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Optimization Technique For Enhance the Energy and Network Lifetime of WSN

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Abstract

A network of self-configurable nodes is the Wireless Sensor Network (WSN). Nodes are run using a limited, irreplaceable source of energy. Service of Node involves the sensing and data transmission to the base station. In this paper, a new routing algorithm based on ant colony optimisation, which uses particular parameters in its skills feature to reduce energy consumption and network node life. A new updater on pheromone has been developed to incorporate energy usage and hops into routing choices in this new algorithm known as life-length routing algorithms for wireless sensor networks. In comparison with AODV, clustering with the proposed routing algorithm could be seen by our results of several simulations. The proposed work deals with effective energy use, movement of nodes, problems with hidden areas and the routing of WSN architecture in a life time. The nodes of early deceased are reduced by the residue energy of the sensing node, the distance from the foundation and the adaptive sleep scheduling algorithms.

Keyword: Wireless sensor network, lifespan, sensing node, energy consumption and Ant colony optimization.

1 Introduction

A Wireless Sensor Network (WSN) is made up of sensing, computing, and communication components. This network monitors different parameters and responds to events in a predefined environment. Typically, the goal to be tracked is a political, commercial, civil, or industrial organization. A biological system, an information technology structure, or the physical world may all be considered the environment [1]. Monitoring, data collection, medical telemetry, and surveillance are the primary applications of WSN. A sensor network consists of four critical components: data collection from dispersed or localized sensors; an interconnecting network; a middle point of information clustering; and a group of computing elements at the middle point to manage event trending, data correlation, data mining, and status querying. Due to the massive amount of data collected, various algorithmic methods for data management are implemented, which plays a critical role in sensor networks [2]. The communication and computational infrastructure associated with WSNs is often explicit and well-established in the device. In sensor networks, in-network processing is preferred over all other options [3]. Furthermore, the node power (battery life) is a significant design consideration. The most recent R&D challenge is to improve low-power communication with low-cost on-node processing and self-organized connectivity/protocols. The need for an extended lifetime of the sensing node in spite of limited battery capacity is the next significant challenge [4-6]. The radio circuit should be carefully constructed with low power consumption in mind. WSNs require a high level of energy efficiency in wireless communication systems. Low power consumption of sensor network circuits is a critical factor in ensuring long operating times or lifetime. An ant colony optimization (ACO) algorithm family has been successfully used to solve some routing problems in WSN. Ant colony optimization has emerged as a leading Meta heuristic tool for solving combinatorial optimization problems over the last two decades [7].

WSNs usually achieve energy efficiency in three ways: To reduce data volume, local / in-network processing is used (to reduce transmission time). Low-Duty-Cycle operation and multi-hop networking greatly reduce the conditions for long-distance transmission. Signal loss (path loss) is, in fact, directly proportional to range or distance. Each node in the WSN functions as a repeater, reducing the need for the nodes to have a wide coverage range. As a result, transmission capacity is diminished. WSNs with cutting-edge architecture usually have connection coverage in multiples of several kilometres. Because of the reduced link coverage range and compressed data payload, the link budget architecture varies from the traditional device design [8]. In contrast, limiting power consumption when using a low-cost sensor node can pose significant design challenges. There are two main types of network architecture. The period during which the network is active, or the time over which it can complete all of its tasks (beginning with the specified amount of stored energy), is referred to as network lifetime. It can be described as the time until the first node dies. It is known as the first node failure or when a node stops working due to a lack of resources.

2 Literature survey

Xuxun Liu [9] suggested a novel scheme for maximizing the lifespan of WSNs. The Ant Colony Optimization (ACO) method was used, as well as the most energy efficient and most energy balanced distances. They started with two ideas: most energy-efficient distance and most energy-balanced distance. Using these notations, a mechanism for determining local optimal transmission-distance acquisition for high energy efficiency and good energy balancing was presented. This proposed mechanism provided the possibility of extending network lifetime. They announced a novel approach to determining network lifespan. A global optimal-distance acquisition scheme was suggested to achieve energy depletion minimization for network nodes that consume the most energy. This technique outperformed state-of-the-art approaches by a wide margin.

Halil Yetgin et al. [10] suggested a new scheme for improving network lifetime by cross-layer optimization of power allocation using scheduling and routing methods. They devised a two-stage network lifetime maximization process. They calculated the network lifetime based on the battery level of the source node since data is transmitted from the source node to the sink node through different paths, each of which has a different Route Lifetime value. The path lifetime value of the different routes originating from the source node to the destination node was initially evaluated. They described the Route Lifetime as the earliest time when the battery power of a sensor node along the route was completely depleted. The next stage measured the amount of all these Route Lifetime values until the source node's battery power was fully depleted. The route lifetime value of each alternate was determined using cross-layer scheduling and power allocation optimization. They suggested the Exhaustive Search Algorithm (ESA), a high-complexity algorithm, and the near-optimal Single Objective Genetic Algorithm (SOGA) (SOGA). They demonstrated that the SOGA outperformed ESA in terms of reduced complexity in a high-complexity network scenario. In terms of extending the network's lifespan, the proposed network maximization approach is more successful.

Cheng, D et al.[11] proposed the wireless sensor network routing power-energy ant colony algorithm, in which ant not only takes the distance from the sink node into account, but also the residue of the next node and the average energy path. This algorithm exceeds the standard ACA algorithm, in terms of balancing node power use and extending grid life.

3 The System Network Model

A common environment is needed for the analysis of the proposed algorithm. Therefore, a common network model is created and followed throughout the research. The following network parameters are taken into consideration and a few basic assumptions are made.

- Network is a homogeneous type, i.e. all nodes are equally equipped and identical.
- The base station is located outside the sensing field.
- Nodes are not equipped with GPS capable antenna.
- Data gathered from nodes are aggregated into single TDMA packet by Cluster Heads (CH).

- All nodes are in time synchronization, i.e., running with the same time period.
- The communication channel is bidirectional or symmetric.
- Nodes communicate with their neighbors within the coverage of those nodes.
- At any instance, the nodes are communicated and controlled by the base station.

Figure 4.2 appearances the transmitter and receiver of a node with their energy levels.

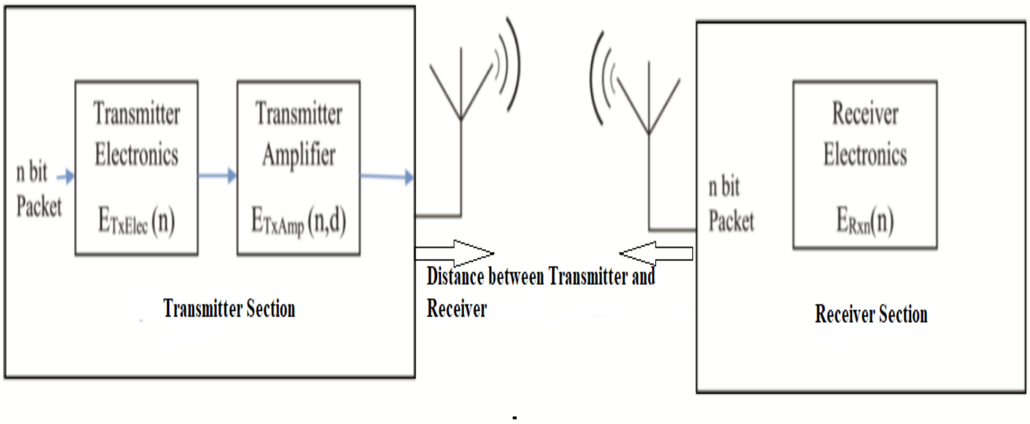

Figure 1. The transmitter and receiver section

'Eelec ' refers to the energy required to transmit or receive one bit of data. 'ETxElec(n)' refers to the energy available in the transmitter electronics. 'ETxAmp(n, d)' refers to the energy available in the transmitter amplifier. Energy required to transmit 'n' bits of information for 'd' distance with threshold 'd0' is given by,

$$ETxn\ (n, d) \ = \ ETxElec\ (n) \ + \ ETxAmp\ (n, d)$$

$$ETxn\ (n, d) \ = \begin{cases} nEelec \ + \ n \ \in fs\ d2, & d \ < \ d0 \\ nEelec \ + \ n \ \in mp\ d, & d \ \leq \ d0' \end{cases}$$

Where '$\in fs$' refers to SNR of free space model and '∈mp' refers to SNR of multipath model. Free space (fs) model or multipath (mp) model is used based on the threshold and the distance between transmitter and receiver.

To receive the above message (n bits), the receiver has to spend:

$$ERxn\ (n) \ = \ nEelec$$

Figure 4.3 shows the cluster formation flow. Each member node can be a CH for next round. As a result, some CHs drain their energy early, thus reducing the lifespan of WSN.

4 Ant Based Routing for Wireless Sensor Networks (WSN)

Ant Colony Optimization (ACO) is a metaheuristic nature based on the solution of complex combinatorial issues (CO). Pheromone model is the core part of the ACO algorithm.

As an optimization technique, the ACO uses the following two steps to solve complex problems:

The candidate solutions are used to adjust pheromone values in a way considered to be biased in the future sampling forward high quality solutions. The Pheromone Model is used for the distribution of the likelihood over solution space.

The basic routing for the Ant base contributes to the creation of an AntNet algorithm.

- Forward ant is started from source node to sink node in order to determine the optimal destination route.
- The key task of forward ant is to find the food source equally likely by using neighboring nodes with a minimum cost to sink.
- The routing table gets changed side by side as the ants switch from node to node to arrive at their destination.
- Forward ants measure all the time, congestion and node identifying information about the route followed.
- The backward ant that follows the same path as the forward ant, i.e. from food source to the nest, will be produced upon reaching the destination node.
- During backward travel, the agents are altered in accordance to the trail and goodness of the local routing table for each node visited.

5 Simulation Results and Analysis

The Simulation is carried out with a network scenario of a fixed number of targets and sensors randomly deployed around the targets. In this simulation, the sensors are considered as equal initial energy. Various iterations are carried out on the simulation of Clustering, Multi-hop Clustering, and the proposed Optimized Maximal Lifetime Coverage Scheduling. The observations are recorded and detailed analysis has been carried out. Particularly, the network parameters such as Average Residual Energy, Average Delay, Packet Delivery Ratio, Packet Loss, Network Lifetime, and Control Overhead are taken into account for analysis. In the simulation environment, it is considered that sensor nodes are deployed randomly with high density in a rectangular area of size 500x500 Sq.m. 100 homogeneous nodes with initial energy of 1 J are taken into account. The size of the data packet is predetermined as 600 bytes. It is depicted in Table. 1. Based on the results obtained from the simulation tool, comparative analysis is presented.

Table 1. Simulation parameter

Parameter Value	**Parameter Value**
Number of nodes	100
Network Grid	Network Grid 500x500 Sq.m
Initial energy of normal nodes	1 joules
Size of data packet	600 bytes

Average Residual Energy

The average residual energy of the nodes in the Clustering Method, AODV and ACO algorithm are compared and shown in Figure 2.

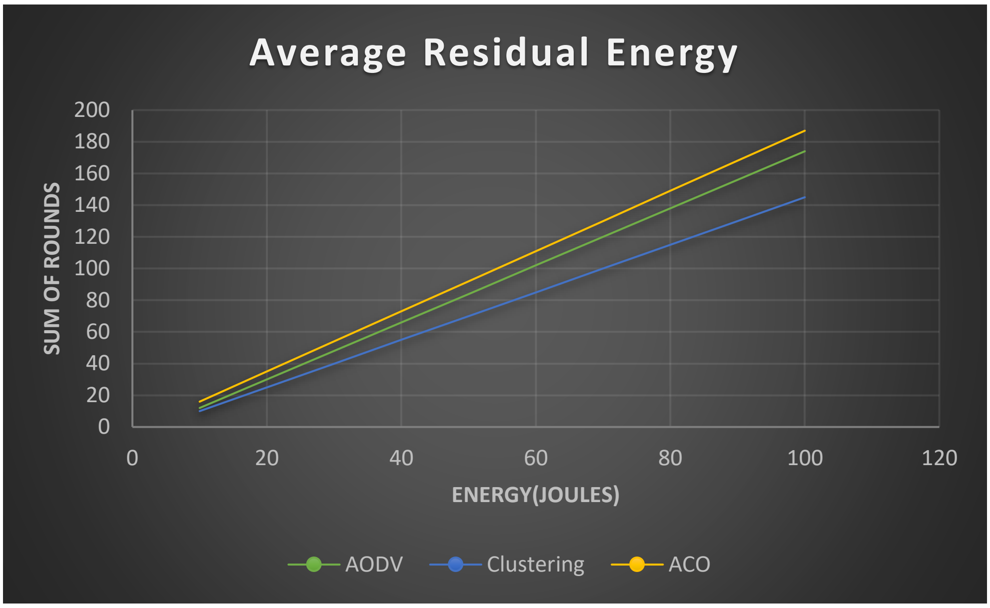

Figure 2. Comparative Analysis of PDR

Average Delay

It is observed that the average delay encountered in the transmission of data under ACO has been reduced considerably when compared to Clustering and AODV. The delay plays a vital role in pulling down the lifetime of sensors. This improvement has been obtained by the consideration of modified scheduling and the reduced data size in ACO and is shown in Figure 3.

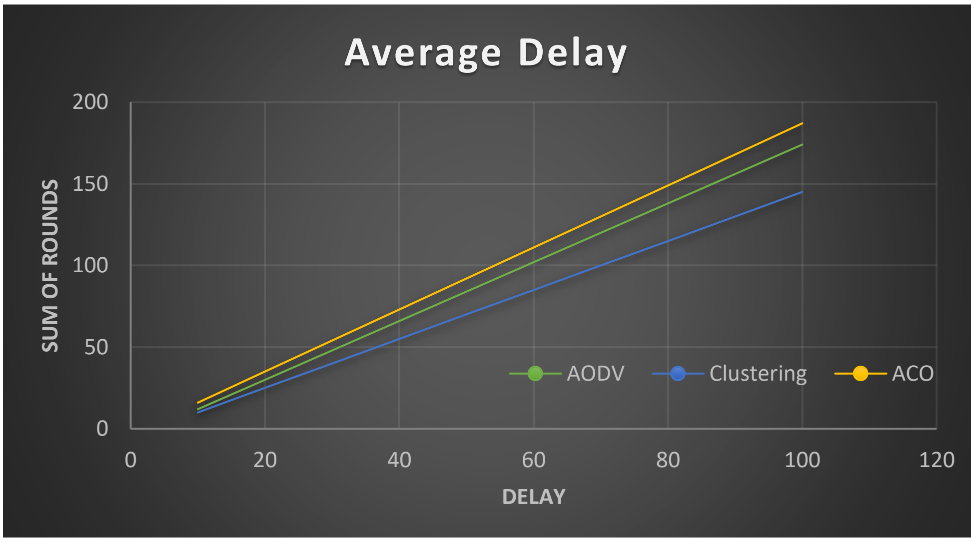

Figure 3. Comparative Analysis of PDR

Packet Delivery Ratio

Packet Delivery Ratio (PDR) is the measure in which the number of packets received at the receiving end is compared with total packets. It should be high for an efficient network system. Figure 4 shows the comparative analysis of the PDR values with different protocols. life time aware routing ACO offers higher PDR high values when compared to other systems.

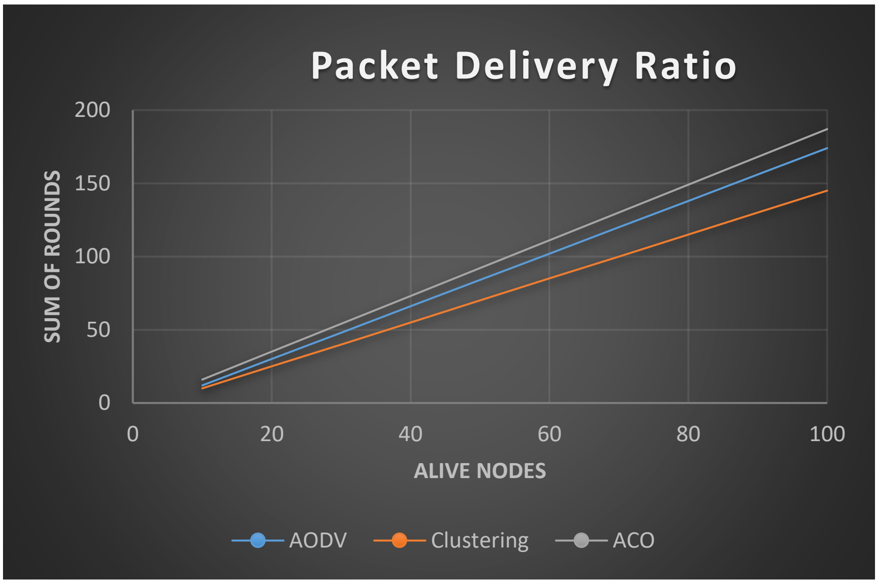

Figure 4 Comparative Analysis of PDR

Network Lifetime

The lifetime of sensor nodes is decided by the battery power. The adoption of a wide range of scheduling and routing algorithms may lead to a different level of power consumption in the sensor nodes.

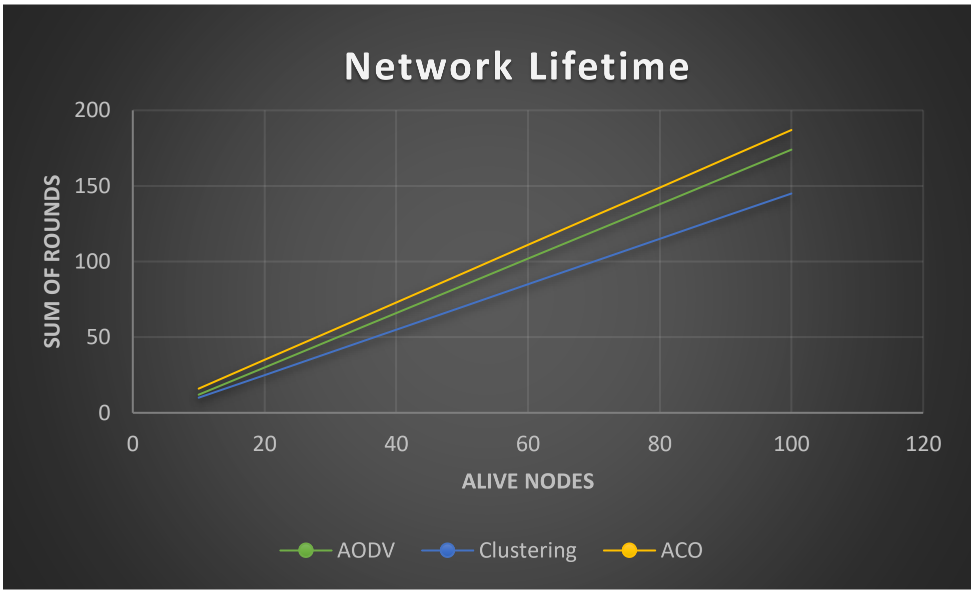

Figure 5. Comparative Analysis of Network Lifetime.

From Figure 5, it is observed that after 1200 rounds, no alive nodes are present in the Clustering method. But at the same time period, 15 and 30 numbers of nodes are alive in AODV and life time aware routing protocols, respectively. Due to the effective design of life time aware routing ACO, the energy consumed by the nodes is minimized considerably. Therefore, the nodes involved in the data transfer are alive for a longer period which in turn prolongs the network lifetime significantly.

Optimizing life time aware routing of nodes in WSN targets the issues of network coverage problem. It includes sleep scheduling, modified clustering algorithm, and multi-hop communication methods. In scheduling algorithm, less than 50% nodes are considered for active process and others are kept in sleep or silent mode to reduce ideal mode energy loss. Modified clustering algorithm considers the round robin method for selection of CHs and it includes the residual energy of the node and distance from base to the node. These considerations improve the performance of the network lifetime by 15% and the improvement in packet loss by 10% in spite of 10% increment in the Control Overhead.`

6 Conclusion

The uneven clusters and multi-hopp mode of communication suggest an energy dependent routing protocol to increase the service life of the network. It is difficult to sustain a network with a large number of node improvements. The proposed work decreases the nodes early dead and raises the nodes life time by the inclusion of residual energy, node distance to basis and life-long conscious routing of the ACO algorithm. Every node's increased life contributes to improved network life. The result has increased energy consumption by 10% and residual energy by 15% and the proposed device performance by 15% and PDR by 15 percent. Energy utilization and energy residual improvement was shown to increase the life span of each node and improve the grid.

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