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Power distribution to reduce interruption distortion and Diversity Order Analysis in wireless sensor networks

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Abstract

Recent years have witnessed rapid and clear development in wireless sensor networks because of the urgent need for it in many fields such as automatic monitoring and control. The importance of WSN is evident in its use in many applications in various areas of life and developing and improving these networks occupies a necessary and important area of interest for specialized institutes and many research centers. The main benefits of using WSN technology include low cost, self-organizing process of the WSN, and low power consumption. Nevertheless, there are still many difficulties remaining in practical. Paying attention to the structures of these networks as a gateway to improving their performance is considered one of the most important techniques and methods that have given great outcomes in this field. The structure of cluster is also

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considered one of the greatest significant structures that have received significant attention in recent times. Therefore, this research aims to provide insight into power distribution to reduce interruption distortion and analyze diversity ranking in wireless sensor networks. The results obtained from previous studies confirmed that there is an important improvement in terms of reducing consumption of energy and hence increasing the life span of network that is, ensuring that the network operates for additional longer periods, compared to the traditional cluster. Nonetheless this was at the cost of slightly lower transmission and delivery rates in the networks. Therefore, balancing the energy consumed between nodes within networks is the purpose of energy-efficient routing protocols. These protocols need to maximize the lifetime of the wireless network. There are many algorithms to try like the A-star algorithm or use a mathematical formulation by changing the permittivity factor to a better value where we have high remaining energy within the network and setting it to a lower value for the nodes that do not have much energy left.

Key words: Power distribution, interruption distortion, sensor networks, diversity order, power allocation, wireless sensor networks.

1. Introduction

Recent years have been an increasingly urgent need for communication between devices utilized for real-time remote control and monitoring. Therefore, WSN technology developed as a result of this requirement and need [1]. WSN is a collection of distributed computing, entrenched system technologies, and wireless communications, such as sensors. Through their collaborative efforts, sensor nodes can sense, analyze and then transmit all

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the data, so they are very important and allow monitoring of phenomena of interest in real time, in addition to controlling motors across a wide area and in different places. Low cost, self-organized operation, low power consumption, and cooperative effort are among the most important characteristics of sensor networks [2]. Due to these capabilities and characteristics, sensor nodes can be placed in many hard-to-reach places, while continuing to operate for long periods thanks to the use of batteries and solar panels as primary sources of energy. Many applications and fields that require low power consumption and low data rates can greatly benefit from sensor networks [3].

In view of the significance of these networks and their many applications, it was necessary to pay attention to performance, and the performance of the network is its work and the accomplishment of its tasks in delivering data to the required destination in the best ways, and knowing the factors affecting performance to work on improving them and then improving the performance and the work required to be accomplished by the network. The most important of these factors is the method of data transmission between the nodes that make up the network, the method of placing those components, as well as the amount of energy consumption by the sensors, as reducing the amount of energy expended will ensure that the network operates for longer periods of time, by prolonging the life time of the sensitive nodes, without the need to replenish the energy source inside the sensor. Many studies have clearly focused on the performance of the WSN, in general, and the problem of node life time and increasing the delivery rate in particular [4].

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The research [3], focused on organizing the nodes that make up the network into groups, as it has recently been proven that the life span of a network with groups is greater than in the case of a cluster network. Each cluster has a head (CH) (head cluster) responsible for it, which receives the packets from all the nodes in his cluster are collected and sent to the BS (Station Base) located outside the monitoring area. Moreover, it showed that the head acts as a central controller, but it suffers from a severe lack of energy as a result of its dealing with the heads of other clusters in multiple hops. Thus, the energy consumption rate in the vertex is better than that of any other node, and in order for communication with the entire network to remain alive as long as possible; the BS (Station Base) (BS) remains alive as long as possible. Therefore, the number of nodes in the clusters closest to the station is smaller than in the farthest clusters [4].

In Addition, research [3] Some research showed that putting the node into a sleep phase when it is not needed, in which most of its radio circuits are closed, meaning energy is saved, and then it returns to work and enters the active phase. Nonetheless, it has also shown that Performance can be improved by reducing energy consumption by reducing the size of the packet sent by each node of the head [3]. This is done by performing a compression process at the sending end, then a decompression process at the receiving end. This method has proven effective when transmitted by each node individually to the destination required, but there is difficulty in applying this method when transmission is done through several successive nodes. While it has also resorted to this by developing new protocols to save energy during data collection and processing operations and has deduced algorithms to improve performance of network, to increases the network's life time and reduce consumption of energy as the cluster heads are chosen dynamically, but the negative of these algorithms appears when the cluster heads are forced to broadcast messages to all neighboring nodes with additional, excessive energy consumption [3].

1.1 Problem statement

WSN is distinct from many networks in that it is set up wirelessly without using infrastructure. Sensors are typically battery-powered, mass-produced, low-cost sensors with limited, simple power, communication, and processing capabilities. It is expected that as technology evolves, sensors will become smaller, which indicates how small a sensor node actually is compared to its large effectiveness and high efficiency. Because sensors are intended for single use only and may be placed in hazardous or difficult-to-access environments, battery replacement is usually expensive and unnecessary. The three operating modes that WSNs (and ad hoc networks in general) use to operate are transmit, receive, and “listen” mode. Each operating mode uses power differently [7].

Furthermore, power is typically used for transmission as well as circuit performance such as digital-to-analog converters. Obviously, transmission power is further important for long-range applications than circuit power, and transmission power is similar for short-range applications [5]. For wireless sensor networks in particular, effective management of the power/energy consumption of sensors is important and vital because ad hoc networks (WSNs) depend significantly and obviously on the rate of energy consumption in various domains. In WSNs, power distribution

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control is a technique utilized to regulate the sensors transmission power in different places. Within power control, WSNs may be distributed, or a combination of the two. When using centralized power control, each network parameter must be collected by a central processing unit, which calculates the power allocation and sends the result back to each sensor. Therefore, increased communication burdens are necessary for centralized power control.

The UCS (unequal size clustering) algorithm worked to achieve a balance in energy consumption by controlling the cluster size through the distance between the cluster head and the station, as well as controlling the cluster angle, which led to a rise in the network's life time [6]. It also determined an ideal size for the cluster to prolong the network life [3]. However, such studies remain difficult to implement due to the lack of the necessary requirements and capabilities [3]. The study was to achieve the desired goals of multi-use sensor networks, without causing any interference, and to solve the problem of narrow frequency spectrum where there was no any previous protocols for spectrum management, and suggested finding new designs that would guarantee the assignment of different frequencies to different nodes, at different times and in different locations [3]. The SAS layer (service spectrum adaptive-self management) was proposed above the physical layer, to achieve better service in spectrum management.

When it comes to regulating power distribution and analyzing diversity, sensors often have the ability to calculate power based on many local data, including data collected from sensors close to them. A little data is sent between the sensors and the CPU in partially centralized/distributed power distribution ways, and the computation is done at both ends [7]. The issue

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of power consumption, power distribution to reduce interruption distortion, and diversity ranking analysis in WSNs is very benefit for the future; this encourages the researcher to conduct study to study power distribution to reduce interruption distortion and analyze diversity ranking in WSNs.

2. Literature review

2.1 Wireless Sensor Networks (WSN)

WSN is defined as a network consisting of a group of sensitive nodes, spread out in a medium that senses the environment in which it is located through information collected via a wireless connection, and the data is transmitted in packets across the network, through hops that pass through gateways. Crossing, or communicating with other networks such as the Internet. This network is used to monitor or transmit a physical or chemical phenomenon (such as humidity and temperature). After that, all information is transmitted wirelessly to the data processing center to obtain the result without the need for a human being in the place where the phenomenon occurs, whether chemical or physical [3], figure 1 shows an example of WSN.

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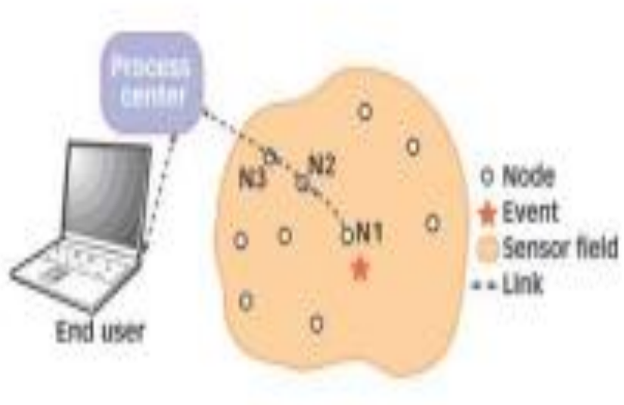

Figure 1: An example of a WSN.

The wireless sensor network has recently appeared significantly, as the wireless sensor network in the twenty-first century began to develop at an accelerated pace as one of the best emerging technologies in last ten years. In recent years, many research and scientific papers have been conducted on the wireless sensor network to improve and develop it in all aspects and fields, including its construction, routing protocols, node operating systems, data collection and integration, and time synchronization.. In the recent period, with the conveniences provided by the wireless sensor network, life has been noticeably affected and changed a lot in several methods [3], [7]. The system model used in this paper for a cluster-based WSN architecture of Nr receiving antennas is shown in Figure 2.

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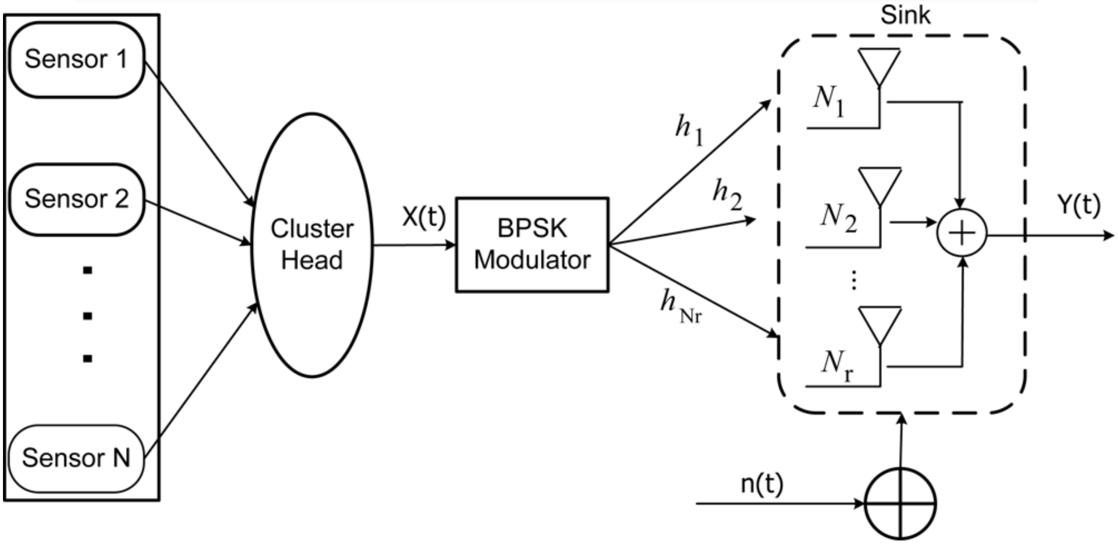

Figure 2: High-Level System Model.

2.2 Approaches of Power Management

Power efficiency is a major concern in WSNs. Many challenges and difficulties in achieving sustainable operations of WSN have been widely explored in the scientific community [8] since existing batteries contain a limited amount of energy. The solutions fall into two basic categories: environmental energy harvesting and energy saving technologies.

1) Energy-Efficient

In energy-efficient approaches, enhancing the basic functions of sensor nodes and their communication methods leads to improving and enhancing energy efficiency in many areas. In wireless communications, data transmission uses much more energy than other sensor node operations such as data processing and sensing [9]. Using energy metrics to determine the best paths based on the remaining energy of sensor nodes, the routing algorithms in [10] successfully balance the energy distribution of all sensor nodes in the network [11]. Several variations of the clustering hierarchy described in [12] significantly reduce energy usage in WSNs by selecting appropriate cluster heads to minimize transmission and data aggregation distances. Mostly, the MAC layer is responsible for implementing another suitable power management technique. The MAC protocols in [13] allow the duty cycle to be changed based on a spreadsheet by specifying time parameters within a special window in a synchronous manner, which greatly reduces the amount of time spent in idle listening. In cluster-based network architecture, there are generally two ways to achieve energy saving: remote processing and task migration, which can be compared to data aggregation. The decision-based randomization method shifts tasks from sensor nodes to the server using an energy-efficient strategy, thus reducing the overall energy usage [14].

2) Energy Harvesting Approaches

It has become clear that suitable energy-efficient approach to manage and reducing energy consumption are well designed by the special considerations in order to optimize and enhance the residual energy utilization of sensor nodes. Furthermore the sensor nodes may be powered by a range of potential ambient energy sources. The primary sources – solar energy, human movement, vibrations, and thermal gradients were obtained by the authors in [15]. It has been shown that solar energy harvesting methods can significantly rise the lifetime of WSNs [16, 17]. For energy harvesting WSNs, a variety of adaptive service cycling techniques for energy harvesting have been proposed in [18]. The goal is to maximize the use of the harvested energy and achieve an energy neutral process. Several analytical models are presented in these works to identify and predict energy harvesting sources, their availability, and appropriate task allocation [19]. The goals of duty cycle conscious harvesting technology are to achieve energy neutral operation, increase work performance, and reduce duty cycle fluctuations. Furthermore, Raghunathan et al. presented a system architecture analysis of solar-powered sensor nodes, including design concerns and the harvesting module. References provide empirical research on solar energy harvesting systems [20].

2.3 Power allocation in orthogonal MAC and coherent

WSN are useful in a wide range of situations. An important and key issue from the perspective of minimizing energy usage in sensor networks is to determine the optimal power allocation. Within the framework of codeless transportation, several previous studies have examined the challenges of multi-sensor estimation and identified the most prominent concerns related to power/energy efficiency [21]. In Figure [3] a diagram of the wireless sensor network architecture with integrated harvesting, sensing and communications.

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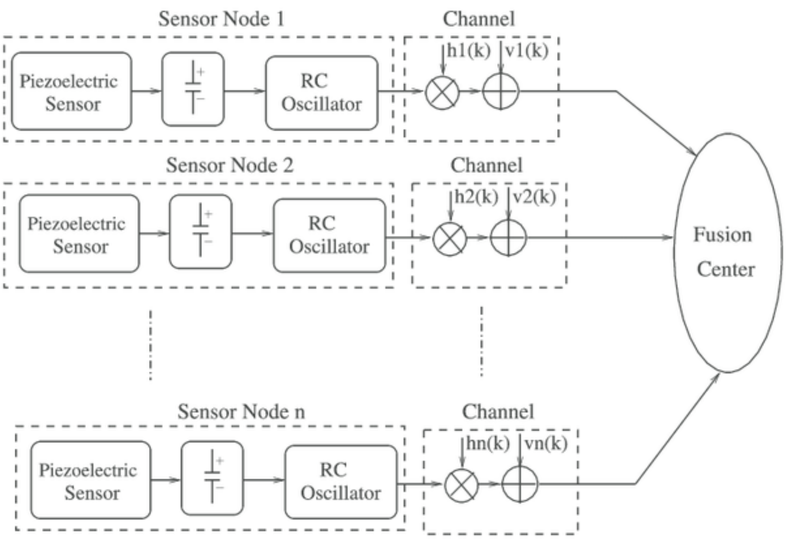

Figure 3: The block diagram of the wireless sensor network structure with integrated harvesting, sensing, and communication.

In distributed estimation, the sensors collect information about a particular physical phenomenon on their own and send it directly to the central dispensation unit, also known as a fusion center, which typically uses sensor measurements to try to reconstruct the physical quantity.

Many recent researches [23] showed that transmission using uncoded analog forwarding of readouts through many sensors is completely optimal in a sensor network of Gaussian. In [22], the researchers used analog and forward amplification with a coherent MAC to determine the best power allocation for a heterogeneous Gaussian WSN while adhering to the distortion constraint.

Finally, they demonstrated that a network of this type may achieve an estimated diversity proportional to the total number of sensors within the network. When compared to an ideal channel setting, it has been shown that the diversity gain remains constant when the channel estimation error

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is included. A broad class of fading distributions has been studied with respect to discontinuity and diversity scaling laws for distributed discretization over multiple orthogonal access channels [7].

2.4 Power Allocation for Distortion Minimization in Distributed Estimation

Recently, several previous studies and literature have examined cross-layer optimization to rise the energy-constrained WSN lifetime. Through this kind of collaborative adaptation, they developed an online heuristic that may keep an important energy amount. The issue of energy-efficient transmission scheduling with delay constraints—both deadline and average delay constraints—has been studied in work. Investigation was conducted on how to save more energy and manage it better by using channel coding and electrochemical processes that allow batteries to recover full energy when not in use. The propose was joint optimization for energy and bio impact management, as well as joint optimization for congestion control and media access control, using a cross-layer optimization approach on wireless biosensor networks in interference-limited WSN. The results indicated that the lifespan of power-limited networks can be extended through the use of several transmission techniques such as interference mitigation and load balancing [7].

Some studies have provided solutions to the issues of reducing the deformation sustaining capacity and reducing the deformation sustaining capacity of multiple orthogonal access channel (MAC). The optimal

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problem of power scheduling was studied using a deconvolved modulated quadratic transmission approach and a global decentralized quantization/estimation technique. Moreover, data security and privacy are important and necessary in many scenarios, including security systems, smart buildings, and hospitals. However, integrating security is very difficult. This is because traditional encryption and cryptography methods require high computational power and capabilities, making them impractical for use in WSNs. In fact, cryptographic systems with small key sizes may not work if the eavesdropper has access to sufficient computing power. Therefore a different approach to achieving data confidentiality is presented by Shannon's concept of perfect security [7].

Research [24], [25] worked to improve performance and prolong the network's lifespan, through what was called ideal flow control, as the congestion occurring in the link was taken into account, as well as the energy efficiency of each sensor. The peculiarity of this research is demonstrated by establishing the system model used, which relies on node diffusion algorithms, to organize movement between components. The research [26] proposed an action plan to improve network performance by increasing the life time of a linear wireless sensor network (i.e. linear placement) by reducing the volume of transmitted data and achieving a balance in the flow. The study showed that the return is maximum, that is, achieving the best possible increase in network life when work is done on Both data compression and control of its flow at the same time. The peculiarity of this study is that it is used when the sensors are placed in a linear, sequential manner, as in networks monitoring power and gas transmission lines, monitoring public roads, etc. The researchers in [27],

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[28], and [29] proposed applying the cluster tree to reduce energy consumption while maintaining the data transmission rate, as well as maintaining a high packet delivery rate between the terminals and the base station. Our research will focus on modifying the cluster tree algorithm to ensure lower energy consumption while not decreasing the transmission rate below the limit that ensures that WSN networks in the proposed applications work well [3].

2.5 Diversity Order Analysis in wireless sensor networks

Theoretically, the cooperation use to produce diversity in WSN was examined in [30], where the cooperation rate region was accessed using Markov overlay block encoding and inverse decoding, subsequently, many decoding, amplification and forwarding methods with minimal complexity have been proposed and investigated in [31]. Each node in these studies was considered to have a common transmission power. Recently, several resource allocation issues for collaborative diversity systems have been examined in [32].The best power allocations for amplification, decoding and forwarding protocols are found in for parallel relay AWGN channels. The best allocation is determined by solving a series of nonlinear equations, which calls for the use of iterative techniques.

In many modern communications disciplines, scheduling approaches to reduce co-channel interference have been documented and the diversity advantage in a multi-user environment has been widely investigated. However, there are not many researches that examined multi-user scheduling and communication performance in the WPSNs context in the literature, such as [33]. Two scheduling strategies have been developed by

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the authors in [34] to enhance the secrecy performance in WPSNs, where the secrecy outage probability is utilized in order to measure the system performance. In addition, a joint selection technique is provided to select a friendly jammer and transmitter node for WPSN when passive eavesdropping is present. While the end-to-end SNR-based selection strategy provides adequate and improved outage performance in different system situations, a general selection mechanism for WPSN is proposed, which is compatible with many diverse channel state information needs and implementation-related challenges [33].

Many advantages of using receive diversity are described in [34] for WSN applications that need high data accuracy and resolution at the moment of event triggering in many fields. The collaborative diversity method with similar sensors randomly spread across an area; it improves and enhances connection reliability and increases network longevity. In practice, these situations present an access problem since the nodes are not powerful enough to send data directly to the remote receiver due to the low-power transmitter design. Moreover, a distributed method is provided that can compute linear signal expansions for a sensor broadcast protocol where all sensors collect associated samples, broadcast to all other sensors an encoding bounded by their sampling rate and generate an estimate from the whole field. Sensors simply need access to samples from a small number of surrounding sensors in order to uncorrelate. Applications such as collecting data from a remote location are common. In addition, a distributed diversity strategy that uses geographical dispersion of sensor nodes was investigated and developed. However, in order to ensure

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increased network performance, optimal assumptions such as cooperation and concurrency are included.

Furthermore, the use of diversity methods in the receiver may significantly reduce power consumption, which directly affects and leads to decrease in battery consumption and thus an increase in network life, in addition to ensuring that data is received correctly in the remote receiver and thus leads to improved performance in specific field. Taking advantage of the variation in WSNs, several new relay mechanisms based directly on Luby switch codes have been presented in. It is accepted that diversity is implemented at the sender end, which then leads to a relatively low level of decoding complexity at the receiver. Although decoding and encryption operations need more energy, a group-based cooperative strategy for multi-hop WSN may reduce the consumption of energy. In addition, two distinct group-based models were used to study the efficiency of energy of cooperative multi-input, single-output (MISO) system for a multi-hop WSN. The data was encrypted using space-time block cryptography (STBC), which requires additional energy from the cooperating nodes to complete the encryption process [34].

3. Conclusion

This paper presented energy-efficient power allocation algorithms for WSN used in distributed estimation and diversity ranking analysis in WSN. In this paper, problems that require reducing the probability of distortion discontinuity are mentioned. Through previous studies, three power allocation algorithms based on full CSI were proposed and a theoretical analysis of the diversity order of discrimination discontinuity of each

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scheme was presented. In conclusion, the uses of WSN are an inspiration for many future ideas in many fields. Even with the development of many MAC and routing protocols and methods, there are still many problems and difficulties that require further investigation in many areas. This paper reveals that routing is a very challenging problem in WSNs due to the large number of threats and risks associated with transmission. It means that two major considerations - safe method and optimal path - must be taken into account while creating a routing system in many areas. As a result, it is highly recommended to use protocols that may extend the network lifetime and are clearly reliable and energy efficient.

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