International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
ISSN: 2457-0362

Maximizing Network Lifetime for WSNs using ACO Algorithm

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Abstract Wireless sensor networks (WSNs) are capable of performing both monitoring and communication tasks simultaneously. As a result of its inexpensive cost and broad variety of applications, WSNs have piqued the interest of many researchers. A wireless sensor network (WSN) is a distributed system that uses several tiny sensor nodes that are placed in different contexts to detect the real world. WSNs have a wide range of applications in real-time monitoring, including combat field surveillance, environmental monitoring, personal health monitoring, and other similar functions. The most difficult difficulty in wireless sensor networks (WSNs) is minimising power consumption while increasing network longevity.

Index Terms— Ant colony Optimization (ACO) algorithm, Energy efficiency.

I. INTRODUCTION

WSNs are one of the most demanding fields in today's electrical industry, and they have a long history of success. Among the characteristics required of these networks are their sovereignty, low-power challenge, context awareness, and adaptability [1]. A final application may have a greater number of sensor nodes that are dispersed across an area [2], making the distribution and support of WSNs a difficult challenge to solve. The purpose of a WSN is to provide users with access to information of interest generated from data collected by geographically dispersed sensors in real time. The energy required by the sensor nodes is often provided by a battery with a limited amount of capacity. Lower energy usage and network longevity are critical to the widespread use of WSNs for a variety of applications. In order to evaluate a WSN, one of the most important criteria to consider is the network lifespan [3], which is defined as the amount of time during which the network meets the needs of the application. Because the vast majority of wireless sensor networks (WSNs) are powered by nonrenewable batteries, the study of how to extend the network's lifespan has emerged as one of the most significant and problematic challenges in WSNs. In a WSN with a high density of nodes [4], a fraction of the nodes is already capable of addressing the coverage and connectivity problems.

For energy conservation purposes, the remaining nodes can be switched to a sleep state. As a result, the lifetime of a WSN can be extended by carefully scheduling the active intervals of nodes. At every point during the network lifetime, the active nodes must form a connected cover in order to provide sensing coverage and network connectivity. Nodes in a WSN are responsible for both monitoring and communication tasks. The monitoring job necessitates the use of nodes that provide sufficient sensing coverage to the target. It is necessary for nodes to establish a linked network in order to gather and distribute information through radio emissions in order to complete the communication job. Due to the fact that each linked cover must provide both sensor coverage and network connection at the same time, determining the maximum number of connected covers is a challenging challenge to solve. In this study, a common kind of distinct wireless sensor networks (WSNs) is explored, and an unique activity planning strategy for reducing power consumption and extending the network lifespan is presented for consideration. The method may be used in both discrete point coverage and area coverage scenarios. We concentrate on the coverage of a certain region; the WSNs under consideration are composed of two kinds of nodes: sensors and sinks. The sensors continuously monitor the target and relay the results of their monitoring to the sinks. The sinks are responsible for relaying monitoring findings to the destination. As a result, a linked cover in the WSNs must meet the three requirements listed below: The sensors provide total coverage of the item in question. All of the monitoring data acquired by the sensors are transferred to the sinks, and the sinks collectively form a wireless network that is linked to the sensors. Due to the fact that the second restriction includes both sensors and sinks, these three constraints interact with one another. Thus, finding the maximum number of connected covers is more difficult to solve than either the problem of maximising the number of sensor subsets under the coverage constraint or the problem of maximising the number of sink subsets under the connectivity constraint, which are both more difficult problems. Anti-social construction procedures (ants) are stochastic constructive processes that generate solutions while walking on a construction graph in ACO. Because of its advantageous search behaviour, ACO is well-suited for the solution of combinatorial optimization problems. Apart from that, ACO makes use of previous search experiences and domain expertise to expedite the search process. ACO algorithms have been successfully used to a variety of industrial and scientific challenges with varying degrees of effectiveness. ACO-based routing algorithms were suggested in this research, which may be utilised to improve the power efficiency of unicasting [5, transmission [6, 7], and data collecting [8] applications. Specifically, the ACO algorithms that are focused on the routing challenges in WSNs, in order to maximise the lifespan of WSNs by determining the largest number of linked covers, are used.

II. RELATED WORK

It is structured by a large number of sensor nodes that communicate with one another over a wireless connection. Given that sensor nodes are often powered by batteries, determining how to effectively and sensibly manage energy to prolong the network lifespan as much as feasible has emerged as one of the most pressing challenges in sensor networks [9. It is necessary to have effective network routing to provide efficient communication in a network, which is why the WSNs routing algorithm has emerged as a major research hotspot in the field of WSNs. This protocol, called LEACH (Low- Energy Adaptive Clustering Hierarchy) [10], is an application-specific data distribution protocol that makes advantage of clustering to extend the network lifespan. When picking a cluster head (CH), however, the algorithm does not take the residual energy of each node into consideration, which results in lower-energy nodes being picked as CHs. Additionally, all of the CHs interact directly with the base station, which causes nodes to die prematurely. In [11], a fully distributed clustering (HEED) method has been suggested, with the algorithm selecting some candidates' CH based on the residual energy of the node and then selecting the final CH based on the level of the cost of cluster communication. This approach, however, necessitates the transmission of several messages with each iteration in the cluster radius, resulting in high communication expenditure. [12] proposes a distributed routing system for data aggregation that is based on the ANT algorithm and is implemented in Java. The primary concept behind the algorithm is that it makes use of artificial agents, sometimes known as "ants," to determine the most efficient route to the destination node, and that it makes use of the positive feedback effect of the ANT algorithm to fulfil its data gathering goal. However, the method is unable to resolve the problem of energy load balancing in the network. In [13], the authors suggested ACRA, which, by changing the Ant Colony Optimization algorithm, might improve performance (ACO). Energy consumption and delay have both decreased as a result of the use of the primary path and alternate path; however, because the ants only consider the impact of pheromone when finding paths, the ants' coverage to the optimal solution that results from congestion and makes the energy consumption relatively concentrated. In [14], the authors presented PARA, which incorporates the energy level and transmission distance into the pheromone increment formula in order to make it more suitable for usage in WSNs. The algorithm, on the other hand, does not take into account the problem of energy stabilisation over the whole network. Because the CH is close to the base station, it is required to relay a large amount of data from other CHs, which is too heavy and causes the node to fail prematurely. We present a unique uneven clustering routing method for wireless sensor networks based on the ant colony algorithm (ACA) and clustering routing algorithm in wireless sensor networks, which is based on the ant colony algorithm (ACA) and clustering routing algorithm in wireless sensor networks.

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III. SIMULATION RESULTS

Figure 1 depicted a comparison of the simulation for the average energy consumption of the node with the rounds between LEACH, PAPA, and our method, with the results of the simulation for the average energy consumption of the node. The total energy consumed by 200 nodes is 100J, and the nodes are all killed at 1150 rounds in LEACH, which consumes 100J of energy, PARA consumes 80J of energy, and our algorithm consumes 55J of energy, which reduces 45J of energy, resulting in significantly improved network performance and more evenly distributed energy consumption across all nodes in the network.

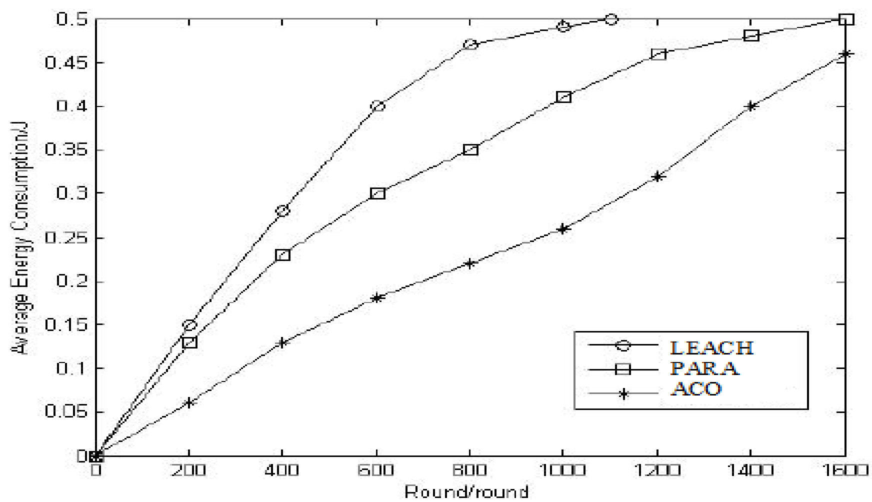

Figure 1. Average Energy Consumption

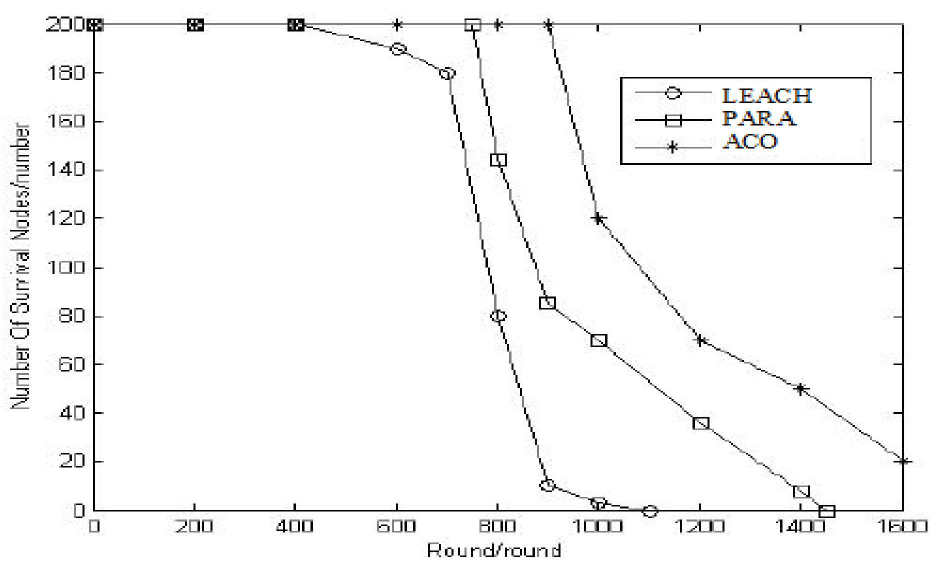

Figure 2. The Survival Rate of Node

IV. CONCLUSION

In this study, we provide an ACO method for wireless sensor networks that is based on homogeneous clustering and is designed to reduce energy while also maximising network longevity. By ensuring that nodes in the clusters are distributed uniformly, the lifespan of the network is extended. The remaining energy of existing cluster heads, the holdback value, and the closest hop distance of the node are used to determine which node will become the next cluster head. The homogenous approach ensures that every node in the wireless sensor network is either a cluster leader or a member of one of the clusters that have been established. The suggested clustering ACO method ensures that cluster members are consistently dispersed across the network, allowing the network's life to be prolonged. Furthermore, in the proposed protocol, only cluster chiefs broadcast the cluster creation message, rather than every node in the cluster. As a result, it helps to extend the lifespan of sensor networks. Because battery power is one of the most limited resources available to sensors, energy efficiency is one of the most significant difficulties in the design of protocols for WSNs. With the protocol design, the ultimate goal is to keep the sensors operational for as long as possible, thereby extending the network's useful life span.

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