Research Article

Investigation of Energy Consumption Optimization Methods in Wireless Sensor Networks

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Abstract: One of the most important issues in wireless sensor networks is the issue of severe energy constraints. Also, since the performance of sensor networks is highly dependent on the life of the network, it is vital to consider energy storage algorithms in the design of long-life sensor networks.

This paper discusses the Nature-Sync-inspired Algorithm (ACOTS) algorithm based on Ant Colony optimization to provide an energy efficient solution for simultaneous synchronization solution in WSN And it was observed that it drastically reduces the number of packets sent and received during the synchronization process. This helps solve synchronization time and also creates an energy efficient network with less energy consumption. The proposed ACOTS algorithm is compared with existing algorithms. It is broadcast reference synchronization (RBS) and time synchronization protocol for sensor network (TPSN). Comparative results show that ACOTS uses less message exchange than other schemes.

Keywords: power optimization, wireless sensor, networks, Acots sync

Introduction

One of the most important issues in wireless sensor networks is the issue of severe energy constraints. Also, since the efficiency of sensor networks is highly dependent on the life of the network, so it is vital to consider energy storage algorithms in the design of long-life sensor networks (Abadia et al., 2016).

Wireless sensor networks have been used in almost every field in recent years. This includes many applications and environments. The most common uses of WSNs are in war surveillance, inventory tracking, modern homes, the medical industry, climate monitoring, etc.) Abadia et al., 2016; Esra Sarak et al., 2014)

Therefore, in WSN, time synchronization is an important aspect for their proper performance. By maintaining the accuracy of time information in each system, meaningful information can be shared among nodes, and the system can also be synchronized with the real world (Sharma et al., 2016). Therefore, many new ways of using them have been developed in the last few years.

The biggest limitation for WSN is the limited battery life of the sensor nodes, the best choice of pair to synchronize the network system and minimize the number of message exchanges by listening to the node. Inspired by the synchronization method above, this synchronization protocol provides energy-saving time based on ant clone optimization, which results in an efficient energy grid with lower energy consumption.

1. Wireless sensor networks

Wireless sensor networks are used to collect information in areas where the user cannot be present. In a sensor network, the sensors individually sample (measure) local values and send this information to other sensors if necessary, and finally to the main observer. The function of the network is to report phenomena that occur to the observer who does not need to know anything about the structure of the network and the sensors separately and their relationship. . These networks are independent and self-governing and operate without human intervention. Usually all nodes are the same and work together to meet the overall purpose of the network. The main purpose of wireless sensor networks is to monitor and control atmospheric, physical or chemical conditions and changes in an environment with a certain range (Zhang et al., 2015). Wireless sensor network is a special type of case networks. Is. The topic of wireless sensor networks is one of the new topics in the field of network engineering and information technology.

Recent advances in the design and manufacture of commercial chips have made it possible for signal processing and sensing to be performed on a single chip, called wireless network sensors, which include microelectromechanical systems (MEMS) such as sensors, actuators, and components. Is an RF radio.

Small wireless sensors have been developed that can collect data from a distance of several hundred meters and send data between wireless sensors to the main center, and with this technology, information on temperature - fluctuations, sound, light, humidity and magnetism can be collected. These wireless sensors can be installed in low cost wireless sensor networks; But the downside of wireless sensors also has its drawbacks. Semiconductor technology has led to high-speed processors with high memory, but powering these circuits is still a major problem limited to battery usage. Power supply is an important and limited part that if batteries are used in these networks, replacing the batteries in case of a large number of network nodes will be a difficult task and the nodes will have to use communications in order to save and save energy. Wins will be shortened. The difference between an efficient wireless sensor and a low-energy wireless sensor is in their performance in hours over weeks. Increasing the size of the WSN network increases the complexity of routing and sending information to the main hub; But routing and processing still require energy. Therefore, one of the key points in the development and introduction of new routing algorithms is to reduce and save energy consumption. Different parts of wireless sensor networks must be simulated and modeled to evaluate their performance. To do this, the sensor sensor networks are mapped to graphs in which each node corresponds to a node in the network and each edge represents a connection or communication channel between two nodes in the network. If the connection between the nodes in the network is two-way, the mapped graph will be directionless, and if the connection between the nodes in the network is asymmetric, then the mapped graph will be directional. Of course, the communication model between the nodes in the network can be one by one or one to all. Providing a practical model for the sensors is a complex and difficult task due to the variety of different types of sensors, both structurally and in terms of their operation. Sensor networks have unique features that have led to special protocols for them (Yildiz, 2016)

In wireless sensor networks, there are only one or two base stations and a large number of sensor nodes are scattered in the environment. Due to the limited range of these sensors and the battery power, many nodes are not able to communicate directly with the base station; But it quickly connects to the base station by relying on nodes such as itself and other sensor nodes, which is also done by ordinary nodes in MANET networks.

The communication architecture of wireless sensor networks can be seen in Figure 2-4 (Yildirim et al., 2015). In wireless sensor networks, a large number of nodes with communication facilities, processing, sensing the environment, etc. Are scattered in an environment with a definite framework. The event that occurred or the questions asked by the central node and the mission assigned to each node cause connections to be made between the nodes. . The information exchanged can be a report of the status of the area under the sensor nodes to the central node or a request from the central node to the sensor nodes. The central node, as the communication gateway of the sensor network with other systems and telecommunication networks, is in fact the final receiver of the report of the sensor nodes and after performing a series of processes, sends the processed information to the user. (Using a communication medium such as the Internet, satellite, etc.). On the other hand, user requests are also transmitted to the network by this node.

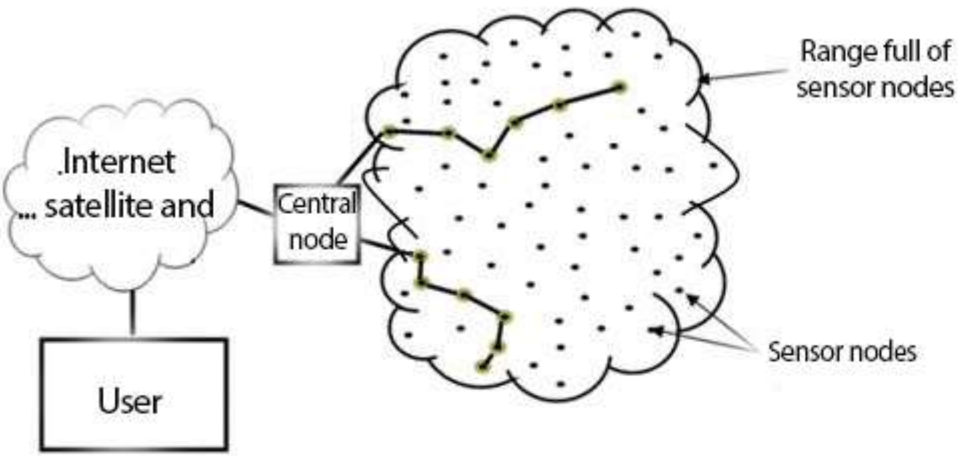

Figure 2: Communication architecture of wireless sensor networks

A sensor node can take on one of two roles: generating data or relaying data generated by other nodes. Generally in sensor networks, most nodes play both roles together. Establishing and designing the structure and architecture of communications between network nodes requires consideration of many different factors, including fault tolerance, scalability, production cost, operating environment, sensor network topology, hardware constraints, communication tools and media, energy. Consumption and ... is. Refer to Appendix A for more information on wireless sensor networks.

1.1 Issues in Wireless Sensor Networks

Numerous factors are influential in the design of sensor networks and there are many issues in this field that are not covered in this article, so we will suffice to mention some of them briefly.

1-Routing: The main nature of sensor networks is that what they do should be local because each node can only communicate with its neighbors and general information about the network is not available. (Gathering this information takes a lot of time and money). The information obtained by the nodes should be somehow sent to the central node using routing techniques (Garone et al., 2015)

2 - Hardware bottlenecks: Each node, while having all the necessary components, must be small enough, light and compact. At the same time, each node must have very low energy consumption and low cost and be compatible with environmental conditions. These are all limitations that make the design and construction of sensor nodes challenging. . Providing light and compact hardware designs for each component of the node, especially the wireless and sensors, is one of the research topics that has a lot of work to do. Advances in high-density, low-consumption integrated circuit technology have played a significant role in reducing hardware bottlenecks.

3-Error tolerance and reliability: Each node may be damaged or completely destroyed by environmental events such as an accident or explosion, or it may fail due to depletion of the power supply. Tolerance or reliability means that node failure should not affect the overall performance of the network. In fact, we want to build a reliable network using unreliable components.

4- Topology: Network topology is one of the basic concepts in sensor networks on which other items such as routing, etc. are defined. There are many structures in topology that are superior to each other based on different priorities and under different conditions. Among the factors that affect the choice of a structure are low power consumption, thin structure, low knot degree, fault tolerance and interference.

5. Scalability: The network must be scalable both in terms of the number of nodes and the distribution of nodes. In other words, the sensor network, on the one hand, must be able to work with hundreds, thousands, and even millions of nodes, and on the other hand, must also support the different distribution densities of the nodes. In many applications, the distribution of nodes is random and it is not possible to distribute with a specific and uniform density or the nodes are displaced due to environmental factors. Therefore, the density must be able to vary from a few to several hundred nodes. The issue of scalability also applies to methods. Some methods may not be scalable, ie they operate at a density with a limited number of nodes. In contrast, some methods are scalable.

6- Environmental conditions: A wide range of applications of sensor networks are related to environments in which humans can not be present; Such as chemically, microbially, nuclei or studies polluted on the ocean floor and space or military environments due to the presence of the enemy or in the forest and habitat of animals that the presence of humans causes them to escape. . In each case, environmental conditions must be taken into account in the design of the nodes. For example, in the sea and wet environments, the sensor node is placed in a chamber that does not transfer moisture.

7- Communication media: In sensor networks, communication of nodes is done wirelessly through radio, infrared, or optical media. The most widely used radio media uses various industrial, scientific, and medical bands that are free in most countries. . Frequency determination in this medium is due to some hardware limitations, antenna efficiency and power consumption. Due to the need for direct vision between transmitter and receiver, infrared media is not widely used in sensor networks, although they are cheap and easy to build. Recently, optical media has been considered as a communication medium. Among these considerations, we can mention its use in smart particles (Sharma, 2016). The choice of communication media from these three media (radio, infrared and optical) according to the limitations and characteristics of the intended application of Issues are raised in the design of sensor networks.

8- Increasing the life of the network: The life of the nodes is short due to the energy limit of the power supply. In addition, sometimes the special position of a node in the network exacerbates the problem. For example, a node that is one step away from the central node, on the one hand, loses its energy very quickly due to high workload, and on the other hand, its failure causes the connection of the central node with the whole network and as a result causes The network fails. The problem of premature discharge of energy in the case of nodes in low-density areas also applies to the non-uniform distribution of nodes. It would be appropriate to make the least use of critical situations. According to the above, all algorithms and techniques used in sensor networks look at energy as a serious limitation and try to act with knowledge of the level of energy consumed to consume the least energy and As a result, it increases the life of the sensor network (Sarvaghdi, 2016)

1_2 Environmental coverage in wireless sensor networks

Coverage is one of the most important manifestations of service quality in wireless sensor networks. . Assuming an area is monitored, the question is how many sensor nodes are needed and where they should be located. This question has been registered as a makeup issue and has been subject to several interesting restrictions (such as cost constraints, the presence of obstacles, the availability of different types of sensors, etc.). If there is interference between several sensors, some sensors can be put to sleep. Without damaging the cover. This saves energy and prolongs the life of the network. In the following, we will review some of the terms related to coverage in sensor networks (Rao et al., 2018)

Research records

Liu and Mao (Zhou et al., 2018) studied the coverage of wireless sensor networks for circular fields, and they achieved the expected coverage ratio under the deployment of random sensors based on the Digital Elevation Model (DEM).

. In the paper (Lee et al., 2018) an algorithm based on scalable coordination search in terms of execution time, the K-coverage increase algorithm (KCEA) is presented whose main purpose is to increase the initial coverage and reach the appropriate degree of case coverage Need for a specific application.

The authors in (Mann et al., 2019) proposed the "Genetic Algorithm for Data Flow Management in the Sensor Network" approach for data flow management, and the genetic algorithm is used to determine a sufficient number of means to generate knowledge from data collected by the population. . Different types of information can be exchanged in the context of the sensor network, especially to warn drivers of significant, life-threatening events. As a result, during their journey, vehicles are overwhelmed with information provided by others. Relevant data is then used locally to inform or warn the driver. In (Zhang et al., 2018) has used fuzzy logic for synchronization. In this algorithm, three fuzzy variables are used. Node energy, node focus, and node centrality are these three parameters. In this method, the master station first gathers the necessary information from all nodes and then selects one node as the head of the cluster based on fuzzy rules. In this method, there is only one choice for each cycle, while more CHs are needed to balance power consumption and improve grid life.

In (Abdolrashid et al., 2018) the ant colony algorithm based on the backpack problem has been used to expand the sensors. The expansion of sensors is one of the most important issues in WSN, because an optimal expansion plan can reduce costs, increase WSN routing capability, quality of observation and monitoring in WSN by increasing the coverage area. In the proposed design, the life of the network is extended.

In (Lee et al., 2018) the DAACA ant colony algorithm algorithm is used to synchronize the data. This algorithm includes three phases, initialization, packet transfer, and operations on the pheromone. In the transfer phase, the remaining energy of each node and the amount of neighboring pheromones are estimated to select the next hop. The next step is to regulate the pheromone, which includes benefits during evaporation. This step includes 4 strategies that increase the life of the network. Research on a large number of nodes, DAACA, has greater performance and longevity, less computational complexity, and a more successful transfer rate per hop than other algorithms.

Advantages	Disadvantages	Method	Year and reference	Row
Reduce energy consumption High throughput	High delay Managers of networks Homogenous	A modified ant colony optimization algorithm to find an energy efficient pathway to utilize	(Joohamkaran, 2018)	**1**
Reduce energy	Low throughput Low	Propose a secure time-synchronization model based on	(Lee et al., 2018)	**2**

consumption flexible	package delivery rate	the ant colony method to improve wireless network space		
High throughput Low delay	High energy High error	Genetic algorithm is used to determine the sufficient number of devices to generate knowledge from data collected by the population.	(Man et al., 2019)	**3**
Suitable for all types of networks Simplicity of implementation	Delay Energy loss	Use fuzzy logic for synchronization based on multiple variables	(Zhang et al., 2018)	**4**
Low energy consumption Increase network life	Low throughput High delay	Ant Colony Algorithm Based on Backpack Problem for Sensor Expansion	(Abdul Rashid et al., 2018)	**5**
High throughput High package delivery rate	High computational overhead High energy Delay	The DAACA data collection ant colony algorithm is used to synchronize the data. This algorithm includes three phases, initialization, packet transfer, and operations on the pheromone.	(Lee et al., 2018)	**6**

Conclusion

In this paper, the issue of synchronization in wireless sensor networks using ant colony algorithm with the focus on optimizing service quality parameters was discussed. For this purpose, a relatively comprehensive study was performed in the field of energy consumption in the sensor network. In addition, service quality criteria were examined to some extent. The main issue discussed in this article has been the importance of service quality parameters and their improvement in the field of synchronization.

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