Wireless Sensor Networks: A survey

M.Govindrajan

Master of Computer Science and Engineering

KSR College of Engineering

Tiruchengode, India

Mr.P.Balamurugan M.E,

Associate Professor, Department of CSE

KSR College of Engineering

Tiruchengode, India.

***Abstract*—Wireless Sensor Network (WSN) is an important application such as remote environmental monitoring and target tracking. This has Wireless sensor Network is provide ability with availability, of sensors that are smaller, cheaper, and intelligent. Recent research in Wireless Sensor Network involving urban areas that are covered by Sensor Nodes (SN) that are monitoring by the environmental parameters. Mobile Sinks (MS) is nothing but node which is fixed in moving vehicles or animals providing most suitable conveniences to effectively retrieve data from Wireless Sensor Networks fields. In that Energy efficient and data collection of the Sensor Nodes are the important suggest problem of the Wireless Sensor Networks. To make efficient data collection Mobile Sink that are roaming around the Sensor Island and collecting data's in Multi hop Network using clustering. We review the major development of low energy consumption and efficient data collection in Wireless Sensor Networks.**

Keywords-Wireless sensor network; Clustering; Mobile Sink; Multi hop Network

I. INTRODUCTION

In recent years, Wireless Sensor Networks (WSNs) has attracted a lot of attentions from researchers in both academic and industrial communities. WSNs can be used to form the fundamental sensing and network infrastructure for pervasive computing environments. A WSN consists a collection of sensor nodes and a sink node connected through wireless channels, and can be used to build distributed systems for data collection and processing. WSN consist of four main components: A radio, a processor, sensors and battery. A WSN is formed by densely deployed sensor nodes in an application area. In most deployments, the sensor nodes have Self-organizing capabilities, to form an appropriate structure in order to collaboratively perform a particular task. Wireless Sensor Networks are found suitable for applications such as surveillance, precision agriculture, smart homes, automation, vehicular traffic management, habitat monitoring, and disaster detection. A WSN typically has little or no infrastructure. It consists of a number of sensor nodes (few tens to thousands) working together to monitor a region to obtain data about the environment. There are two types of WSNs:

- Unstructured
- Structured

An **unstructured** WSN is one that contains a dense collection of sensor nodes. Sensor nodes may be deployed in an ad hoc manner into the field. Once deployed, the network is left unattended to perform monitoring and reporting functions. In an unstructured WSN, network maintenance such as managing connectivity and detecting failures is difficult since there are so many nodes.

In a **structured** WSN, all or some of the sensor nodes are deployed in a pre-planned manner. The advantage of a structured network is that fewer nodes can be deployed with lower network maintenance and management cost. Fewer nodes can be deployed now since nodes are placed at specific locations to provide coverage while ad hoc deployment can have uncovered regions. Most of the Wireless, Sensor Networks (WSN) work is similar to the operation of Ad-Hoc networks. That means without any infrastructure nodes are communicating or exchanging data between Mobile Sink (MS) to Sensor Island. To illustrate this point, the differences between sensor networks and ad hoc networks are outlined below:

- The number of sensor nodes in a sensor network can be several orders of magnitude higher than the nodes in an ad hoc network.
- Sensor nodes are densely deployed.
- Sensor nodes are prone to failures.
- The topology of a sensor network changes very frequently.

• Sensor nodes are limited in power, computational capacities, and memory.
• Sensor nodes may not have global identification (ID) because of the large amount of over head and large number of sensors

Since large numbers of sensor nodes are densely deployed, neighbor nodes may be very close to each other. Hence, multi hop communication in sensor networks is expected to consume less power than the traditional single hop communication. Furthermore, the transmission power levels can be kept low, which is highly desired in covert operations. Multi hop communication can also effectively overcome some of the signal propagation effects experienced in long-distance wireless communication. One of the most important constraints on sensor nodes is the low power consumption requirement. Sensor nodes carry limited, generally irreplaceable, power sources. Therefore, while traditional networks aim to achieve high quality of service (QoS) provisions, sensor network protocols must focus primarily on power conservation. They must have inbuilt trade-off mechanisms that give the end user the option of prolonging network lifetime at the cost of lower throughput or higher transmission delay.

II. SENSOR NETWORK APPLICATIONS

Sensor networks may consist of many different types of sensors such as seismic, low sampling rate, Magnetic, thermal, visual, infrared, acoustic and radar, which are able to monitor a wide variety of ambient conditions that include the following [1]:

- Temperature,
- Wetness,
- Vehicular movement,
- Lightning condition,
- Pressure,
- Soil makeup,
- Noise levels,
- The presence or absence of certain kinds of objects,

Sensor nodes can be used for continuous sensing, event detection, event identification, and location sensing, activation control. The concepts of micro-sensing and wireless connection of these nodes promise new application areas.

A. Military Applications

Wireless sensor networks are the primary skill of military command, control, communications, computing, intelligence, surveillance, and targeting systems. In Sensor networks are sensors are closely placed together and move into position for military actions of disposable and low-cost sensor nodes, destruction of some nodes by military enemies that does not affect a military operation as much as the destruction of a traditional sensor, which makes sensor networks concept a better approach for battlefields. Some of the military applications of sensor networks are:

1) *Monitoring Friendly Forces and equipment supply:* Leaders and commanders can constantly monitor the status of friendly troops, the condition and the availability of the equipment and the ammunition in a battlefield by the use of sensor networks. Every troop, vehicle, equipment and critical ammunition can be attached with small sensors that report the status. These reports are gathered in sink nodes and sent to the troop leaders. The data can also be forwarded to the upper levels of the command hierarchy while being aggregated with the data from other units at each level.

2) *Battlefield Surveillance:* Critical lands, planning routes, paths and straits can be rapidly covered by the sensor networks and closely watched for the activities of the opposing forces. As the operations evolve and new operational plans are prepared, new sensor networks can be deployed anytime for battlefield surveillance.

3) *Battle Damage Assessment:* Just before or after attacks, sensor networks can be deployed in the target area to gather the battle damage assessment data.

B. Environmental Applications

Some environmental applications of sensor networks include tracking the movements of birds, small animals, and insects; monitoring the 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; *Forest fire detection:* Since sensor nodes may be strategically, randomly, and densely deployed in a forest, sensor nodes can relay the exact origin of the fire to the end users before the fire is spread uncontrollable . Millions of sensor nodes can be deployed and integrated using radio frequencies/ optical systems.#

Also, they may be equipped with effective power scavenging [2] methods, such as solar cells, because the sensors may be left unattended for months and even years. The sensor nodes will collaborate with each other to perform distributed sensing and overcome obstacles, such as trees and rocks that block wired sensors line of sight.

1) *Flood Detection:* An example [3] of flood detection is the ALERT systems are deployed in the flood areas. Several types of sensors deployed in the ALERT system are rainfall, water level and weather sensors. These sensors supply information to the centralized database system in a pre-defined way. Distributed approaches in interacting with sensor nodes in the sensor field to provide snapshot and long-running queries.

2) *Precision Agriculture:* Some of the benefits are the ability to monitor the pesticides level in the drinking water, the level of soil erosion, and the level of air pollution in real time.

C. Health Applications

Some of the health applications for sensor networks are providing interfaces for the disabled; integrated patient monitoring; diagnostics; drug administration in hospitals; monitoring the movements and internal processes of insects or other small animals; tele monitoring of human physiological data; and tracking and monitoring doctors and patients inside a hospital.

1) *Tele Monitoring of Human Physiological Data*: The physiological data collected by the sensor networks can be stored for a long period of time, and can be used for medical exploration [4]. The installed sensor networks can also monitor and detect elderly people's behavior, for example a fall. These small sensor nodes allow the subject a greater freedom of movement and allow doctors to identify pre-defined symptoms earlier. Also, they facilitate a higher quality of life for the subjects compared to the treatment centers.

2) *Tele monitoring of Human Movements data*: The Movement data collected by the sensor networks can be stored for a long period of time, and can be used for monitoring movements and also

The installed sensor networks can also monitor and detect elderly people's behavior, for example, escaping. These small sensor nodes allow the subject a greater freedom of movement and allow head to identify pre-defined symptoms earlier. Also, they facilitate a higher quality of life for the subjects compared to the treatment centers.

3) *Tracking and Monitoring Doctors and Patients inside a Hospital:* Each patient has small and light weight sensor nodes attached to them. Each sensor node has its specific task. For example, one sensor node may be detecting the heart rate while another is detecting the blood pressure. Doctors may also carry a sensor node, which allows other doctors to locate them within the hospital.

4) *Drug Administration in Hospitals:* If sensor nodes can be attached to medications, the chance of getting and prescribing the wrong medication to patients can be minimized. Because, patients will have sensor nodes that identify their allergies and required medications.

D. Home Applications

Some of the important home applications is the sensors are:

1) *Home Automation:* As technology advances, smart sensor nodes and actuators can be buried in appliances, such as vacuum cleaners, micro-wave ovens, refrigerators, and VCRs. These sensor nodes inside the domestic devices can interact with each other and with the external network via the Internet or Satellite. They allow end users to manage home devices locally and remotely more easily.

2) *Smart Environment*: The design of smart environment can have two different perspectives that is human-centered and technology-centered [5]. For human-centered, a smart environment has to adapt to the needs of the end users in terms of input/ output capabilities.

E. Other Commercial Applications

Some 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 guidance in 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 control of actuators; detecting and monitoring car thefts; vehicle tracking and detection; and instrumentation of semiconductor processing chambers, rotating machinery, wind tunnels, and anechoic chambers.

1) *Environmental Control in Office Buildings:* The air conditioning and heat of most buildings are centrally controlled. Therefore, the temperature inside a room can vary by few degrees; one side might be warmer than the other because there is only one control in the room and the air flow from the central system is not evenly distributed.

III. RELATED WORK

A WSN is composed of a number of wireless sensor nodes which form a sensor field and a sink. These large numbers of nodes with low-cost, low-power, and capable of communication at short distances perform limited computation and communicate wirelessly form the WSNs. Specific functions such as sensing, tracking and alerting can be obtained through cooperation among these nodes. These functions make wireless sensors very useful for monitoring natural phenomena, environmental changes, controlling security, estimating traffic flows, monitoring military application, and tracking friendly forces in the battlefields.

A. Clustering

Clustering is a key technique used to extend the lifetime of a sensor network by reducing energy consumption. A sensor network can be made scalable by forming clusters. Leader of the cluster is often referred to as the cluster-head (CH). A CH may be elected by the sensors in a cluster or pre-assigned by the network designer. Various clustering algorithms have been specifically designed for WSNs for scalability and efficient communication.

1) Clustering Advantages: Clustering reduces the size of the routing table stored at the individual nodes by localizing the route set up within the cluster. Clustering can conserve communication bandwidth since it limits the scope of inter-cluster interactions to CHs and avoids redundant exchange of messages among sensor nodes. The CH can prolong the battery life of the individual sensors and the network lifetime as well by implementing optimized management strategies. Clustering cuts on topology maintenance overhead. Sensors would care only for connecting with their CHs. A CH can perform data aggregation in its cluster and decrease the number of redundant packets. A CH can reduce the rate of energy consumption by scheduling activities in the cluster.

2) *Cluster-head Capabilities:* The following attributes of the CH node are differentiating factors among clustering schemes:

a) Mobility: CH may be stationary or mobile. In most cases, they are stationary. But sometimes, CHs can move within a limited region to reposition themselves for better network performance**.**

b) Mobility: CH may be stationary or mobile. In most cases, they are stationary. But sometimes, CHs can move within a limited region to reposition themselves for better network performance**.**

c) Node Types: Generally sensor nodes among the deployed sensors are designated as CHs, but sometimes sensor nodes equipped with significantly more computation and communication resources are selected as CHs.

d) Role: Some of the main roles of the CHs are simply relaying the traffic, aggregation or fusion of the sensed data.

e) Mobility: CH may be stationary or mobile. In most cases, they are stationary. But sometimes, CHs can move within a limited region to reposition themselves for better network performance**.**

f) Mobility: CH may be stationary or mobile. In most cases, they are stationary. But sometimes, CHs can move within a limited region to reposition themselves for better network performance**.**

g) Node Types: Generally sensor nodes among the deployed sensors are designated as CHs, but sometimes sensor nodes equipped with significantly more computation and communication resources are selected as CHs.

h) Role: Some of the main roles of the CHs are simply relaying the traffic, aggregation or fusion of the sensed data.

3) CH Selection Criteria: The following are the important criteria to choose a CH in Cluster members.

a) *Initial Energy:* This is an important parameter to select the CH. When any algorithm starts it generally considers the initial energy.

b) *Residual Energy:* After some of the rounds are completed, the cluster head selection should be based on the energy remaining in the sensors.

c) *Average Energy of the Network:* The average energy is used as the reference energy for each node. It is the ideal energy that each node should own in current round to keep the network alive. The above listed clustering attributes are used to classify the clustering algorithms in the next section.

4) Cluster Properties: The following are the important properties of clusters**,**

a) Cluster Count: CH selection algorithms generally pick randomly CHs from the deployed sensors hence yields variable number of clusters.

b) Intra-Cluster Topology: Some clustering schemes are based on direct communication between a sensor and its designated CH, but sometimes multi-hop sensor-to-CH connectivity is required.

c) Connectivity of CH to BS: CHs send the aggregated data to the BS directly or indirectly with help of other CH nodes. It means, there exists a direct link or a multi-hop link.

B. Rendezvous-Based Data Collection

Direct-contact data collection has great advantage for energy savings. However it significantly increases data collection latency because of sinks' low moving speed. Rendezvous-based data collection is proposed to achieve trade off of energy consumption and time delay. Sensors send their measurement to a subset of sensors called rendezvous points (RPs) by multi-hop communication; a sink moves around in the network and retrieves data from encountered RPs. The use of RPs enables the sink to collect a large volume of data at a time without traveling a long distance and thus greatly decreases data collection delay. Relevant research focuses mainly on RP selection. Note that, since RPs is static, data dissemination to RPs is equivalent to data dissemination to static sinks, which has been intensively studied in traditional static WSN. The RP section in multi hop communication is done by the following ways:

- RP selection by fixed track
- RP selection by reporting tree
- RP selection by clustering

1) *RP Selection by Fixed Track:* The root of every tree is taken as RP [7]. Sensors subsequently send their measurement along upward path to the root of their residing tree. As the sink moves, RPs send their own data together with the data received from their tree members to the sink. Two motion control algorithms were presented to adjust sink speed to increase the amount of collected data, In SCD algorithm, the sink stops for a while at locations where sensors are found waiting with data. In MST algorithm, the sink moves slower in regions Where the data delivery success rate is moderately poor and temporarily stops in regions where data loss is severe

2) *RP Selection by Reporting Tree:* In, the authors [8], [9] considered a pre-defined reporting tree rooted at a static base station BS. In this tree, nodes shared by multiple data reporting paths are called *junction nodes*. Suppose that the locations of source nodes and junction nodes are known and that nodes are densely deployed. Then the reporting tree can be approximated by a geometric tree TR rooted at BS and composed of source nodes and junction nodes. To maintain this routing tree following algorithms are described,

- RP-CP (Rendezvous Planning with Constrained Path)
- RP-UG (Rendezvous Planning utility-based greedy heuristic)

3) *RP Selection by Clustering:* Clustering [10] provides an effective method for prolonging the lifetime of a wireless sensor network. Current clustering algorithms usually utilize two techniques; selecting cluster heads with more residual energy, and rotating cluster heads periodically to distribute the energy consumption among nodes in each cluster and extend the network lifetime. However, they rarely consider the hot spot problem in multi hop sensor networks. When cluster heads cooperate with each other to forward their data to the base station, the cluster heads closer to the base station are burdened with heavier relay traffic and tend to die much faster, leaving areas of the network uncovered and causing network partitions. To mitigate the hot spot problem, we propose an Unequal Cluster-based Routing (UCR) protocol. It groups the nodes into clusters of unequal sizes. Cluster heads closer to the base station have smaller cluster sizes than those farther from the base station, thus they can preserve some energy for the inter-cluster data forwarding. A greedy geographic and energy-aware routing protocol is designed for the inter-cluster communication, which considers the tradeoff between the energy cost of relay paths and the residual energy of relay nodes.

IV. CONCLUSION

Unlike other networks, WSNs are designed for specific applications. Applications include, but are not limited to, environmental monitoring, industrial machine monitoring, surveillance systems, and military target tracking. Each application differs in features and requirements. To support this diversity of applications, the development of new communication protocols, algorithms, designs, and services are needed.

REFERENCES

[1] D.Estrin, R.Govindan, J.Heidemann, S.Kumar, Next century challenges: scalable coordination in sensor networks, ACM MobiCom'99, Washington, USA, 1999, pp. 263–270.
[2] A.Chandrakasan, R. mirth rajah, S. Cho, J. Goodman. Konduri, J. Kulik, W. Rabiner, A. Wang, Design considerations for distributed micro-sensor systems, Proceedings of the IEEE 1999 Custom Integrated Circuits Conference, San Diego, CA, May 1999, pp. 279–286.
[3] P. Bonnet, J. Gehrke, P. Seshadri, Querying the physical world, IEEE Personal Communications (October 2000)10–15.
[4] M. Ogawa , Fully automated biosignal acquisition in daily routine through 1 month, International Conference on IEEE-EMBS, Hong Kong, 1998, pp. 1947–1950.

[5] G.D. Abowd, J.P.G. Sterbenz, Final report on the interagency workshop on research issues for smart environments, IEEE Personal Communications (October 2000) 36–40.

[6] V.Katiyar, N.Chand, S.Soni,A Survey on Clustering Algorithms for Heterogeneous Wireless Sensor Networks, Int. J. Advanced Networking and Applications, Volume: 02, Issue: 04, Pages: 745-754 (2011)

[7] A. Kansal, A.A. Somasundara, D.D. Jea, M.B. Srivastava, and D. Estrin. "Intelligent Fluid Infrastructure for Embedded Networks". In Proceedings of the 2nd International Conference on Mobile Systems, Applications, and Services (MobiSys),, pages 111–124, 2004.

[8] G. Xing, T. Wang, W. Jia, and M. Li. "Rendezvous Design Algorithms for Wireless Sensor Networks with a Mobile Base Station". In Proceedings of the 9th ACM International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc),, pages 231–239, 2008

[9] G. Xing, T. Wang, Z. Xie, and W. Jia. "Rendezvous Planning in Mobility-assisted Wireless Sensor Networks". In Proceedings of the 28th IEEE International Real-Time Systems Symposium (RTSS), Pages 311–320, 2007.

[10] J. Rao and S. Biswas. "Joint Routing and Navigation Protocols For Data Harvesting in Sensor Networks". In Proceedings of the 5th IEEE International Conference on Mobile Ad-hoc and Sensor Systems (MASS), pages 143–152, 2008.

.