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Research on the Modeling and Optimization on Wireless Ad-hoc Sensor Network for Natural Disease

Jinguo Zhao, Chen Min, Qingyun Luo

School of Computer Science and Technology, Hunan Institute of Technology, Hengyang, China

Corresponding author is Chen Min

Abstract
In this paper, the author studied the modeling and optimization on Wireless Ad-hoc sensor network for natural disease. The paper addresses the power consumption in wireless ad-hoc and sensor networks. It primary identifies the wireless aspects. It then shows by mathematical analysis the energy saving, improvement error probability and confirms the analysis by simulation results. After that, it considers the multipath fading problem by modeling, mathematical analysis for fading channels, in addition to it discusses how to mitigate the multipath fading by modulation and diversity, and verifies that by simulation.
Keywords: MODELING, OPTIMIZAITON, WIRELESS AD-HOC, SENSOR NETWORK, NATURAL DISEASE

1. Introduction

Modern technological progresses in sensor networks embedded computing technologies and wireless communications have enabled the design of lightweight low power intelligent monitoring devices. A key technical challenge in most wireless sensor networks is how to successfully arrange and manage the sensors and how to control data collection in order to get a minimum continuous delay, a maximum monitoring duration and a desired excellence of monitoring. The maximum monitoring duration is period of time that monitoring service is provided while excellence of monitoring captures possible performance and accuracy of data.

Modern technological progresses in sensor networks embedded computing technologies and wireless communications have enabled the design of lightweight low power intelligent monitoring devices. A key technical challenge in most wireless sensor networks is how to successfully arrange and manage the sensors and how to control data collection in order to get a minimum continuous delay, a maximum monitoring duration and a desired excellence of monitoring. The maximum monitoring duration is period of time that monitoring service is provided while excellence of monitoring captures possible performance and accuracy of data. The two parameters depend on sensor initial energy deployment, density placement, sampling rate, network connectivity and communication rate.

Wireless ad-hoc and sensor networks are combined simple wireless communication, minimum computation facilities. Besides, some kind of sensing into a new form of network that can be totally fixed in the physical environment. Typical sensing device can be applied for natural diseases such as earthquakes, floods, as well as plane crashes, high-rise building collapses or main nuclear ability break down. Several well-known services that are depended on for everyday communications such as cell phone connectivity and Internet connections, these types of communication are disabled in crisis situations due to the breakdown of the supporting infrastructure throughout system break and system overuse. Unluckily these conditions result in increased requirement and so need efficient communication support. Therefore, the need for an incorporated communication and information system for natural disease management to give efficient dependable, safe exchange and processing of related information is increased.

Recently, information and communication technologies (ICT) devices and schemes have been developed that offer advanced tasks for publication, association, visualization explore recovery and sharing of information in addition to tasks sustaining communication teamwork and connecting of persons in community networks. Moreover, the ICT can possibly play an essential role in natural disease prevention, alleviation and administration. Besides, these technologies having a vital task in assisting the rebuilding procedure and in synchronizing the return of displaced by natural diseases to their residences and societies. Furthermore, the usage of ICT for health is one of the major sciences, which is growing quick and have an important social and financial impact. Therefore, the proposal of utilizing ICT to allow patients and people to administer their physical condition and existence has been used for years. Natural diseases, whether natural or man-made arbitrarily or willfully make a challenge society's ability for both planning and response are presented in [1-6].

2. Wireless Energy Optimization

As mentioned in [7], WSNs typically has little or no inti-astructure. It consists of number sensor nodes (few teas to thousands sensor nodes) working together to monitor a region to obtain data about the environment. Figure 1 shows the direct transmission in the WSNs.

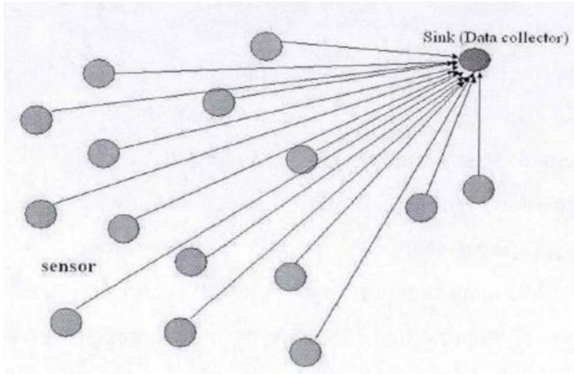


Figure 1. Direct Transmission in WSNs

There are two types of WSNs:

1. Unstructured WSNs:

It is one type of the WSNs that contains a dense collection of sensor nodes. Sensor nodes may be deployed in an ad hoc manner (in ad hoc deployment, sensor nodes may be randomly placed into the field) into the field. Once deployed, the network is left unattended to perform monitoring and reporting functions. In unstructured WSNs, network maintenance such as managing connectivity and detecting failures is difficult since there are so many nodes [8].

2. Structured WSNs:

All or some of the sensor nodes are deployed in a pre-planned manner (in pre-planned deployment, sensor are pre-determined to be placed at fixed locations). The advantage of structured networks is that fewer nodes can be deployed with lower network maintenance and management cost. Fewer nodes can be deployed now since nodes are deployment can have placed at specific locations to provide coverage while ad hoc uncovered regions.

Unlike traditional networks, WSNs have their own designs and resource constraints:

1 .Resource Constraints include a limited amount of energy, short communication range, low bandwidth, and limited processing and storage in each node.

2. Design Constraints are application dependent and are based on the monitored envmonment.

Research is WSNs aims to meet the above constraints by introducing new design concepts, creating or improving existing protocols, building new applications and developing new algorithms.

WSNs have great potential for many applications in scenarios such as military target tracking and surveillance, naW ral disaster relief, biomedical health monitoring, and hazardous environment exploration and seismic sensing. Therefore, WSNs applications, as shown in Figure 2, can be classified into two categories:

1. Monitoring Applications:

These include indoor/outdoor environmental monitoring, health and wellness monitoring, power monitoring, inventory location monitoring, and seismic and stnictural monitoring.

2. Tracking Applications:

Tracking objects, animals, humans, and vehicles. An important question we need to mention now is "What are the requirements of a future wireless environment?" Ubiquitous connectivity, devices heterogeneity, high capacity, poor spectrum usage, high efficiency, low energy consumption, low interference, mobility, flexibility, and autonomous operations are the main concerns. Ubiquitous computing leads to ubiquitous connectivity for example connectivity anywhere, anytime, in anyplace, to anyone. Another fundamental requirement is to stay connected while moving, i.e. mobile connectivity.

Also, it will be required to deal with a large variety of devices, with different constraints, e.g. sensors, cars, mobile phones, PDAs, etc. Finally, it will be required to have a WSN with never ended lifetime. WSNs are currently receiving significant attention due to their unlimited potential.

However, it is still very early in the lifetime of such systems and many challenges exist. As mentioned previously, some of the challenges are energy constraint, communication capabilities, and security and privacy. From these challenges, we will use our modified optimization to help in extending the wireless network lifetime, by controlling the energy consumption.

In large scale WSNs, scalable architectural and management strategies are required to achieve goals such as extended lifetime, scalability, coverage, robustness and especially simplicity.

3. The Design Principle

Clustering schemes have some prominent advantages except for scalability, as listed in the following points:

1. Less Overheads:

As all cluster members only send data to CHs and CHs only send data to base stations or sinks after data aggregation and fusion within clusters, clustering schemes can dramatically alleviate flooding overheads while still fulfilling the network QoS requirements by decreasing the retransmission of broadcast or multicast packets. This features significantly reduces transferring data, saves energy and bandwidth resources, and also scales well in routing path building phase and data transmitting phase.

2. Easy Maintenance:

After cluster formation, clustering schemes make it easier for network topology control and responding to network changes caused by network dynamics, node autonomy, node mobility, local changes and unpredicted failures. Since all these changes only need to be detected, and managed within an individual cluster, not the entire network, the entire network is more robust and easy for maintenance and management.

Basically, clustering schemes consist of two phases, cluster formation and cluster maintenance. Cluster formation is referred to how to construct a hierarchical cluster structure in the network initialization stage, while cluster maintenance is referred to how to update, control and manage the network topology changes caused by node mobility, failures, link breakage or some other reasons.

Actually, a cluster head serves as a central coordinator to perform the distributed sensing tasks in a local cluster, which node is chosen to be a CH is the key problem during the entire network initialization phase. Moreover, a cluster head consumes more energy than the other nodes in a cluster because it has additional functions.

In general, it is hard to set a common criterion for various underlying clustering schemes, including the similarities and differences between schemes in the same category. However, we will list some of the famous criteria for WSNs according to Cluster-Head (CH) properties:

1. Existence:

Depending on whether there exist cluster heads with a cluster, clustering schemes can be grouped into CH-based clustering and non-CH-based clustering.

2. Count variability:

In some application environments, the set of cluster heads are predetermined and thus the number of clusters is preset. Therefore, clustering schemes can be categorized into fixed or variable cluster-heads clustering.

3. Selectivity:

According to whether cluster-heads are pre-assigned or chosen from the deployed nodes set by certain cluster-head selection rules, clustering schemes can be grouped into pre-assigned or dynamic selected.

4. Role:

In WSNs, cluster head can simple act as a local coordinator for its cluster members, perform intracluster transmission or serve as a backbone node for higher cluster hierarchy. Thus clustering schemes can be grouped into local or global ones.

5. Node Mobility:

Clustering schemes can be grouped into stationary or mobile ones according to the mobility attributes of cluster heads.

6. Distance:

Depending on hop distance between node pairs in a cluster, clustering algorithms can be grouped into 1-hop clustering and mufti-hop clustering.

7. Explicit Control Messages:

Clustering schemes can be grouped into explicit control message-dependent or non-explicit control message ones.

8. Overlapping:

In some cases, when sensors scattered or placed not properly, there exist overlapping areas among clusters and nodes. Therefore, clustering schemes can be grouped into overlapping clustering and non-overlapping clustering.

4. The PSO Algorithm

The basic concept of particle swarm optimization stems from research on bird flock predator behavior. People get revelation from bird folck predator model and use for solution optimization problem. In particle swarm optimization, each optimization solution is a bird in search space which is called particle. All of particles have a fitness value decided by optimization function and they also have a velocity to determine the direction and distance.

For each generation, particles update their speed and location based on a formula such as the following:

$$v_{id} = w \times v_{id} + c_1 \times random() \times (p_{id} - x_{id}) + c_2 \times random() \times (p_{gd} - x_{id}) \quad (1)$$

$$x_{id} = x_{id} + v_{id} \quad (2)$$

w indicates the inertia weights. $random()$ is a random number between zero and one. C1 and C2 indicates a learning factor. In addition, every dimension speed of the particle has a maximum velocity which is $V\max$.

There are six basic steps in particle swarm optimization. 1) initialize each particle's initial position and velocity. 2) calculate the fitness value of each particle. 3) update the best location with current fitness values as the best fitness value superior to its own position for each particle. 4) update the overall best new locations with the particle who has the best fitness value in the entire paricles group if there is such an individual whose fitness value is better than the history best location for the whole particles group. 5) recalculate the velocity of the particles according to equation (1), and then recalculate the particle's position according to equation (2). 6) If it reaches the maximum number of iterations or minimum standards, it finishes; otherwise, it goes to step 2).

The frame of the programme as shown in Figure 3. The frame of the Image-Based Visual Servo System programme as shown in Figure 4.

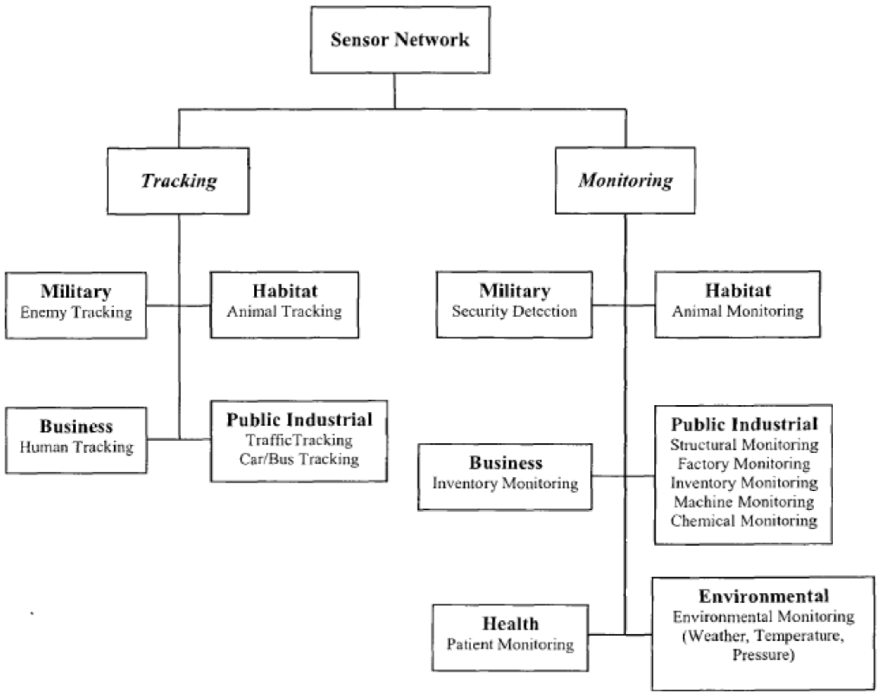


Figure 2. Overview of WSNs Applications

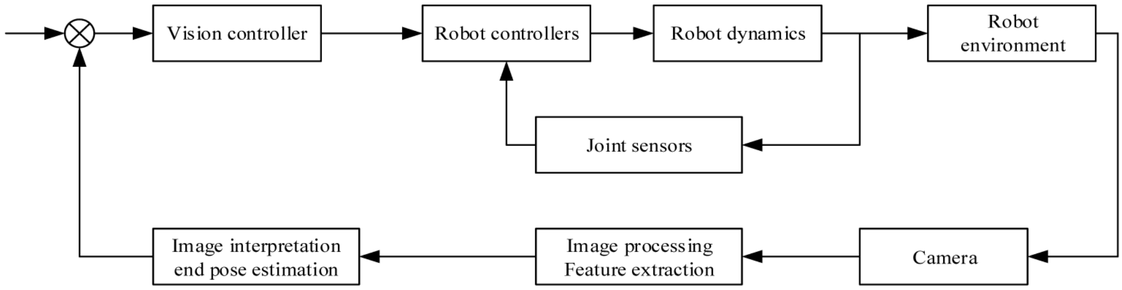


Figure 3. Position-Based Visual Servo System

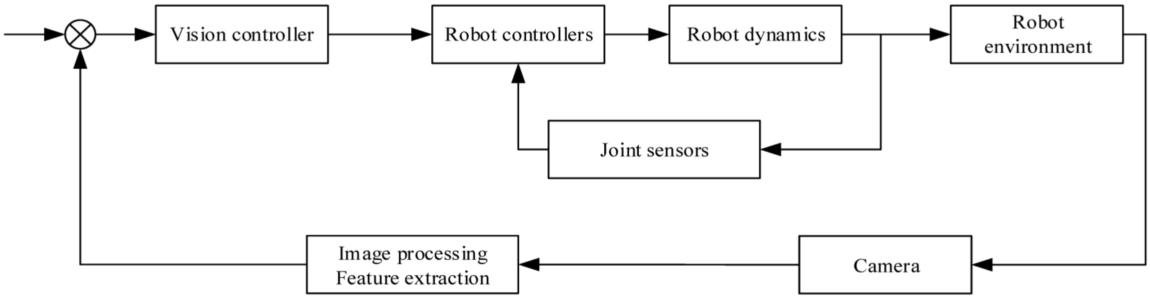


Figure 4. Image-Based Visual Servo System

We entered the location or speed to cartesian space or robot joint space egardless of its dynamic nature, and then the visual servo errors can establish control law.

$$\mu = K_{p^e}(\mathrm{k}) + \mathrm{k}_1 \sum_{1}^{k} e(k) \quad (3)$$
$$+K_D(e(\mathrm{k}) - \mathrm{e}(\mathrm{k}-1))$$

$$e(r(t)) = C(S(r(t)) - S^*) \quad (4)$$

It assumes that track and manipulator control performance based on joint sensor control is idealized.

$$x(k) = x_d(\mathrm{k}) = \mu(\mathrm{k}) \quad (5)$$

We can have following state space description:

$$\xi(k+1) = A\xi(k) + \mathrm{B}\,\mu(\mathrm{k}) + \mathrm{E}\,\mathrm{d}(\mathrm{k}) + \mathrm{H}\,\mathrm{v}(\mathrm{k}) \quad (6)$$

$$\varphi(k) = C\,\mathrm{q}^{-d}\,\xi(k) + D\,\mathrm{w}(\mathrm{k}) \quad (7)$$

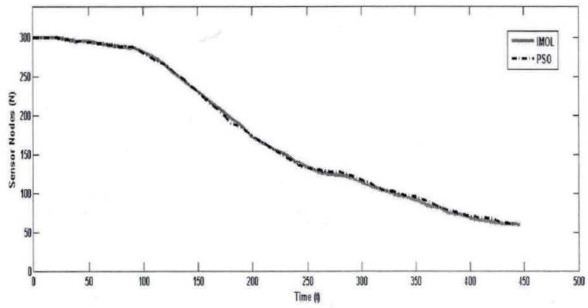
5. The Experiment and Data Analysis

In this subsection, two different values for the maximum and minimum weight are tested, that are 0.9, 0.4 and 0.4, 0.01, respectively. For each group of the inertia weight, three different acceleration values are chosen, that are 0.2, 2 and 4.

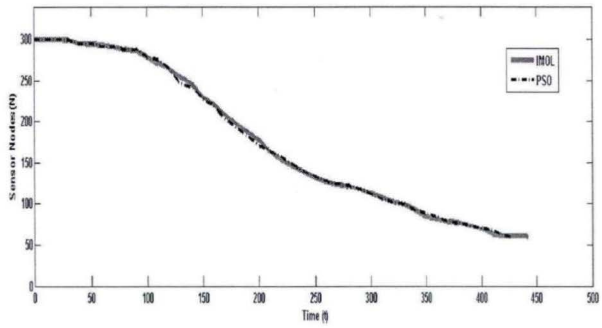
In the following figure, Cases 1 where Wmax and Wmin are 0.9 and 0.4, respectively, are explained. The figure 5 shows the experiment result in different c.

Conclusions

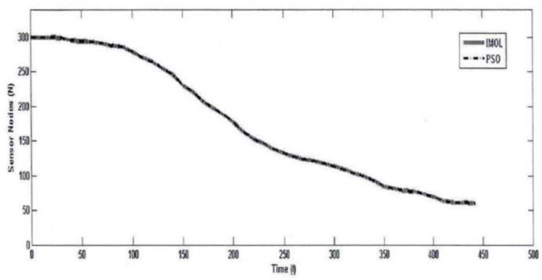
In this paper, the author studied the modeling and optimization on Wireless Ad-hoc sensor network for natural disease. The paper addresses the power con-



a) Wmax=0.9, Wmin=0.4, c=0.2, IMOL =>t=442, PSO =>t=427



b) Wmax=0.9, Wmin=0.4, c=2, IMOL =>t=442, PSO =>t=427



c) Wmax=0.9, Wmin=0.4, c=4, IMOL =>t=442, PSO =>t=427

Figure 5. The Experiment Result

sumption in wireless ad-hoc and sensor networks. It primary identifies the wireless aspects.

After cluster formation, clustering schemes make it easier for network topology control and responding to network changes caused by network dynamics, node autonomy, node mobility, local changes and unpredicted failures. Since all these changes only need to be detected, and managed within an individual cluster, not the entire network, the entire network is more robust and easy for maintenance and management. It primary identifies the wireless aspects. It then shows by mathematical analysis the energy saving, improvement error probability and confirms the analysis by simulation results. After that, it considers the multipath fading problem by modeling, mathematical analysis for fading channels, in addition to it discusses how to mitigate the multipath fading by modulation and diversity, and verifies that by simulation.

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