must be reliable, persistent, and transparent.

1.6 Other commercial applications:

A few of the commercial applications are monitoring material fatigue; building virtual keyboards; managing inventory; monitoring product quality; constructing smart office spaces; environmental control in office buildings; robot control and assistance within automatic manufacturing environments; interactive toys; interactive museums; factory process control and automation; monitoring disaster area; smart structures with sensor nodes embedded inside; machine diagnosis; transportation; factory instrumentation; local management of actuators; detecting and monitoring car thefts; vehicle tracking and detection; and instrumentation of semiconductor processing chambers, rotating machinery, wind tunnels, and anechoic chambers [27,37,44,14,13,28,39, 23,29,15,8].

1.6.1 Environmental control in office buildings:

The air conditioning and also heat on most buildings are centrally controlled. Therefore, the temperature in a very room can differ by few degrees; one side may be warmer compared to other since there is just one control within the room as well as the air flow through the central strategy is not distributed. A distributed wireless sensor network system may be installed to manage the air flow and temperature around the room. It's estimated that such distributed technology can reduce energy consumption by two quadrillion British Thermal Units (BTUs) in the US, which amounts to saving of $55 billion per year and reducing 35 million metric a lot of carbon emissions [29].

1.6.2 Interactive museums:

Later on, children should be able to communicate with objects in museums to understand more about them. These objects should be able to interact with their touch and speech. Also, children can participate in real time cause-and-effect experiments, which may help them learn about science and environment. Additionally, the wireless sensor networks provides paging and localization within the museum. An example of such museums may be the San Franciso Exploratorium which includes a variety of data measurements and cause- and-effect experiments [29].

1.6.3 Detecting and monitoring car thefts:

Sensor nodes are now being deployed to detect and identify threats inside a geographic region and report these threats to remote end users through the Internet for analysis [23].

1.6.4 Managing inventory control:

Each item in a very warehouse could have a sensor node attached. The end users can find out the exact location with the item and tally the amount of items in a similar category. When the end users desire to insert new inventories, all of the users have to do is always to attach the proper sensor nodes towards the inventories. The end users can keep track of and locate in which the inventories are in all times.

1.6.5 Vehicle tracking and detection:

There's two approaches as described in [15] to follow and detect the vehicle: first, the line of bearing from the vehicle is established locally inside the clusters after which it can be forwarded towards the base station, and second, the raw data collected through the sensor nodes are forwarded for the base station to determine the location with the vehicle.

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II. LITERATURE REVIEW

2.1 Wireless Sensor Network:

A Review I.F. Akyildiz et al.. [18] performed a survey on wireless sensor networks in 2002. Previous works concentrate wired sensor network concepts and architecture. But, this paper described the concept of Wireless sensor networks which includes been made practical through the convergence of MEMS Technology, wireless communications and digital electronics. Then, the communication architecture for sensor networks is outlined, and also the algorithms and protocols developed for every layer within the literature are explored. In the future, this lots of application areas can make sensor net works an integral part of our everyday life.

F. L. Lewis [19] conducted an evaluation on wireless sensor networks in 2004. This paper performed an overview on wireless sensor network technologies, protocols and applications. Later on, conduct a review according to wireless sensor network routing techniques, power consumption techniques, IEEE standards and MAC protocols.

Jennifer Yick et al.. [30] performed a survey on wireless sensor network in 2008. The objective of survey is always to present an extensive overview of the recent literature because the publication of [I.F. Akyildiz et al.., A survey on sensor networks, IEEE Communications Magazine, 2002]. This paper described and compared different proposed designs, algorithms, protocols, and services. Moreover, we have now highlighted possible improvements and research in each area.

2.2 Energy Consumption in Wireless Sensor Network:

An overview Giuseppe Anastasi et al..[21] presented a survey on energy conservation in wireless sensor networks in 2009. Sensor nodes are usually battery-powered devices, the critical aspects to manage concern how you can reduce the energy usage of nodes, so that the network lifetime might be extended to reasonable times. In this particular paper first break down the energy consumption for that different parts of a standard sensor node, and discuss the primary directions to energy conservation in WSNs. Then, present a systematic and comprehensive taxonomy with the energy conservation schemes, which can be subsequently discussed thorough.

Sidra Aslam et al.. [47] projected power consumption in wireless sensor networks in 2010. Much studies have been carried out design schemes for power conservation and power management in sensor nodes upon all layers of protocol stack. To improve sensor node's lifetime, integration of harvesting technologies, low power sensor network design, and energy-conscious protocols is mandatory. Therefore, generic cross-layer optimization techniques are needed to fulfill applications demands. The objective of this research is always to present and discuss several strategies for instance power-aware protocols, cross-layer optimization, and harvesting technologies utilized to alleviate power consumption constraint in WSNs.

Zahra Rezaei and Shima Mobininejad [55] performed an energy saving in wireless sensor networks in 2012. Sensors is not easily replaced or recharged because of the ad-hoc deployment in dangerous environment. Given that energy saving behave as one of several hottest topics in wireless sensor networks. Because of this, this paper focused mainly on duty cycling schemes which represent one of the most compatible technique for energy saving as well as target the data-driven approaches which you can use to enhance the energy efficiency. Later on, need to analyze most of mobility model.

2.3 Routing Protocols for Wireless Sensor Network:

A Review In the year of 2003 Stefan Dulman et al.. [45] introduced the reliability in multipath routing for wireless sensor network. In wireless sensor networks (WSN) data produced by a number of sources normally has being routed through several intermediate nodes to succeed in the destination. Problems arise when intermediate nodes neglect to forward the incoming messages. The reliability with the system might be increased by giving several paths from source to destination and sending exactly the same packet through all of them. Applying this technique, the traffic increases significantly. Because of this reason, analyze a different mechanism that allows the tradeoff involving the quantity of traffic along with the reliability. The data packet is split in k sub packets (k = number of disjoined paths from source to destination). If perhaps Ek sub packets ($Ek < k$) are essential to rebuild the main data packet, then this trade-off between traffic and reliability might be controlled. The near future work is targeted on finding methods for estimating the failing probability of each node.

Kemal Akkaya and Mohamed Younis [31] performed a survey on routing protocols for wireless sensor networks in 2005. Recent advances in wireless sensor networks have resulted in many new protocols specifically made for sensor networks where energy awareness is a vital consideration. The majority of the routing protocols they may differ according to the application and network architecture. This paper surveys recent routing protocols for sensor networks and presents a classification for that various approaches pursued. The three main categories explored within this paper are data-centric, hierarchical and location-based. Each routing protocol is explained and discussed within the appropriate category. Other possible future research for routing protocols includes the integration of sensor networks with wired networks (i.e. Internet).

Ewa Niewiadomska-Szynkiewicz et al.. [17] conducted a comparative study of wireless sensor networks energy-efficient topologies and power save protocols in 2009. In existing survey conducted based on only topologies and protocols for wireless sensor network. Proposed paper provided the short introduction to the energy conservation techniques and algorithms for calculating energy-efficient topologies for wireless sensor networks. The energy conservation techniques and algorithms for computing the optimal transmitting ranges to be able to generate a network with desired properties while reducing sensors energy consumption are discussed and compared through simulations

Ali Norouzi et al.. [4] proposed a novel energy-efficient routing protocol in wireless sensor networks in 2011. A primary issue of gossiping is when to assign time slots to nodes for interference-free data transmission. Because of this reason, this paper proposed a whole new routing protocol according to Gossiping called Fair Efficient Location-based Gossiping (FELGossiping) to enhance the issues of Gossiping and it is extensions. FELGossiping includes three phases: Initialization, Information Gathering and Routing. Later on, introduce a “Green Wireless Networks” routing protocol that optimizes energy consumption and bandwidth.

Smriti Joshi and Anant Kr. Jayswal [48] projected a review on energy-efficient MAC protocol for wireless sensor networks in 2012. Influencing through the design principles of traditional layered protocol stack, current MAC protocol designing for wireless sensor networks (WSN) seldom takes load balance into consideration, which greatly restricts WSN lifetime. This paper, a novel forwarding election-based MAC protocol is presented to extend WSN lifetime through improving energy efficiency and enhancing load balance. This paper gives the performance analysis of all of the protocols which have been proposed for wireless sensor networks till date. Further work should include the issues of those MAC protocols.

Sourabh Jain et al.. [49] proposed an energy efficient maximum lifetime routing algorithm for wireless sensor networks in 2012. For maximizing the duration of these nodes most routing algorithm in wireless sensor networks uses the energy efficient path. These energy efficient routing algorithms decide on a best path for data transmission and consume less energy. But an individual best path puts extra load with a specific node causing lower lifetime. This paper proposes an energy efficient maximum lifetime routing algorithm. It can be with different greedy heuristic method to maximize duration of the system. For achieving maximum system lifetime proposed algorithm uses the energy expense of links for constructing energy efficient path. In future work, concentrate some security mechanism.

III. CONCLUSION:

Later on, this lots of application areas will always make sensor networks a fundamental portion of our everyday life. However, conclusion of sensor networks needs to meet the constraints introduced by factors like fault tolerance, scalability, cost, hardware, topology change, environment and power consumption. Review is carried out depending on following categories: wireless sensor network methods, energy consumption in wireless sensor networks, routing protocols for wireless sensor networks. This survey concludes with all the suggestions towards the future direction within the energy efficiency model for that sensor networks.

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IV. ABOUT AUTHORS

K.Vijaya Bhaskar Presently he is pursuing Ph.D in Computer Science, S.V.University, TIRUPATI. His main research interest includes wireless sensor, Computer Networks, Security, Attacks. Routing.

Dr.R.Seshadri Working as Professor & Director, University Computer Centre, Sri Venkateswara University, Tirupati. He was completed his PhD in S.V.University in 1998 in the field of "Simulation Modeling & Compression of E.C.G.Data signals (Data compression Techniques) Electronics & Communication Engg.". He has richest of knowledge in Research field; he is guiding 10 Ph.D in Fulltime as well as Part time. He has vast experience in teaching of 26 years. He published 15 national and international conferences and 24 papers published different journals.

Dr. A. Rama Mohan Reddy, obtained his Bachelor Degree in Mechanical Engineering and Master's degree in Computer Science Engineering from NIT Warangal and Ph.D degree from Sri Venkateswara University and at present working as an Professor in Department of Computer Science and Engineering, Sri Venkateswara University College of Engineering. His areas of interest include Software Architecture and data mining. He has more than 27 years of experience in teaching and research.