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Overview on Wireless Sensor Networks

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ABSTRACT

Recent advancement in wireless communications and electronics has enabled the development of low-cost sensor networks Here we describe the three major aspect of wireless sensor network.WSN Applications, Routing and clustering. In the field of a wide variety in WSN applications we specifically introduce Environmental applications, Military Applications and SHM systems in health monitoring scope. The introduction of the routing protocols with the head topics of Flooding, Gossiping, EAGR, GEAR and REAR take place in routing section.
KEY WORDS: *wireless sensor networks, clustering routing protocol, routing protocol, WSN applications.*

I. INTRODUCTION

One of the major abilities that the sensors have is that they gathered the acts of sensing, data processing, and communicating components together. Sensor networks represent a significant improvement over traditional sensors, which are deployed in the following two ways [1]

- Sensors can be positioned far from the actual phenomenon, i.e., something known by sense perception. In this approach, large sensors that use some complex techniques to distinguish the targets from environmental noise are required.
- Several sensors that perform only sensing can be deployed. The positions of the sensors and communications topology are carefully engineered. They transmit time series of the sensed phenomenon to the central nodes where computations are performed and data are fused.

With the Recent advances in micro-electro-mechanical systems (MEMS) technologies wireless sensor networks continue to grow. And quickly gaining popularity due to the fact that they are potentially low cost solutions to a variety of real-world challenges [2]. 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.[3]

These autonomous and self power sensors can monitor both physical and environmental conditions. Within the military or civilian tasks, and send the gathered data to the main location. A typical WSN map is shown in Fig.1

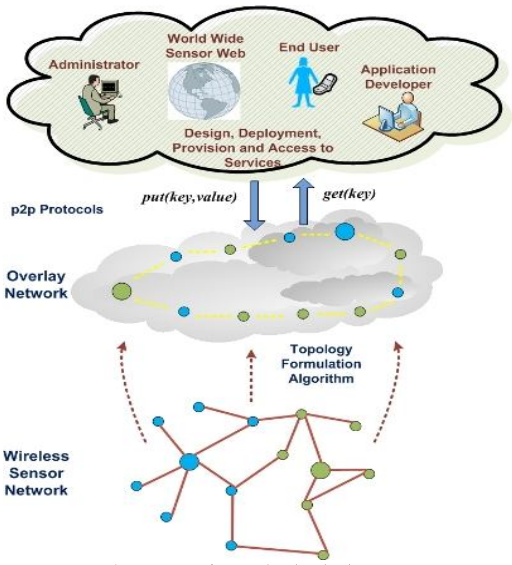

Figure 1. Network set-up of a typical wireless sensor network

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The remainder of the paper is organized as follows: In Section 2. We present generic overview of sensor network which show the benefits of sensor networks with the major contents of applications, Routing, and clustering.

II. WIRELESS SENSOR NETWORKS

A sensor network is the combination of a large number of sensor nodes which are densely deployed either inside the phenomenon or very close to it [3].Sensor nodes are small embedded devices which are mainly able to perform simple computations and to send/receive data. Their typical usage is to gather information about their Environment via sensors, to potentially pre-process these data, and to finally transmit them. An autonomous set of such nodes is called a wireless sensor network (WSN) [3]. Because of cost and energy constraints, only one node is generally able to transmit data from the sensor network to the "outside world "by means of a longer-range connection (e.g., GPRS). This node is called a sink since it acts as such with regards to the DataStream coming from the network [4]

A. ***Sensor Network Application Classes***

Sensors are consisting of a wide range of variety in order to sensing the world, such as magnetic, infrared, acoustic and thermal they are able to monitor a wide range of areas that include the following:

- Medical Monitoring
- Machine Monitoring
- Animal Monitoring
- noise levels
- vehicle monitoring
- And so on.

Sensor nodes can be used for continuous sensing, event detection, event ID, location sensing, and local control of actuators. The concept of micro-sensing and wireless connection of these nodes promises many new application areas. We categorize the applications into military, environment, health, home and other commercial areas. It's possible to expand this classification with more categories such as space exploration, chemical processing and disaster relief.

A classification of sample applications according to the Design space is presented, considering deployment, mobility, resources, cost, energy, heterogeneity, modality, infrastructure, topology, coverage, connectivity, size, lifetime and QoS. These sample applications are: Great Duck (bird observation on Great Duck island), Zebra Net, Glacier (glacier monitoring), Herding (cattle herding), Bathymetry, Ocean (ocean water monitoring), Grape(grape monitoring), Cold Chain (cold chain management),Avalanche (rescue of avalanche victims), Vital Sign (vital sign monitoring), Power (power monitoring), Assembly(parts assembly), Tracking (tracking military vehicles),Mines (self-healing mine field) and sniper (sniper localization).[5]

A.1 ***Environmental applications***

Some aspects in sensor network can be categorized in generic modes. We must be considering the requirement of a specific application such as Environment monitoring. We can translate the needed characteristics of an environmental monitoring system into the following technical requirements [6]

- Autonomy. Batteries must be able to power the weather stations during the whole deployment. Because the radio transceiver is a massive energy consumer, the network has to be energy-wise, even if a renewable source of energy's used (e.g., solar power). Protocols that require the radio to be always on must be discarded.
- Reliability. The network has to perform simple and predictable operations, to prevent unexpected crashes. Human maintenance should be avoided, first, because end users may not have networking knowledge, second, because areas of interest are most often remote. Achieving reliability is difficult because packet losses are more likely to happen during harsh weather conditions (e.g., heavy rain, intense cold) which are at the same time, the Most interesting episodes for data analysis.
- Flexibility. One must be able to quickly add, move, or remove stations at any time depending on the needs of the applications. For instance, it may turn out that the current location of the stations is not correct to gather the required data, or that new stations should be added at new points of interest. Nodes thus have to automatically detect their network neighborhood to account for such changes, and one cannot rely on a priori knowledge when designing the network.

One way to achieve all of this is to keep things simple. TASK [6] is a set of WSN software and tools, designed At Berkeley, that has been used for outdoor deployments, For instance during the Microscope experiments. The Experience of

TASK's authors is of great value, and they claim that simple and application-specific approaches provide the most robust solutions for real-world usage. This is especially true for environmental monitoring, because gluing existing and complex components together takes a lot of time and effort for in-depth understanding of their interaction. It is sometimes, however, not worth this effort because the targeted application may not require that many features. By keeping things simple, it is possible to create a robust network, well fitted for the intended application and outdoor usage. [5]

A.2 Military applications

Wireless sensor networks can be an integral part of military command, control, communications, computing, intelligence, surveillance, reconnaissance and targeting (C4ISRT) systems [3]. Wireless sensor networks can be used by the military for a number of purposes such as monitoring militant activity in remote areas and force protection. Being equipped with appropriate sensors these networks can enable detection of enemy movement, identification of enemy force and analysis of their movement and progress.[7] the usage of the wireless sensor network in military is one of the key investigated areas on WSN research and development process during the time. The military use-cases for wireless sensor networks are diverse. They encompass applications such as [7]:

- monitoring militant activity in remote areas of specific interest (e.g., key roads, villages);
- Force protection (e.g., ensuring that buildings which Have been cleared remain clear from infiltration by An adversary).

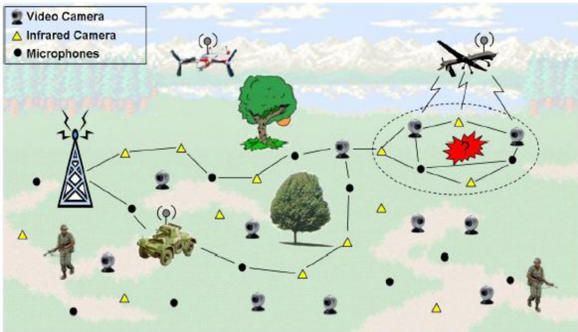

Figure 2. A typical usage of WSN in military field

A.3. Structure Health Monitoring (SHM) system

SHM is another important domain for sensor network application. The combined US and Canada Civil infrastructure assets have an estimate value of US$25 trillion SHM applications, serving as precaution measure, can have great social and economical impact. The widely accepted goals of SHM system include detecting damage, localizing damage, estimating the extent of the damage and predicting the residual life of the structure, as proposed in. SHM has been an evolving technology since it was first proposed in 1990's, the latest approach, wireless sensor network based approach, is promising because it has many advantages: low deployment and maintenance cost, Large physical coverage, high special resolution etc. One of the barriers is that damage detections very difficult even for sophisticated sensors, thus breakthrough in damage detection using small MEMS sensors is much needed. So far, a SHM system using wireless sensor network technology is yet to emerge. [8]

B. ***Routing Protocols***

Nodes can forward the data to next node. In case of multi-hop networks several nodes forward the data until it reaches the sink [9]. Different routing protocols are used for data Communication in Wireless Sensor Networks (WSN) because of several factors (i.e Application for which the nodes are used, the number of nodes, topology of network and limitations of energy level available, energy required for transmission and capability of processing data)[10].We are Here introduce you the following routing protocols briefly:

- Flooding
- Gossiping
- EAGR: Energy Aware Greedy Routing in WSN
- GEAR: Geographical and Energy Aware Routing
- REAR: Reliable Energy Aware Routing

B.1 Flooding

It is a very simple yet costly routing protocol for sensor networks. It works on broadcasting technique. Each sensor node creates multiple copies of the packet and forwards it to all its neighbors. This protocol is simple to implement but it has many drawbacks. [9].

As given below: -a. Implosion is the problem of getting same packet multiple times. It happens because of getting the same Packet from more than one neighbor's. Overlap problem arises when more than one sensors sense the same data and sends information about it to their common neighbor. The neighbor gets more than one copy of a packet. c. Resource blindness is the most costly problem of flooding because the sensor nodes have limited energy level and bandwidth. Flooding uses these resources blindly. Thus, resulting in wastage o limited resources [10].

B.2 Gossiping

Gossiping is the enhanced version of flooding. In this protocol, all the neighbors do not get the copy of a packet when a node gets packet it forwards it to some randomly selected neighbor. By selection of random node, gossiping overcomes the problem of implosion but introduces delay in the reception of data.[10]

B.3 EAGR: Energy Aware Greedy Routing in WSN Flooding

Razia et. Al [11]. Suggest a location based protocol that works on geographical information of the node as well as the energy level available in the sensor node. In most of the greedy routing algorithms, only shortest path is calculated keeping aside the fact that in this case the node present in most of the shortest paths will loose its energy very quickly. Therefore, creates a hole in that area and results in dropping of packets. EAGR combines the location information and Energy level of nodes so beautifully that the workloads evenly distributed amongst the alive nodes. In EAGR, all the nodes have same energy level and a threshold energy level is set. Node having less than that energy level is considered dead. Then, it finds out the location of each node. All the nodes having energy level greater than their threshold value get information about their neighbor and create a table of their Locations.

On the basis of this table average, distance to Its neighbor is calculated. For forwarding data, it selects the node having distance equal to or less than this average distance value and having maximum energy level amongst the neighbors. By considering energy level in selection, every time a new node is selected and no single node gets depleted its energy more quickly. Resultantly, giving longer life to the Network.

B.4 GEAR: Geographical and Energy Aware Routing

Yu ET. al. [12] has suggested a protocol that uses

Geographical information of the nodes, to propagate data to some specific rectangular region with energy efficiency. It also has a mechanism for dealing with holes. This algorithm works in two phases. a. Forwarding the Packet towards the Target Region: When there is a node available whose distance from destination is less than the forwarding node, and then the Forwarding node selects that neighbor for its next hop. If all the nodes have greater distance than the forwarding node, it means there is a hole. This whole problem is solved by selecting the next hop on the basis of learning cost mechanisms. Disseminating the Packet within the Region: When the packet reaches the region, recursive geographic Forwarding algorithm is implemented on it. When the Density of nodes is high, recursive geographic algorithm creates four copies of the packet and divides the region into four sub-regions and gives one copy to each sub-region. It divides the sub-regions further until the sub-region contains only one node. By doing this, all the nodes in a particular region will get the copy of the packet. In case the density of nodes is low in a region restrictive flooding method is used instead of recursive geographic forwarding. In GEAR each node knows two types of costs: (1) estimated cost that is used for simple forwarding, consisting of the remaining energy level and the distance and (2) is learning cost that is used to tackle the problem of holes. [10]

B.5 REAR: Reliable Energy Aware Routing

Hassanein et. al. [13]. Have proposed a routing algorithm in which reliability of packet delivery is high and it is also energy aware. REAR uses three types of nodes in a network Sink, Intermediate Nodes (IN) and Target Source (TS).This algorithm works on two layers network layer over which it provides the energy aware path using energy-reservation mechanism and on transport layer, it provides reliability. Parts of REAR are as under a Service Path Discovery (SPD): In SPD, the node known as sink sends the request over network for path discovery. It uses flooding for this path request. On the way the broadcasting speed is combined with available energy to select the energy efficient path. Once the node is selected it contains two logical energy levels (one is available energy and the other is reserved energy occupied by the path). When this candidate path reaches the source, it generates a path reservation request in which it reserves the required energy of nodes for this path. Any other path cannot use this energy until it is released. Backup Path Discovery (BPD): It is also initiated by sink and has same procedure as SPD. The only difference is that it will not contain the nodes already selected for service path. Backup path is used in case of failure of service paths. Reliable Transmission: For reliable transmission, each sending node stores the data until it gets acknowledgment from the receiver. Due to low memory, all the packets are not stored in case of SP link failure. The source node will transmit all the packets again. d. Reserved Energy Release: When the link fails, an error message is transmitted to all the intermediate nodes, which release the reserved energy for that path. Authors of the REAR claims that it can transmit 10%- 20% more packets to the destination node.[10]

C. *Clustering Algorithms*

Since the fundamental advantage of WSNs is the ability to deploy them in an ad hoc manner, as it is not feasible to organize these nodes into group's redeployment. For this reason, there has been a large amount of research into ways of creating these organizational structures (or clusters) [6], [7].we are here definite the organizational structure [14].

- Sensor Node: A sensor node is the core component of a WSN. Sensor nodes can take on multiple roles in a network, such as simple sensing; data storage; routing; and data processing
- Clusters: Clusters are the organizational unit for WSNs. The dense nature of these networks requires the need for them to be broken down into clusters to simplify tasks such a communication.
- Cluster heads: Cluster heads are the organization leader of a cluster. They often are required to organize activities in the cluster. These tasks include but are not limited to data-aggregation and organization the communication schedule of a cluster
- Base Station: The base station is at the upper level of the hierarchical WSN. It provides the communication link between the sensor network and the end-user.

C.1 Heuristic Algorithms

A heuristic algorithm is an algorithm that usually has one or both of the following goals in solving a problem: Finding an algorithm with reasonable run-time (time Needed to set up clusters is affordable); and/or With finding the optimal solution This means that an heuristic algorithm leads to reasonable performance and is not based on particular metrics. There are many types of heuristic algorithms that exist in choosing cluster heads [14]

- Linked Cluster Algorithm (LCA)[15][16]LCA,
- Was one of the very first clustering algorithms developed? It was initially developed for wired sensors, but later implemented in wireless sensor networks.
- Linked Cluster Algorithm 2 (LCA2) [15], [16]: LCA2was proposed to eliminate the election of an unnecessary number of cluster heads, as in LCA. In LCA2, they introduce the concept of a node being covered and non-covered. A node considered covered if one of its neighbors is a cluster head. Cluster heads are elected starting with the node having the lowest ID among non-covered neighbors.
- Highest-Connectivity Cluster Algorithm [15]: This algorithm is similar to LCA. In this scheme the number of node neighbors is broadcast to the surrounding nodes. The result is that instead of looking at the ID number, the connectivity of a node is considered. The node with the highest connectivity (connected to the most number of nodes) is elected cluster head, but in the case of a tie, the node with the lowest ID prevails.
- Max-Min D-Cluster Algorithm [16]: With Max-Min D-cluster, the authors[19] propose a new distributed cluster head election procedure, where no node is more than d (d is a values elected for the heuristic) hops away from the cluster head. This algorithm provides load balancing among cluster heads[14]

III. CONCLUSION

Wireless sensor network is an integral part of our lives with the wide range of application that it's provide For remote sensing. High sensing fidelity, fault tolerance, flexibility, and rapid deployment characteristics of sensor networks create the wsn usage an inseparable fact in many areas. Realization of sensor networks needs to satisfy the constraints introduced by factors such as fault tolerance, scalability, cost, hardware, topology change, environment and power consumption. Since these constraints are highly Stringent and specific for sensor networks, new Wireless ad hoc networking techniques are required. In wireless sensor networks, the energy limitations of nodes play a crucial role in designing any protocol for implementation [2].

In addition, Quality of Service metrics such as delay, data loss tolerance, and network lifetime expose reliability issues when designing recovery mechanisms for clustering schemes. These important characteristics are often opposed; as one often has a negative impact on the other [14].In this paper we introduce the three areas of aspects: applications, routing and clustering in which they are the three of major

Research areas. The other hot topics for going throw them are remained here: Security Monitoring ,Node tracking scenarios, Hybrid networks, System Evaluation Metrics, Lifetime, Coverage, Cost and ease of deployment, Response Time, Temporal Accuracy, Security, Effective Sample Rate, Power, Flexibility, Robustness.

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