Perspective of wireless sensor networks towards Environment: Gaps and Challenges

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Abstract. Wireless sensor networks have a huge number of applications in the environment for sensing and broadcasting the information at very low cost. Wireless sensor networks are composed of a large number of nodes which are deployed in close proximity to the phenomenon to be monitored. The wireless sensor network is comprised of computing, communication and sensing elements which gives the opportunity to the administrator to an object, sense and an instrument in the events in a specified environment. They are popular due to unique and advance property of wireless sensor but they have fundamental problems like limited battery life, overhearing, coverage area, node deployment, blindness and much more. This paper will address various issues related to wireless sensor networks in environmental field. The various challenges comprehended in wireless sensor network while constructing the deployment algorithms and communication protocols are coverage area, efficient data gathering, sensor lifetime and overhearing.

Index Terms— Wireless sensor network (WSN), deployment, data gathering, coverage and protocols.

1. Introduction

A wireless sensor networks (WSN) are the spatially distributed autonomous devices that wield sensors to invigilate physical or environmental conditions. Wireless sensor network epitomizes a new generation of real time embedded system with considerably different communication constraints from the traditional network system. Basically, the wireless sensor network is comprised of computing, communication and sensing elements which gives the opportunity to the administrator to monitor an object and sense the events in a specified environment. The wireless sensor network consists of four basic components:-

- The centre point of clustering information,
- A congregation of localized or distributed sensors,
- A set of computing methods to maintain the current events and
- The intercommunication of the network.

In wireless sensor networks the data is forwarded through the number of nodes from the base station, where these nodes are also known as motes. Basically, motes are the wireless devices which are multifunctional and energy efficient. In other words, motes are the tiny computers that work collectively in order to form a network. Motes are the key for environmental applications of wireless sensor networks. A group of motes gathers the signal from the environment to execute a particular target.
are hundreds or even thousands number of sensor nodes in wireless sensor network while other sensor network like, Ad hoc networks have very less number of nodes and even without infrastructure.

The objective of this research is to comprehend the various challenges in wireless sensor networks in constructing the deployment algorithm and communication protocols, thus the result show that there is limitation in energy efficiency to cover a large area, delay in data gathering and forwarding, overhearing and lifetime of sensor nodes.

**Figure 1.** Model of wireless sensor network

2. Implementation of wireless sensor network

2.1 Data gathering and aggregation

Wireless sensor networks are used in environmental fields and have large number of applications of gathering and disseminating data from environment for compiling and recording the information before transferring to the applications where its lies and to the base station. The function of wireless sensor network is to gather and forward the data to the base station or sink. The problems in data gathering are:

- lessening the shearing data in large scale, unsecure data aggregation in a multi-layer large sensor, the processing of big data with specific component is difficult, no energy consumption in data aggregation mechanism and in analyzing of large amount of data, no processing securing and analysis can take place.

Above mentioned challenges have been summarized in tabular form for better understanding in the field of data aggregation strategies in wireless sensors networks and shown in Table1.

**Figure 2.** Shows single hop and multi hop approaches
2.2 Wireless sensor network protocols

The shearing of medium access in wireless sensor network is the major factor in determining the performance of a wireless sensor network in outer world. To overcome this problem several methods have been developed to solve the medium access shearing problem. To provide the balance between getting the better-quality resource allocation decision and the necessary process to reach this decision several methods attempted by various mechanisms.

![Basic protocol stack](image)

**Figure 3.** Basic protocol stack

2.2.1 Parameters of wireless sensor network protocols

A. Limitation of energy

The energy source in wireless sensor networks is battery which is non-rechargeable. The life of wireless sensor network is fully depending on battery which causes a problem of limitation of energy. Low-energy adaptive clustering hierarchy—LEACH is the approach which is designed to collect and deliver data to the base station. Basically, low energy adaptive clustering hierarchy is a routing algorithm. In this approach network is converted into the set of clusters. Every respective cluster is controlled by the specific cluster head. Multiple tasks can be performed by the cluster head, collection of data from the other cluster members, aggregation of the data and forwarding the data to the base station to the base station directly etc. Power-efficient gathering in sensor information system—PEGASIS is also a routing algorithm design in order to transmit and receiving the information to the base station. PEGASIS has two main objectives, first is to decrease the delay so that data reaches on time to the base station and second is to provide high energy efficiency and energy consumption to increase the life time of the networks.

B. Coverage

In many wireless sensor networks energy is supplied by the RF source through antenna which enables the sensor nodes to cover the entire environmental area. Wireless sensor network are deployed in environmental field to sense and observe the remote and sensitive area which should require an excellent covering. Due to this, the deployed sensor should sense every part of the deployment area or sensed by at least one active deployed sensor.
C. Energy efficiency
The succession of deployed wireless sensor network is based on its energy consumption. The energy efficiency is affected by the sensor size, unavailability of power sources and unreachable locations. So it is very important to achieve the lifetime performance of wireless sensor networks by enhancing battery life.

3. Comparison of study

| Challenges                                                                 | Clustering | Processing Gathering | Processing Analysis | Securing | Energy Saving |
|---------------------------------------------------------------------------|------------|----------------------|---------------------|----------|---------------|
| Lessening the sharing of data in Large-Scale Wireless Sensor Network       | Yes        | No                   | No                  | No       | No            |
| Data aggregation in a multi-layer big sensor networks                      | Yes        | No                   | No                  | No       | Yes           |
| For large data in Wireless Sensor Network, enhancement of the compression of data aggregation | Yes        | No                   | No                  | No       | Yes           |
| Data aggregation with specific component analysis in big data wireless Sensor Network | Yes        | No                   | Yes                 | No       | Yes           |
| Data aggregation Mechanism for desired privacy                            | Yes        | No                   | No                  | Yes      | No            |
| Analysing of large amount of data in wireless multi sensors systems        | Yes        | No                   | No                  | No       | Yes           |

Author represented a grid based uniform deployment technique for large scale network in order to reduce the number of sensors. This algorithm is also used to achieve the efficient deployment when best detection performance is required [1]. Author has given node deployment algorithm which is divided into two parts, first is continued point based deployment and second is grid point based deployment to achieve the connectivity and coverage in wireless sensor network. Node deployment algorithm is divided into two parts, first is continued point based deployment and second is grid point based deployment to achieve the connectivity and coverage in wireless sensor network. The strategy ensured is to provide sufficient routing path and at least one sensor is monitored at every point of interest [2]. Some researchers have worked for monitoring and rescuing snow landslide victims, a path loss model has been deployed in various outdoor wireless sensor network applications. The path loss was defined on wireless sensor networks at 2.425GHz by the practical sensor nodes on a road. This happened by measuring the radio frequency in snowy environment [3]. Author provides a ground-based sensing network for remote sensing applications in order to measure number of surface parameters which are land area, surface temperature and the moisture of soil. They have also deployed layout at pixel scale depending on the parameter’s heterogeneity with length and width about one kilometer. Author has proposed a partial matrix completion algorithm to analyze and recovered the missing data in wireless sensor networks. Due to this objective, matrix completion scheme uses Spatio-temporal compressive
data collection (STCDG) by reducing the traffic in wireless sensor network. This scheme is also applicable in low rank and short-term stability [4]. Author has presented Multi-channel network coding clustering in the presence of bit error rate and high packet in order to collect mobile data. Multi-channel network coding clustering (MuCC) is applied in global field by performing number of field operation on each and every bit where the bits are divided into multiple packets mathematically [5]. Some researchers have presented two step approaches for data gathering by charging the jointly selected nodes. The scheme is performed by two steps, first is to dictate the mobility of the sensor for each time period where the data is gathered on located charged sensor nodes and second step is to studying about the schemes to get brilliant data gathering performance where the sensor penetrates amongst the different points. This scheme also increases the utility of the network and adjusted data rates [6].

Author have proposed an Acknowledgement (ACK) protocol and the main objective of this scheme is to focus on the designing of protocols for wireless sensor network so that time synchronization takes place in sensors network in order to reduce the overhearing of neighboring sensor nodes. In wireless sensor network time synchronization is a very challenging aspect that increases the sensor cost and data fusion [7]. Author have given a fully distributed and effective PKC-Based DoS attacks-resistant scheme on Public-key cryptography (PKC). In wireless sensor network Public-key cryptography (PKC) gains large interest because it uses only Diffie-Hellman key and digital signatures which overcomes the problem of authentication and different problems. Public-key cryptography (PKC) can be failed because of the false messages sent by the attackers. So this scheme takes full responsibility of public key cryptography (PKC) operations by continuously dropping the messages which have differential PKC requests [8]. Author has represented a preamble sampling mechanism for medium access protocols (MAC) in wireless sensor networks to save the energy. In this technique, the nodes goes on a sleep mode and off their radios to avoid the unwanted listening and waking up for a short period of time simultaneously to receive the information and to check the channel’s status. The preamble was transmitting when the nodes detected the transmission action in the network. The preamble sampling takes place between the single and general transmission [9]. Author presented hybrid medium access protocol for wireless sensor networks in order to save the energy and increase the life time of the sensor motes. This protocol is basically designed for personal stations. The hybrid medium access protocol is divided in to two parts, first is time division multiple access (TDMA) specially designed for increasing the energy efficiency and life of the network and second is carrier-sense multiple accessing with collision avoidance (CSMA/CA) protocols which is mainly designed to save the energy of wireless sensor networks [10].

Some researchers have showed the outcome in over-dimensional wireless sensor network, wherein the sensor nodes in this scheme need to go to the rest mode or sleep mode when the temperature is low and perform normal functions when the temperature is inflated. So that the energy is only allowed to the working nodes and saving energy by now allowing energy into the sensor nodes which are in sleep mode [12]. Author have developed an intelligent hybrid power system for self-sustaining wireless sensor network which have energy management system to control the power distribution, solar panels that contains thermoelectric and photovoltaic generators for energy conversions and lithium battery work on reservoirs. One of the main limitations of this scheme is that the battery discharges after every two hours and it has to be recharged again. During the charging the work is stopped [13].

In this paper, a reinforcement learning-based sleep scheduling for coverage (RLSSC) scheme is represented for solar powered wireless sensor networks to get the desired coverage area. The scheme followed has two-step scheduling mechanism. In first mechanism, all sensor nodes are divided into groups in order to get desired coverage area. In second step Q-learning mechanism is designed which enlarges the sensor nodes into multiple groups. This scheme schedules the sleep time of sensor nodes so that the other nodes do not interfere with the selected sensor nodes information and it reduces the energy consumption of the wireless sensor network [14]. Author has designed a Modulated backscattering (MB) Technology to get communication area by using an external radio frequency (RE) power sources in wireless passive sensor networks. These techniques enhance the lifetime of the WSN because the energy
is supplied by RF external sources through antenna. So, when the antenna is switched on the information is transmitted to the desired communication nodes in wireless sensor network [15].

4. Gaps in study

- On surveying these papers several gaps are found in the algorithms and technologies. The grid-based deployment techniques designed by various researchers are very complex.
- The shortcoming of the algorithms applied are modified to get desired outcome but at the cost of increased complexity in hardware and software.
- The other deployment algorithms are only applicable for large scale system and require more sensors to cover the region which increases the sensor cost.
- The data gathering schemes have limited storage and are only applicable on multiple nodes and have higher chances of overhearing due to higher cluster members.
- The Acknowledgement (ACK) protocol, PKC-Based DoS attacks-resistant protocols and medium access (MAC) protocols are limited to small scale systems and conserve more residual energy.
- In many schemes of wireless sensor network only few sensor nodes are worked actively by sensing their own temperature and large numbers of nodes go to sleep.
- For self-sustaining wireless sensor network, an intelligent hybrid power system is developed which has energy management system to control the power distribution, solar panels that contains thermoelectric and photovoltaic generators for energy conversion and lithium battery work on reservoirs. One of the main limitations of this scheme is that the battery discharges after every two hours and it has to be recharged again. During the charging the whole of wireless sensor network’s work is stopped.
- The cost of new generation wireless sensor devices is very high and difficult to understand.
- Wireless sensor devices are mainly based on the embedded system which is very difficult to understand for a non-programmer.
- Continuously increase in the delaying of messages shows the unreliability of wireless sensor networks which occurs when the collective data provided by the target cluster depends on single node not on any nodes.
- A ground base sensing network is deployed and its layout at pixel scale depends on the parameters (land area, surface temperature and moisture of soil) heterogeneity with length and width only in one kilometer.
- Some of the wireless sensor network algorithms require external source of radio frequency which decreases the portability of the wireless devices.

5. Conclusion

Now a day’s wireless sensor networks have become novel, wide and most popular area for researchers due to its best performance in the commercial and industrial applications because wireless sensor networks uses low power computing embedded devices and advance communication and processor. Wireless sensor networks accomplish many tasks which include smart sensing, data aggregation, data processing, storage etc. To perform these tasks large numbers of algorithms are designed. Some gaps are found after surveying the relevant literature/algorithms. The issues finding in various research papers in wireless sensors networks are given in this paper. The demand of wireless sensor networks increases day by day. This paper provides aspects to look on the various concept of wireless sensor network. Researchers have studied all the possible aspects but still there are many issues which need to be resolved. Reducing the gap between the applications and technology is a major issue that needs to be resolved in wireless sensor networks.
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