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" OPTIMIZATION IN WIRELESS SENSOR NETWORKS TO EXTEND THE LIFE TIME OF THE NETWORK"

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ABSTRACT

Wireless sensor networks (WSNs) have been adopted by many industries, including disaster management, chemical and heavy industry, oceanography, and space exploration. One of the main problems of wireless sensor networks is their short life cycle. Many methods have been proposed to extend life. In this process, an auto-based algorithm is proposed whose purpose is to reduce the amount of information sent. In this approach, the head and size are not determined in advance. Instead, they are determined dynamically at the beginning of each iteration. Reducing the average power attenuation rate, reducing the number of dead nodes, and finally extending the network lifetime are three important issues in the design of routing algorithms for wireless sensor networks. This paper provides a comprehensive review of optimal routing protocols for wireless sensor networks to increase the lifetime of the network.

KEYWORDS : *Wireless Sensor Network (WSN), Latency, Clustering, Network Lifetime, Energy Consumption.*

I. INTRODUCTION

A wireless sensor network consists of a set of sensor nodes used to detect specific physical properties. The ability of microsensors to detect and process information and communication is increasing, allowing the realization of wireless sensor networks based on the integration of many microsensor nodes [2]. Wireless sensor networks have many applications. As wireless sensor networks develop, they will become an integral part of our daily lives. Future applications of wireless sensor networks require efficient and complex data transfer. Because wireless sensor networks have many sensor nodes that can recognize certain aspects of the body or environment. In order to obtain reliable observations and make correct decisions, the physical event or environment must be trusted by sensor nodes. Since the sensor node has a large amount of sensed raw data, the sensor node needs to process the sensed data and send only the processed data. In order to use the network effectively, the system must be able to manage itself. The basic architecture of the test module is shown in the figure below:

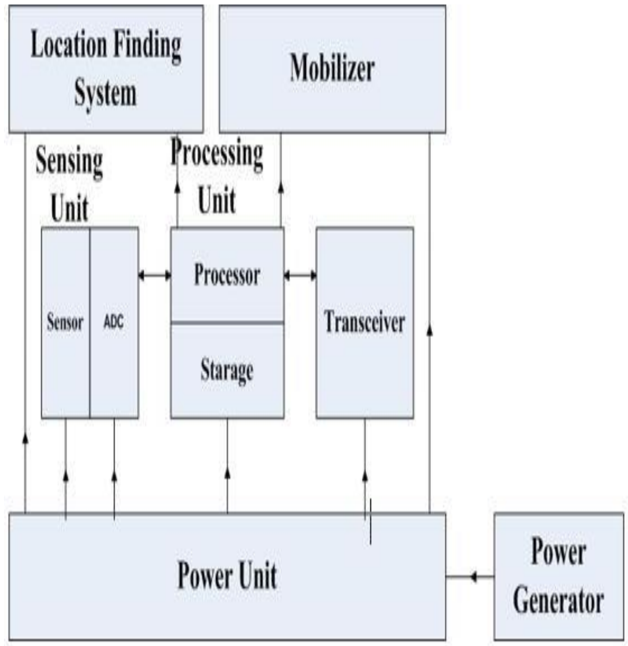

Fig.1 Basic Architecture of Wireless Sensor Network

The basic components of WSN nodes are:

1) Sensing unit,
2) Processing unit,
3) Transceiver unit
4) Power unit.
5) Mobilizer and Location Finding Unit

The sensing module is basically an amalgamation of the analog sensor which senses the analog data such as temperature, pressure etc. However, there is a need to convert the data into digital format which needs the analog to digital converter. The ADC processes the data and converts the data to be compatible with digital formats. There also exists a processor which processes the data and has a storage capacity in the memory. The data may be needed to be help for a while prior to transmission.

The transceiver is of fundamental importance which is responsible for the transmission and reception of data packets. The power unit is generally operated via batteries since it's not feasible to operate a line wired power source to the sensing module. The battery operated sensing module imposes the limitation of the power consumption and the network lifetime. This puts a fundamental necessity on the system of attaining a high network lifetime.
The mobilizer and position finding system are optional modules in the WSN. It may be needed to locate the sensing module at times and change its position. The position finding system does the work of finding the position of the sensing module and relaying the information to the control station. Typically, servo motors etc. are used as mobilizers. This however may be optional in WSNs.

II. ENERGY CONSUMPTION & LATENCY IN WSNS

If we consider an ideal situation, then all the nodes in the network can be assumed to be distributed uniformly. They would howeverhave different individual lifetimes. Thus average energy for round k can be given by $\overline{E}(r)$ of r^{th} round is as follow:

$$\underline{E}(k) = \frac{1}{L} E_{Tot} \left(1 - \frac{k}{R}\right) \qquad (1)$$

Here,

R is an indicative of the aggregate rounds of the lifetime of the WSN. M is the total number of transmissions L is the number of nodes.

The latency in the Network is given by:

$$L = \frac{1}{n} \sum_{i=1}^{n} T_i^s - T_i^r \qquad (2)$$

L is the average latency
n is the number of nodes
T_i^s represents the time at which data is sensed by node i
T_i^r represents the time at which node i's data is received by data sink

III. RELATED WORK

The following section summarizes some of the prominent work in the field of WSNs in a chronological order. It can pave the path for further improvements in the field.

Gamal et al. proposed that the lifetime of WSNs must be prolonged to increase their use for various applications. One of the most effective methods for improving the network's lifetime is clustering with the optimal cluster head (CH). This study proposes a fuzzy Logic (FL) low- energy adaptive clustering hierarchy (LEACH) technique-based particle swarm optimization (PSO). It employs hybrid PSO and a K-means clustering algorithm for cluster formation. It selects the primary CH (PCH) and secondary CH (SCH) using FL.

Huang et al. proposed a a communication scheme named first relay node selection based on fast response and multihop relay transmission with variable duty cycle (FRAVD) is proposed. The scheme can effectively reduce the network delay by combining first relay node selection with node duty cycles setting. In FRAVD scheme, first, for the first relay node selection, we propose a strategy based on fast response, that is, select the first relay node from adjacent nodes in the communication range within the shortest response time, and guarantee that the remaining energy and the distance from sink of the node are better than the average.

Cen et al. presented the idea of LANET: which stands for visible light mobile ad-hoc networks. The data transfer in this case was in the form of visible frequencies. It was shown by dint of the experimental set-up that the proposed system was capable of increasing the network lifetime as the power consumption compared to conventional techniques was lesser in the proposed case.

Liu et al. proposed the QTSAT model. This was primarily used for the delay minimization in wireless sensor networks. The system was basically developed using the MAC protocol for the WSNs. Power consumption was not the primary focus of the paper and throughput enhancement was targeted.

Quing Liu et al. proposed a technique for the implementation of unicast-broadcast mechanism for WSNs. It was shown that often, unicast mechanisms in a broadcast network can provide more energy saving compared to conventional techniques. The evaluation of the system was based on the energy required per transmission.

Mathews et al. proposed a technique for software defined radio (SDR) concept for wireless sensor networks. It was a new approach for the design of Software Defined (SD) based WSNs. The information leveraged in this case was the channel information of the WSN for increasing the network lifetime.

Zhan et al. presented the concept of UAV enabled data collection in wireless sensor networks. The idea was to increase the lifetime and decrease the delay latency of the network by switching to the UAV technology of the network. The evaluation parameters were the network lifetime and average delay.

Yuxin Liu et al. proposed a technique for secure and trustworthy techniques for data routing in WSNs. The approach evaluated the chances of data theft in Wireless Sensor Networks in the absence of strong encryption algorithms which may not be practically possible in real life situations due to the limitations of the sensor module.

Ren et al. evaluated the lifetime and energy holes in Wireless Sensor Networks. The technique tried to evaluate the free spectrum and term it as a hole to avoid data congestion in the WSN. Lesser congestion would lead to lesser delays.

Dong et al. presented a concept to increase the lifetime and also decrease the delay in wireless sensor networks. The approach was tested under the constraints of reliability constraints of the WSN architecture. This approach was practical in the sense that WSNs are seldom highly reliable.

Khan et al. presented a VDGRA based approach in which a virtual grid based approach was used. The evaluation of the system was done based on network lifetime. It was shown that the proposed approach could attain a network lifetime of around 800 rounds of data transfer for a node count of 400.

Luo et al. put forth opportunistic algorithm approach for wireless sensor networks. It was shown that ss the network lifetime is of a key importance for the performance of the wireless sensor network, improvement and its enhancement can be very beneficial. This could be done using optimization based approaches.

Yao et al. presented a WSN architecture for delay minimization and lifetime enhancement in heterogeneous networks. It was shown that with Link heterogeneity one can get huge information transmission range easily. As it is more bound towards the link and connectivity framework it yields better and reliable links and connection paths for routing. It gives a good transreceiver which is greater in size and length.

Guo et al. presented an opportunistic flooding in WSNs. It was proposed that the routing and information exchange must be designed diligently such that the entire functions consume minimum power. Also the power consumption parameter hugely impacts the overall network functioning effectiveness and power of the sensor node.

Yang et al. proposed a Complete Targets coverage in Energy Harvesting based approach for WSNs. It was shown that the connectivity metric is of enormous use as it decides the protocol of the information transmission. Strong data exchange connectivity amidst the cluster heads and sensor nodes shall impact the time period of the sending and receiving of the data. Butun et al. presented an intrusion detection mechanism for wireless sensor networks. The approach was targeted at detecting the chances of possible attacks in WSNs. The need for the study arose due to the fact that node modules are not sophisticated enough to implement complex encryption algorithms to thwart off security threats in WSNs.

Ranjan Rout et al. presented a method for the increasing network lifetime using the duty cycle approach and network coding. It was shown that the technique of network coding could indeed increase the network lifetime. It was also shown that strong data exchange connectivity amidst the cluster heads and sensor nodes shall impact the time period of the sending and receiving of the data.

Yao et al. presented an approach in which it was shown that with Link heterogeneity one can get huge information transmission range easily. As it is more bound towards the link and connectivity framework it yields better and reliable links and connection paths for routing. It gives a good transreceiver which is greater in size and length.

Tyagi et al. proposed a survey on the LEACH algorithm used for clustering techniques. It was shown that clustering is of high importance in this context. The objective here has to be minimum energy consumption by the nodes. The sensor node is operated by battery hence the network lifetime then becomes dependent on the lifetime of the battery. So the routing and information exchange must be designed diligently such that the entire functions consume minimum power.

Ehsan et al. proposed a survey on routing protocols with the Quality of Service or QoS as the primary metric. The proposed system explained the need for the connectivity must all matter when the base station and control station interact with the sensor nodes and the user for the target data. So, proper connection between all the network nodes and units must exist for a robust WSN design. The Qos was responsible for rendering reliability to the WSN data transfer.

Aziz et al. presented a survey on different techniques on distributed control topologies for the increase in network lifetime of WSNs. The target was the increase in network lifetime for battery powered wireless sensor networks. It was shown that the adaptive routing algorithms could enhance network lifetime. The approaches renders insight into the common approaches employed to increase the network lifetime and reduce the latency.

IV. CONCLUSION

The evaluation parameters for the performance evaluation of the WSN are:

Energy Consumption

DC = 1/k (3)

Here,
DC represents the duty cycle.
K is the number of nodes among which a CH is selected.
It can be clearly inferred that as the value of K increases (duty cycle decreases), the number of nodes for which one CH is chosen also increases. This clearly decreases the energy consumption i.e. the energy consumption decreases with decrease in duty cycle and increases with the increase in the duty cycle i.e.

$$Energy\ Consumption = f\ (DC) \quad (4)$$

One Hop Delay

Also, as the group grows, that is, as K increases (DC decreases), the one-yard delay of the system increases, which is the only delay used in single packet transmission. Therefore, a decrease in DC increases the single-hop delay, while an increase in DC reduces the single-hop delay.

Network Delay

The network delay is often computed w.r.t. the distance from the sink. Clearly, as the distance from the sink increases, the time required for the data to reach the base station also increases i.e.

$$ND = (d_{sink}) \quad (5)$$

ND is the network delay f stands for a function of d_{sink} is the distance of the nodes from the sink

Energy Consumption and Residual Energy of nodes w.r.t. distance from sink

In case the node is far away from the sink, its chances for a long distance transmission reduces, hence it would transmit to a nearby node, thereby reducing the energy consumption. This would in-turn increase the residual energy of the nodes.

V. CONCLUSION

From the previous discussion, it can be concluded that it is important to reduce the delay and energy consumption of wireless sensor networks. This is important because a short lifespan can result in degraded performance of WSNs as the system will need to be shut down frequently. Another important factor is the delay or waiting time, and this time should be reduced as much as possible. This article provides a comprehensive review of current trends in the field to provide insight into future strategies.

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